

Destination – Cross-sectoral solutions for the climate transition

This Destination covers thematic areas which are cross-cutting by nature and can provide key solutions for climate, energy and mobility applications. In line with the scope of cluster 5 such areas are batteries, hydrogen⁸⁸, communities and cities⁸⁹, early-stage breakthrough technologies as well as citizen engagement⁹⁰. Although these areas are very distinct in terms of challenges, stakeholder communities and expected impacts, they have their cross-cutting nature as a unifying feature and are therefore grouped, if not addressed in other places of this work programme, under this Destination.

This Destination contributes to the following Strategic Plan's **Key Strategic Orientations (KSO)**:

- *C: Making Europe the first digitally enabled circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems;*
- *A: Promoting an open strategic autonomy⁹¹ by leading the development of key digital, enabling and emerging technologies, sectors and value chains to accelerate and steer the digital and green transitions through human-centred technologies and innovations;*
- *D: Creating a more resilient, inclusive and democratic European society, prepared and responsive to threats and disasters, addressing inequalities and providing high-quality health care, and empowering all citizens to act in the green and digital transitions.*

It covers the following **impact areas**:

- Industrial leadership in key and emerging technologies that work for people
- Affordable and clean energy
- Smart and sustainable transport

The **expected impact**, in line with the Strategic Plan, is to contribute to the “*Clean and sustainable transition of the energy and transport sectors towards climate neutrality facilitated by innovative cross-cutting solutions*”, notably through:

- Nurturing a world-class European research and innovation eco-system on **batteries** along the value chain based on sustainable pathways. It includes improvement of technological performance to increase application user attractiveness (in particular in

⁸⁸ The bulk of activities are supported by the Institutional Partnership ‘Clean Hydrogen’.

⁸⁹ Communities and cities are mainly supported under the Mission on Climate-Neutral and Smart Cities, and through the co-funded Partnership ‘Driving Urban Transition’, implemented in this work programme as a grant to identified beneficiary.

⁹⁰ Citizens engagement as well as social sciences and humanities are mainstreamed across multiple topics across various Destinations in this work programme.

⁹¹ ‘Open strategic autonomy’ refers to the term ‘strategic autonomy while preserving an open economy’, as reflected in the conclusions of the European Council 1 – 2 October 2020.

terms of safety, cost, user convenience, fast charging and environmental footprint), in parallel supporting the creation of a competitive, circular, and sustainable European battery manufacturing value chain (more detailed information below).

- Nurturing the development of **emerging technologies** with high potential to enable zero-greenhouse gas and negative emissions in energy and transport (more detailed information below).

A competitive and sustainable European battery value chain

Batteries will enable the rollout of zero-emission mobility and renewable energy storage, contributing to the European Green Deal and supporting the UN SDGs by creating a vibrant, responsible and sustainable market. Besides climate neutrality, batteries also contribute to other UN SDGs directly and indirectly such as enabling of decentralized and off-grid energy solutions.

The strategic pathway is, on the one hand, for Europe to rapidly regain technological competitiveness in order to capture a significant market share of the new and fast-growing rechargeable battery market, and, on the other hand, to invest in longer term research on future battery technologies to establish Europe's long term technological leadership and industrial competitiveness

The Partnership “Towards a competitive European industrial battery value chain for stationary applications and e-mobility”, with as short name Batt4EU, to which all battery-related topics under this Destination will contribute, aims to establish world-leading sustainable and circular European battery value chain to drive transformation towards a carbon-neutral society.

The main impacts to be generated by topics targeting the battery value chain under this Destination are:

- Increased global competitiveness of the European battery ecosystem through generated knowledge and leading-edge technologies in battery materials, cell design, manufacturing and recycling.
- Significant contribution to the policy needs of the European Green Deal through new solutions for circularity and recycling of batteries.
- Accelerated growth of innovative, competitive and sustainable battery manufacturing industry in Europe.
- Development of sustainable and safe technologies and systems for decarbonisation of transport and stationary applications.
- Contributing to the strategic independence of Europe through investigation of alternative battery chemistries using non-critical raw materials and efficient recycling technologies.
- Increasing synergies with other partnerships and initiatives.

Emerging breakthrough technologies and climate solutions

Although the contribution of a wide range of technologies to reach climate neutrality is already foreseeable, EU R&I programming should also leave room for emerging and breakthrough technologies with a high potential to achieve climate neutrality. These technologies can play a significant role in reaching the EU's goal to become climate neutral by 2050.

Relevant topics supported under this Destination complement the activities supported under Pillars I or III. They address emerging technologies that can enable the climate transition with a technology-neutral bottom-up approach. Research in this area is mostly technological in nature but should also, where relevant, be accompanied by assessments of environmental, social and economic impacts, by identification of regulatory needs, and by activities supporting the creation of value chains to build up new ecosystems of stakeholders working on breakthrough technologies.

The main expected impacts to be generated by the topic targeting breakthrough technologies and climate solutions under this Destination are:

- Emergence of unanticipated technologies enabling emerging zero-greenhouse gas and negative emissions in energy and transport;
- Development of high-risk/high return technologies to enable a transition to a net greenhouse gas neutral European economy.

The following call(s) in this work programme contribute to this destination:

Call	Budgets (EUR million)		Deadline(s)
	2023	2024	
HORIZON-CL5-2023-D2-01	111.70	16.30	18 Apr 2023
HORIZON-CL5-2023-D2-02	42.00		05 Sep 2023
HORIZON-CL5-2024-D2-01		72.00	18 Apr 2024
HORIZON-CL5-2024-D2-02		39.00	05 Sep 2024
Overall indicative budget	153.70	127.30	

Call - Cross-sectoral solutions for the climate transition

HORIZON-CL5-2023-D2-01

Conditions for the Call

Indicative budget(s)⁹²

Topics	Type of Action	Budgets (EUR million)		Expected EU contribution per project (EUR million) ⁹³	Indicative number of projects expected to be funded
		2023	2024		
Opening: 13 Dec 2022 Deadline(s): 18 Apr 2023					
HORIZON-CL5-2023-D2-01-01	RIA	21.00 ⁹⁴		Around 7.00	3
HORIZON-CL5-2023-D2-01-02	RIA	15.00 ⁹⁵		Around 5.00	3
HORIZON-CL5-2023-D2-01-03	RIA	14.00 ⁹⁶		Around 7.00	2
HORIZON-CL5-2023-D2-01-04	IA	15.00 ⁹⁷		Around 7.50	2
HORIZON-CL5-2023-D2-01-05	IA	12.00 ⁹⁸		Around 6.00	2
HORIZON-CL5-2023-D2-01-06	IA	10.00		Around 10.00	1

⁹² The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.

The Director-General responsible may delay the deadline(s) by up to two months.

All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

⁹³ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

⁹⁴ Of which EUR 11.02 million from the 'NGEU' Fund Source.

⁹⁵ Of which EUR 7.50 million from the 'NGEU' Fund Source.

⁹⁶ Of which EUR 7.00 million from the 'NGEU' Fund Source.

⁹⁷ Of which EUR 7.50 million from the 'NGEU' Fund Source.

⁹⁸ Of which EUR 6.00 million from the 'NGEU' Fund Source.

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HORIZON-CL5-2023-D2-01-07	CSA	4.00 100101		Around 1.00	4
HORIZON-CL5-2023-D2-01-08	COFUND	20.70	16.30	Around 37.00	1
Overall indicative budget		111.70	16.30		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

A competitive and sustainable European battery value chain

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D2-01-01: Technologies for sustainable, cost-efficient and low carbon footprint downstream processing & production of battery-grade materials (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately.

⁹⁹ Of which EUR 5.00 million from the 'Digital, Industry and Space' budget.

¹⁰⁰ Of which EUR 2.00 million from the 'Digital, Industry and Space' budget.

¹⁰¹ Of which EUR 1.00 million from the 'NGEU' Fund Source.

<i>project</i>	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 21.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependency on third countries for critical raw materials by promoting resource efficiency.
- Increased European competitiveness by offering sustainable, safe, energy efficient and low carbon, water and biodiversity footprint battery materials production technologies and scalable solutions and by creating new business opportunities and circular models for European industry.
- Battery-grade intermediates which are developed, produced and refined/purified in a sustainable and socially acceptable way, improving the competitiveness and value of European battery and mobility industries.
- Proven technical feasibility of downstream processing for battery-grade materials at larger scale, considering economic feasibility, safety, health and regulatory targets.
- A stronger European battery manufacturing industry, through the implementation of continuous processes related conditions at larger scale with reduced carbon emissions, increased energy efficiency and more efficient resources use; (e.g. combining secondary materials into existing primary processing).
- Use of European post-mining (or post-extraction, in the case of e.g. geothermal fluids) primary materials and secondary material sources such as tailings (e.g., as a source of nickel, cobalt and lithium) or underutilised battery raw materials deposits and extend the local refining capacity of battery-grade materials, to reduce the dependency on imported materials and to limit supply risks.

Scope: Proposals are expected to cover research and innovation activities with focus on improved battery metal and material production, refining and recovery while minimizing environmental impact of downstream processing by addressing all of the following points:

- Developing sustainable and cost-efficient processing methods for battery-grade materials and components, coming from either primary or secondary streams and novel technologies for battery metals processing enabling the reduction of carbon footprint and other emissions while increasing energy and resource efficiency; enabling thereby vertical integration into the battery production.
- Developing and demonstrating technologies to improve battery grade metals and materials production, refining and/or recycling with efficient and stable reagent circulation, targeting low use chemical and reducing environmental impacts from such processes while improving recovery rate/grade and yield considering the SRIA objectives and KPIs, the Green Deal objectives and the proposed Batteries Regulation¹⁰² where relevant.
- Addressing zero waste and zero discharge strategies for the valorisation of the generated waste materials during the refining processes by: improving the reuse of waste where CRM are present; Increasing the sustainability of batteries materials by reducing the use of chemicals and energy use in the downstream processing considering the objectives of the proposed Batteries Regulation as evaluated by LCA or similar approaches; using safe and low impact disposal methodologies for those materials that cannot be recycled.
- Pre-assessing recycling concepts by their life cycle sustainability and safety impacts (in line with Safe and Sustainable by Design Framework¹⁰³ to be set by the Commission for assessing safety and sustainability of chemicals and materials and which should be considered as a reference in the proposal) and studying overall techno-economical solutions for recovery systems in order to minimize cost, environmental impact and system losses.
- Addressing understanding of physico-chemical mechanisms for more sustainable hydrometallurgical steps in order to propose significant processes' improvements to reduce significantly water effluents quantities and chemical reagents.
- Implementing of continuous process for cathode active materials and precursors synthesis related conditions at larger scale.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the

¹⁰² COM(2020) 798 final, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

¹⁰³ See documents defining the SSbD framework and criteria on: https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-materials-and-chemicals_en

introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Proposals should indicate to which chapters of the Strategic Research and Innovation Plan for chemicals and materials¹⁰⁴ they will contribute.

Projects may collaborate and/or contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08.

International cooperation with Africa, the Mediterranean Region, and the United States is encouraged.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-01-02: New processes for upcoming recycling feeds (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used). The Joint Research Centre (JRC) may participate as member of the consortium selected for funding.
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

¹⁰⁴ https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-materials-and-chemicals_en

- A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependencies for critical raw materials by promoting a circular economy.
- The development of recycling technologies targeting upcoming recycling feeds and producing high quality precursors, semi-products and battery materials enabling their use in the battery production and other production processes.
- Achievement of the recycling efficiency and material recovery targets as described in the proposed Batteries Regulation¹⁰⁵ by industries, especially for low metal and low material value components.
- Recycling chains with a cost-effective process in comparison with primary materials.
- Safeguarding of the sustainability, low CO2 footprint, low chemicals usage and minimal emissions of newly developed recycling processes.

Scope: Proposals should focus on improved and verified circularity of collected, dismantled and pre-treated battery waste feeds (Strong interaction with call “Advanced sustainable and safe pre-processing technologies for End-of-Life batteries recycling (2024)” is encouraged). All recycling concepts should address waste stream(s) in question in a comprehensive manner, aiming at the maximal recovery of input elements and components, rather than selected fractions. Focus on all concepts should be kept on recycling process development considering specific areas of improvement for each of the possible processes of battery recycling; a maximised material recovery and recycling efficiency, operational energy efficiency, less waste water, mass- and energy balance, purity of the recycled material and verified holistically decreased carbon footprint supported by life cycle assessment. Battery development is out of the scope, interaction with other projects is, however, encouraged.

The following issues should be addressed:

- New recycling concepts targeting the recycling of economically low value materials, (e.g. from Lithium-iron phosphate or sodium-ion ...) are expected to be covered. To enable recycling of low value battery compositions, new recycling concepts should be developed, including direct recycling routes that may include selective material recovery technologies and the reconditioning of the active materials. The additional recovery and recycling of non-cathode component materials are encouraged.
- Highly efficient recycling of battery manufacturing scrap, whether emanating from lab-scale or large production, are expected to be covered, for example including direct recycling concepts to re-introduce the materials in the battery production chain, including the handling and processing of relevant semi-material.

In addition, at least one of the following issues are expected to be addressed:

¹⁰⁵ COM(2020) 798 final, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

- Highly robust or flexible processes for the recycling of material streams of varying composition and quality may be covered.
- Material feeds from other industries (e.g. Ni/Co rich materials) may be introduced into the recycling concepts.
- Material feeds from future battery technologies with an expected market introduction no later than 2025 may be included.
- The processing of side streams (e.g. waste waters and other waste products) may be targeted.

All proposed recycling concepts are expected to be pre-assessed for their economical, ecological and safety impact.

This topic is building upon the BATTERY 2030+ Roadmap (<https://battery2030.eu/research/roadmap/>). Projects are expected to collaborate and contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08. The proposal is expected to cover the contribution and collaboration to the Coordination and Support Action.

Proposals are encouraged to establish links with those submitted under topic HORIZON-CL5-2024-D2-01-01, “Advanced sustainable and safe pre-processing technologies for End-of-life (EOL) battery recycling”.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Proposals should indicate to which chapters of the Strategic Research and Innovation Plan for chemicals and materials¹⁰⁶ they will contribute.

Proposals could consider the involvement of the European Commission's Joint Research Centre (JRC) whose contribution could consist of providing added value regarding various aspects of battery sustainability.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-01-03: Advanced digital twins for battery cell production lines (Batt4EU Partnership)

Specific conditions

¹⁰⁶ https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-materials-and-chemicals_en

<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 14.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- The understanding of digital twins as systems with automated data acquisition, connected digital models and value-adding applications.
- The capacity to go beyond single process consideration with potential perspective on the process chain.
- The implementation and the transfer of digital twins into existing and future battery cell production plants.
- Safety and security, scalability, explainability, computational speed as well as contributions to sustainability of battery cell production.
- Optimise product quality, improving the resource efficiency and, consequently, the production time and cost of battery cells in the manufacturing process at the targeted scale.

Scope: The battery production chain consists of diverse multi-disciplinary, rather novel processes with numerous influencing factors and interdependencies. Digital twins, as a core element of the accelerating digitisation in manufacturing, bear the potential to improve planning and operation of current and future battery production system. With their connection of advanced digital models and most up-to-date data, decision support or even autonomous control of battery production processes and process chains is enabled. First applications can be found in research and partly also in industrial practice – however, those still tend to be rather specific, covering just selected aspects of digital twins (e.g. just specific models) and are often hardly transferable between production stages and between different battery

configurations in terms of the underlying IT architectures and models. Proposals are expected to address all following points:

1. Developing digital twins of battery cell manufacturing routes at pilot line level that incorporate appropriate models but also their connection to real manufacturing plants, e.g. to support process development and operation, battery cells optimisation, accelerate the set-up of effective manufacturing processes for the next generation battery cells or to demonstrate the capability for predictive maintenance.
2. Design robust digital tools integrating multi-physics, data-driven models and hybrid modelling.
3. Flexible Digital Twins capable to evolve to different battery chemistries, new disruptive materials as well as new manufacturing processes (the model would be chemistry neutral so easily adaptable to new disruptive materials and chemistries).
4. Verify the transferability from pilot to production plant level.
5. Propose applications that will enable to overcome single process considerations towards process chain perspectives.
6. Implementation of the sensorisation of the manufacturing plant and automatisisation of the data acquisition.
7. Ensuring greater interoperability, by implementing available data standards¹⁰⁷, e. g., Modelling-Data (MODA) and Characterisation Data (CHADA), as well as, a common semantic framework, like The European Materials Modelling Ontology (EMMO) and the battery interface ontology (BattINFO).
8. Promote the control and decision making of the manufacturing chain.
9. Aspects like safety and security, explainability of models as well as contributions to sustainability of battery production will be addressed.

This call topic addresses the need of increasing the level of autonomy to the whole battery cell value chain (with special emphasis in the manufacturing). Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

This topic is building upon the BATTERY 2030+ Roadmap¹⁰⁸ and will build upon the shared data infrastructure, standards and protocols developed within this initiative, and in particular the BIG-MAP¹⁰⁹ project. Projects are expected to collaborate and contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-

¹⁰⁷ See <https://emmc.eu>

¹⁰⁸ <https://battery2030.eu/research/roadmap/>

¹⁰⁹ <https://www.big-map.eu/>

01-08. The proposal will cover the contribution and collaboration to the Coordination and Support Action.”

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-01-04: Battery management system (BMS) and battery system design for stationary energy storage systems (ESS) to improve interoperability and facilitate the integration of second life batteries (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>The Joint Research Centre (JRC) may participate as member of the consortium selected for funding.</p>
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.</p> <p>Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the</p>

	Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹¹⁰ .
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Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- Battery pack and Battery Management System (BMS) design for single module operation or recombination (reconfiguration) of modules or battery packs for consolidated and new battery technologies.
- Safe, accessible and reliable operation of batteries and compatible with the battery passport concept.
- Battery system design to enable disassembly and reconfiguration for second life.
- Development of fast and efficient qualification strategies and assessment of Electric Vehicle (EV) batteries for second life applications and quantify it with respect to state of the art in terms of time and efficiency.
- Reduction of 30% of repurposing/refurbishment cost for adapting EV batteries to stationary applications in second life.
- Environmental impact assessment, from both positive and negative aspects, for adapting EV batteries to second life applications.
- Impact in the European economy by a growth of the market and employment, by facilitating the uptake of stationary ESS Feasibility of operation in the batteries extended life domain (second life).

Scope: This topic aims at developing an open and interoperable BMS and suitable battery system design for stationary ESS, enabling a better integration of second life applications for used batteries. To strengthen European battery production ecosystem, projects are encouraged to implement batteries produced in Europe, especially with respect to 1st life batteries, at large or pilot plant scale.

In order to fulfil these objectives, activity in all of the following fields is expected:

- The BMS could be used for first and second life batteries in stationary applications, e.g., microgrids, uninterrupted power supply, hybrid (different types of chemistries and batteries, multi-battery management systems) and circular power system, ensuring safety during operation.
- The BMS and system design should be technology agnostic and not exclusive to second life EV batteries and should ideally cover consolidated technologies as well as new

¹¹⁰ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

battery technologies. Pending amendments to Renewable energy directive to be taken into account regarding BMS development.

- Development and validation of open-source algorithms and BMS, allowing for the integration of second life batteries including approaches as semi-empirical, data-driven, and multi-physics supported battery state estimators. Recommendations for the development of standards related to the battery state defining parameters, e.g., State of Health and safety assessment at the end of first life applications.
- Development of BMS software that can be adapted via firmware update to other communication protocols, estimation algorithms and models.
- Development of functionalities focused on increasing the reliability during the second life application, e.g., prediction of remaining useful life, self-diagnostic algorithm for assessment of second life use suitability and BMS connectivity to track batteries during second life application.
- Recommendation to standardisation of a BMS public structure and access to public SOX in order to ease the second use of a battery. The goal is expected to lead to an agreement of a minimum set of data requirements, duly justified, to be provided by the batteries and let the industry define the best procedure to provide this set of data and link up with battery passport concept.
- Development and demonstration of strategies to recombine optimally and safely used batteries to be operated in second life, with special focus on advanced critical event control and mitigation systems. Recommendations for standardisation of second life battery system design for stationary applications based on packs, type of chemistry and cell.
- Design of accessible and adaptable BMS in order to customize the BMS to the requirements of the second life use case, including improved battery models for improved BMS design.
- Demonstration of battery operation in second life use according to TRL6.
- Projects are expected to share information with projects emanating from topic HORIZON-CL5-2023-D2-02-03 where relevant and conform to all relevant EU standardisation requirements.
- The proposal should take into account pending amendments to the Renewable Energy Directive, including Article 20A dealing with access to battery SOX information.
- Proposals are expected to establish links with the results of the following topics - HORIZON-CL5-2022-D2-01-09: Physics and data-based battery management for optimised battery utilisation (Batteries Partnership), HORIZON-CL5-2022-D2-01-10: Streamlined collection and reversed logistics, fully automated, safe and cost-efficient sorting, dismantling and second use before recycling (Batteries Partnership) and

HORIZON-CL5-2022-D2-01-05: Next generation technologies for High-performance and safe-by-design battery systems for transport and mobile applications (Batteries Partnership), [LC-SC3-ES-6-2019 - Research on advanced tools and technological development](#). They should specifically address BMS and system design issues that affect stationary Energy Storage Systems (ESS) and in particular, the integration of used batteries as a second life application.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Proposals could consider the involvement of the European Commission's Joint Research Centre (JRC) whose contribution could consist of performing experimental or desk-top research on battery performance or safety.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-01-05: Hybrid electric energy storage solutions for grid support and charging infrastructure (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to all the following outcomes:

- Demonstration of hybrid energy storage technologies for long duration storage (from at least 12 hours to days) and provision of multiple grid services with improved technical performances (increased power and energy density with respect to single electrical energy storage system +20%, reduced storage system losses -10%, improved HESS cycle life +15%, improved reliability and availability +15%), sustainability, as well as increased safety during operation, transport and storage.
- Enable improved levelized cost of storage supported by design optimisation and optimal service stacking, putting the cost of storage on the path to fall below 0.05 €/kWh/cycle by 2030 (for storage durations > 12 hours) while reducing the use of critical raw materials (CRMs).
- Creating synergies between producers and strengthening the European Battery Ecosystem, improving the European battery value chain and thus contributing to the EU climate neutrality objectives.
- Increasing digitalisation of energy storage systems from design to operation phase enabling a faster development and optimal use in grid applications.
- The establishment of multi-service approaches to energy storage reducing costs and increasing benefits for the European electricity system.
- Promoting an increased reliability and resilience of the electricity system by demonstrating new multi-purpose energy storage solutions.

Scope: The objective is to design and demonstrate in at least three different use cases a Hybrid Energy Storage System (HESS) capable of long duration storage and provision of multiple services for supporting the electrical grid and EV charging infrastructure.

In particular, proposals are expected to:

- Design and demonstrate a sustainable and safe HESS either combining different battery technologies, including next-gen technologies, or combining batteries and other electrostatic/electrochemical storage technologies (e.g., supercapacitors) aiming at providing long duration storage while ensuring the possibility of service-stacking and enabling ultra-fast services. Use of second life battery modules is within the scope. The proposed storage solution should be scalable and modular and show clear innovation with respect to the state of the art (new materials or new designs), always bearing in mind the objectives of sustainability and performance. Proper power conversion devices should be selected or customized for enabling an efficient operation of the hybrid storage in grid-connected, grid-following and grid-forming modes.
- Perform a life cycle assessment of the HESS starting from the design phases to ensure its sustainability along the entire value chain, also avoiding, whenever possible, or limiting the use of CRMs.

- Develop physics-based and data-driven digital models of HESS supporting optimal design, and real-time management and diagnosis as well as facilitating the inclusion of storage in grid-planning processes considering forecasted weather conditions, production and consumption. Models should allow the combination of different battery technologies based on specific use cases.
- Develop and validate management policies and control systems (battery management systems and energy management systems) for HESS that maximise the benefits of a hybrid storage, facilitate asset management and participation in electricity and service markets. Pending amendments to the Renewable Energy Directive to be taken into account in development of the BMS.
- Demonstrate HESS usage in at least three different use cases in collaboration with relevant stakeholders (e.g., DSO, EV charging infrastructure owners) and its integration in standard grid architectures (Smart Grids Architecture Model – SGAM) ensuring interoperability for most use cases of energy storage systems (e.g., provision of services to the European grid, supporting islanded and weak distribution grids, load levelling for charging stations).
- Analyse business cases of the proposed hybrid solution considering electricity and balancing markets of three representative EU Member States/Associated Countries, also assessing the applications where HESS provides improved techno-economic performances compared to non-hybridized storage systems.

Proposals are expected to establish links with projects funded under the following topic: HORIZON-CL5-2022-D3-01-10 - Interoperable solutions for flexibility services using distributed energy storage.

The selected projects are expected to contribute to the BRIDGE initiative¹¹¹, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

International cooperation with USA, Australia, Africa or India is encouraged.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

¹¹¹ <https://www.h2020-bridge.eu/>

Cross-cutting

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D2-01-06: Open Pilot Line/Test Bed for hydrogen

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Contribute to the goals of the European Hydrogen strategy to support the European Green Deal and progress towards climate neutrality by 2030.
- Provide services for testing innovative hydrogen production technology leading to technology upscaling, reducing cost, accelerating time to the market, and reducing investment risk.
- Contribute to the creation of an industrial ecosystem of green hydrogen production technology providers.

Scope: The Staff Working Document on hydrogen highlighting the EU R&I support for implementing the Green Deal hydrogen strategy and contributing to a roadmap of actions called for better synergies at European and national level as well as between European and Member States programmes and activities. A single-entry approach for testing hydrogen production technology was identified as the Open Innovation Test Bed (OITB).

Open Innovation Test Beds were first conceived in the Horizon 2020 work programme. They are entities, established in at least three Member States or Associated Countries, offering access to physical facilities, capabilities and services required for the development, testing and upscaling of technology in industrial environments. OITBs will upgrade existing or

support the setting of new public and private test beds, pilot lines, and demonstrators to develop, test and upscale technologies and services for new innovative products for specific technology domains.

The applicants are required to implement the set-up of an Open Innovation Test Bed (OITB) for hydrogen production technologies. The proposal should address the following:

- Provide services for testing of emerging hydrogen production technologies mentioned in the Agenda Process SRIA¹¹². It will cover all activities from the prototyping to industrial production, and especially the testing in an industrial environment, the validation of the characteristics H₂ production technologies and the control of the respect of legal and regulatory constraints.
- Provide a technology assessment base line for future developments of the technology being tested.
- Provide an assessment of the circularity of the technology being tested as well as potential domains for increasing its sustainability /Ensure that the innovations tested contribute to sustainability considering circularity in the design phase, less (or no) use of (critical) raw materials and decreasing negative environmental and social impacts.
- The OITB needs to be operational within the first six month of the start of the project.

Access to the OITB opened to all potential customers. Open access in this context means that any interested party, from Europe and globally, can access test beds' facilities and services independently whether they are part of the consortium or not. It is critical that any interested party from the EU or Associated Countries can access the test beds at fair conditions and pricing and with transparent and mutual obligations with regards to, for instance, security, safety and intellectual property rights.

It is expected that SMEs will have access the test beds at the same conditions as any other entity from the EU or Associated Countries. For SMEs as core targeted user group, the test beds will offer a range of services which are of specific interest to them, e.g. regulatory support and the development of innovative materials that SMEs frequently cannot afford on their own. Proposals should demonstrate a solid and measurable outreach strategy towards SMEs and innovators outside the consortium.

As OITB aims at providing a full service along all the steps of the technological development of a physical innovation, all needed expertise has to be provided to users through a Single-Entry Point (SEP). The SEP is a separate legal entity of which the legal structure is up to the partners involved; however, the consortium needs to come up with a convincing structure that shows its capacity to work together as well as ensure sustainability during the implementation of the grant. If necessary, each test bed will acquire complementary services from other

¹¹² <https://www.clean-hydrogen.europa.eu/system/files/2022-02/Clean%20Hydrogen%20JU%20SRIA%20-%20approved%20by%20GB%20-%20clean%20for%20publication%20%28ID%2013246486%29.pdf>

entities, for instance on characterisation and or modelling, in order to offer a full-service package to users.

The proposal needs to present a credible business plan aiming at future sustainability and operation of the OITB, included after the grant ends. It should set a framework for the definition of the access conditions to their facilities and services respecting transparency and fair access conditions.

Projects should collaborate with the Clean Hydrogen Joint Undertaking on aspects that require integration of hydrogen and are expected to contribute and participate to the activities of the TRUST database and the hydrogen observatory. Where applicable, proposals are expected to complete and/or extend the range of Open Innovation Test Beds that are existing or under development, including those funded under topic HORIZON-CL4-2022-RESILIENCE-01-20.

HORIZON-CL5-2023-D2-01-07: Support for the deployment of R&I results for climate mitigation. Synergies with the ETS Innovation Fund

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 1.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 4.00 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the

	Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹¹³ .
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Expected Outcome: Project outputs and results are expected to contribute to **all** of the following outcomes:

- Further developing the innovation pipeline from system demonstration to deployment stage for innovation in the EU and Associated Countries.
- Developing scientifically sound mature proposals for the deployment of technological solutions to reduce Greenhouse Gas emissions.
- Establishing synergies between different EU R&I funding programmes.
- Contribute to the REPowerEU plan, as well as the overall EU climate targets.

Scope: The aim of this topic is to promote and facilitate technologically, financially, and operationally mature projects from Horizon 2020 to reach deployment phase by means of developing synergies with other EU funding programmes, namely the ETS Innovation Fund.

The topic aims to support four separate coordination and support actions (CSA), each respectively focussing on **one** of the following areas:

- Low-carbon technologies in energy-intensive industries,
- Carbon capture, use and storage (CCUS)¹¹⁴.
- Renewable energy generation.
- Energy storage & hydrogen.

For each individual CSA, consortia should include partners from at least 3 different Horizon 2020 projects having developed mature technological innovations¹¹⁵ with high potential of deployment under IF^{116,117}. However, depending on the specific sector the consortium focuses on, and on the number of Horizon 2020 projects that have already reached an adequate stage of maturity, a higher number of Horizon 2020 projects represented per individual consortium is preferred.

¹¹³ This [decision](#) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

¹¹⁴ Proposals may include CCU, CCS or CCUS approaches.

¹¹⁵ In particular projects aiming at a high TRL level, e.g Horizon 2020 Innovation actions

¹¹⁶ https://ec.europa.eu/clima/eu-action/funding-climate-action/innovation-fund/large-scale-projects_en

¹¹⁷ https://ec.europa.eu/clima/eu-action/funding-climate-action/innovation-fund/small-scale-projects_en

Each CSA should produce as the final output a number¹¹⁸ of sound proposals¹¹⁹ (including detailed plans for scalability, commercialisation, and financial models) to be presented to the IF.

Consortia should mobilise (either through internal competences in the consortia or through outsourcing) the needed expertise for the preparation of sound proposals, keeping in mind the ETS IF evaluation criteria: 1) Project maturity, 2) GHG emissions avoidance potential, 3) Degree of innovation, 4) Degree of technical, financial, and operational synergies within the consortium.

Each proposal should also contribute to the development and operationalisation of a continuous innovation pipeline from Horizon 2020 innovations to deployment. For this, proposals should:

- Work in collaboration with key R&I organisations and industrial associations in their respective areas including Horizon Europe public-private partnerships such as Processes4Planet, Clean Steel, Clean Hydrogen Joint Undertaking, and Clean Energy Transition/Batt4EU.
- Devote sufficient resources to collaborate among the proposals selected in the different areas in particular to organise joint activities to promote the mobilisation of the financial and technical expertise needed for the elaboration of sound IF proposals.
- Organise joint open events within their specific area with key industrial stakeholders to share lessons learnt and to promote synergies between Horizon Europe and the IF (e.g. organising open key information dissemination workshops with a larger group of Horizon 2020 projects).
- Cooperate with IF to seek advice and give feedback on lessons learnt to EU innovation funding opportunities, and to prepare a written report detailing the process and achievements within the respective specific area.

Whilst the topic primarily focuses on supporting the project pipeline from Horizon 2020 to the Innovation Fund, the scope of this topic is not limited to the Innovation Fund, and the promotion of projects to deployment including other relevant funding means either at EU or national/regional levels (such as Regional & Cohesion funds, Recovery and Resilience Facility, Important Projects of Common European Interest) is also desirable.

Communities and Cities

Proposals are invited against the following topic(s):

¹¹⁸ The final number will be decided by the consortia depending on the specific sector and the number of mature projects funded by Horizon 2020.

¹¹⁹ Individual proposals for the IF will not be considered public deliverables to ensure full confidentiality.

HORIZON-CL5-2023-D2-01-08: Driving Urban Transition Co-funded Partnership

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 37.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 37.00 million.
<i>Type of Action</i>	Programme Co-fund Action
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>The proposal must be submitted by the coordinator of the consortium funded under HORIZON-CL5-2021-D2-01-16: Co-Funded Partnership: Driving Urban Transitions to a sustainable future (DUT). This eligibility condition is without prejudice to the possibility to include additional partners.</p>
<i>Procedure</i>	<p>The procedure is described in General Annex F. The following exceptions apply:</p> <p>The evaluation committee will be composed partially by representatives of EU institutions.</p> <p>If the outcome of amendment preparations is an award decision, the coordinator of the consortium funded under the grant agreement that was established in response to the call topic HORIZON-CL5-2021-D2-01-16 will be invited submit an amendment to the grant agreement, on behalf of the beneficiaries.</p>
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>This action is intended to be implemented in the form of an amendment of the grant agreement concluded pursuant to topic HORIZON-CL5-2021-D2-01-16.</p> <p>For the additional activities covered by this action:</p> <ul style="list-style-type: none"> • The funding rate is 30 % of the eligible costs. • Beneficiaries may provide financial support to third parties

	<p>(FSTP). The support to third parties can only be provided in the form of grants. Financial support provided by the participants to third parties is one of the primary activities of this action in order to be able to achieve its objectives. The EUR 60 000 threshold provided for in Article 204(a) of the Financial Regulation No 2018/1046 does not apply. The maximum amount of FSTP to be granted to an individual third party is EUR 5.000.000. This amount is justified since provision of FSTP is the primary activity of this action and it is based on the extensive experience under predecessors of this partnership.</p> <p>The starting date of the grant awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible (and will be reflected in the entry into force date of the amendment to the grant agreement).</p>
<i>Total indicative budget</i>	The total indicative budget for the co-funded European Partnership is EUR 130 million for the period 2021-2027.

Expected Outcome: This topic is for continuation of the Driving Urban Transition (DUT) co-funded partnership to enable it to roll out its full strategy and action plan and assist cities in their sustainability and climate neutrality transitions and by doing so enable the EU to achieve targets set out by the European Green Deal and fulfil its commitments related to the UN Agenda 2030, the Urban Agenda for the EU, the Habitat III New Urban Agenda and the Paris Agreement, European cities need to engage urgently in sustainability and climate-neutrality transitions.

The partnership is expected to contribute to all of the following expected outcomes:

- Enhanced multi-level cooperation and alignment on R&I on sustainable urban development across and within cities, regions and countries, including international outreach and cooperation with other networks and initiatives.
- Strengthen Europe as a role model for R&I on sustainable urban development.
- Innovative, cross-sectoral and inclusive urban governance, policy and decision-making harnessing the full potential of social science and citizens' engagement in the city making process.
- Sustainable, climate-neutral, safe, resilient, socially inclusive, liveable and attractive neighbourhoods, towns and cities with reduced environmental footprint and enhanced well-being and quality of life for citizens.

- Local authorities, municipalities, business, social partners, civil society, knowledge institutions and citizens empowered with necessary capacity, knowledge, skills and tools to actively engage in sustainability and climate-neutrality transitions.
- Science and evidence-based implementation of the European Green Deal, the Urban Agenda for the EU and other European, national, regional and local urban-relevant policies and strategies.

Scope: The objective of this action is to continue to provide support to the European “Driving Urban Transition” Co-funded Partnership identified in the Horizon Europe Strategic Plan 2021-2024 and first implemented under the topic HORIZON-CL5-2021-D2-01-16: Co-Funded Partnership: Driving Urban Transitions (DUT), and in particular to fund additional activities (which may also be undertaken by additional partners) in view of its intended scope and duration, and in accordance with Article 24(2) of the Horizon Europe Regulation.

The proposal should capitalise upon new collaboration opportunities offered by the Association Agreements to Horizon Europe, the “Climate neutral and smart cities” mission and the global Urban Transitions Mission (UTM) mission of Mission Innovation to enhance its expertise, capacities, critical mass and broaden its geographical coverage and outreach capacity. With respect to the latter, mutually benefitting international outreach, collaboration and cooperation with global and international cities and research funding networks should be pursued to align strategies and research agenda and promote scientific evidence and good practice for urban policy on international level.

Taking into account that the present action is a continuation of the topic HORIZON-CL5-2021-D2-01-16 and foresees an amendment to an existing grant agreement, the proposal should describe plans, activities and initiatives that would enable the DUT to ensure, as appropriate, a seamless pursuance of its strategy, objectives and actions to fill important gaps in knowledge, evidence, innovation, technology, data, capacity and skills, integrated approaches, foster inclusive and participatory governance structures and assist cities at European (and, as appropriate, global level) in designing and implementing their sustainability and climate neutrality transitions.

It should, in particular, describe in detail the additional activities (including additional partners) to be covered by the award, and justify their necessity and added value as compared to currently undertaken ones, whilst accounting for the state-of-progress and the evolution in relevant EU and international policy frameworks and urban initiatives. The proposed additional activities (including additional partners) to be covered by the award should also be presented in a separate document in terms of how they would be reflected in the existing grant agreement.

The proposal should elaborate on modalities to scale-up synergies with the works of the NetZeroCities mission platform and relevant projects such as the CapaCITIES networks, the CRAFT platform, the looming Global Knowledge Exchange Centre and, as appropriate, with the missions supporting TRAMI project, to underpin the implementation of the “Climate

neutral and smart cities” mission and ensure coherence and complementarity of activities and leverage of knowledge and investment possibilities.

Furthermore, concrete actions should be envisaged to enhance collaboration and synergies with other Horizon Europe neighbouring European Partnerships such as Clean Energy Transitions (CET), Built environment and construction (Built4People), Rescuing biodiversity (Biodiversa+), Safe and Sustainable Food Systems, Towards Zero Emission Road Transport (2ZERO), Cooperative, Connected and Automated Mobility (CCAM), EIT Urban Mobility and Water4All.

Interfaces to public procurement and investment programmes and links with Urban Innovative Actions (UIA) under the Urban Agenda for the EU, European Urban Initiative (EUI) under cohesion policy, ESIF, private funds, etc. should be explored to support take-up and larger scale implementation of tested approaches and solutions.

The consortium which applied to and received funding under the topic HORIZON-CL5-2021-D2-01-16 is uniquely placed to submit a proposal to continue the envisioned partnership. Not only did this consortium submit the proposal leading to the identification of the partnership in the Horizon Europe strategic planning 2021-2024, it has so far been implementing the partnership through co-funded calls in the year 2022 based on this planning and further to the HE WP 21/22 topic. In this context, the current consortium has particular expertise in relation to the objectives of the Partnership, the activities to be implemented in particular 2022 and 2023 FSTP calls or other calls/scope of calls clearly required/envisaged pursuant to initial proposal/partnership, and other relevant aspects of the action. In practice, another consortium could not continue the activities of the Partnership underway without significant disruption to the ongoing activities, if at all.

While the award of a grant to continue the Partnership in accordance with this call should be based on a proposal submitted by the coordinator of the consortium funded under topic HORIZON-CL5-2021-D2-01-16 and the additional activities (which may include additional partners) to be funded by the grant should be subject to an evaluation, this evaluation should take into account the existing context and the scope of the initial evaluation as relevant, and related obligations enshrined in the grant agreement.

The Commission envisages to include new actions in its future work programmes to provide continued support to the partnership for the duration of Horizon Europe.

Call - Cross-sectoral solutions for the climate transition

HORIZON-CL5-2023-D2-02

Conditions for the Call

Indicative budget(s)¹²⁰

¹²⁰ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.

Horizon Europe - Work Programme 2023-2024
Climate, Energy and Mobility

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹²¹	Indicative number of projects expected to be funded
		2023		
Opening: 04 May 2023 Deadline(s): 05 Sep 2023				
HORIZON-CL5-2023-D2-02-01	IA	24.00	Around 8.00	3
HORIZON-CL5-2023-D2-02-02	RIA	10.00	Around 5.00	2
HORIZON-CL5-2023-D2-02-03	IA	8.00	Around 8.00	1
Overall indicative budget		42.00		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

The Director-General responsible may delay the deadline(s) by up to two months.

All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

¹²¹ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

A competitive and sustainable European battery value chain

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D2-02-01: Advanced materials and cells development enabling large-scale production of Gen4 solid-state batteries for mobility applications (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 24.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6 by the end of the project – see General Annex B.

Expected Outcome: Building on the results of earlier research projects on advanced solid-state materials, the objective of this topic is to demonstrate, at cell level, the scale-up of advanced solid-state materials for anodes, cathodes, electrolytes and, where applicable, separators with performances and costs compatible for mobility markets.

Projects are expected to contribute to all the following outcomes:

- The selection of solid-state cell components and architecture (anode; electrolyte, cathode, collector, and interfaces) meeting, by the end of the project, all performance indicators at ambient and operational temperatures necessary for mobility, as following:
 - Safety: with a technology compatible with the level 4 EUCAR at module/pack level for automotive (level 2 for aviation and waterborne applications).
 - Gravimetric and volumetric energy density: > 400Wh/kg and 1000Wh/l.
 - Cycling: up to 3000 cycles at 50% DoD (Depth of Discharge) with a minimum of 500 cycles at 80% DoD.

- o C Rate at charge up to 5 C at 80% SoC (state of charge), or whichever C-rate / SOC combination that would allow < 20mn full capacity recovery; for aviation applications, up to 10C.
- o Materials and cells design with mechanical properties and constraints that enable large scale production processes at a competitive cost, especially in terms of pressure conditions at cell and module level.
- o Atmospheric conditions in factories.
- A demonstration of the selected materials in a State-of-Art benchmark cell (at least TRL5) with at least 1 Ah capacity.
- A competitive cost level towards 75€/kWh at pack level by 2030.
- An optimised environmental footprint of cell materials in terms of carbon footprint and quantity of metals.
- Cell manufacturing processes which allow the fabrication of performant, reliable, sustainable, and affordable solid-state cells, demonstrated at industrial pilot level.
- Cell materials and designs which are compatible with a recycling process that respects the requirements as put forward in the proposed Batteries Regulation¹²².

Scope: Proposals are expected to cover all the following points:

- Develop or leverage the materials-specific models and digital tools for material and cell design to identify the best combinations of materials and speed up the cell optimisation process.
- Ensure high ionic conductivity ($> 0.5\text{mS}/\text{cm}^2$) and stability of the solid electrolyte.
- Integrate high voltage cathode ($> 4\text{V}$) to reach the KPIs for mobility as listed in the Expected Outcomes section.
- Propose and evaluate interfaces and coating solutions especially to suppress dendrite growth and enable a stable solid-electrolyte interphase (SEI) and cathode-electrolyte interphase (CEI).
- Optimise the cell design with respect to all the cell components to meet high energy density objectives.
- Anode current collectors and/or solid electrolyte capable of accommodating volume changes upon charge/discharge.

¹²² COM(2020) 798 final, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

- Demonstrate the potential for scale up of materials, cells and sustainable industrial processing methods with cells reaching a capacity of several Ah, produced in a statistical meaningful number to demonstrate the process repeatability.
- Project publications should adhere to the guidelines for publication of research results, as laid out by the "Batteries Europe - Reporting Methodologies" report, subject to the need to maintain confidentiality for future commercial exploitation.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Projects should link to ongoing Horizon Europe calls, especially **HORIZON-CL5-2021-D2-01-03: Advanced high-performance Generation 4a, 4b (solid-state) Li-ion batteries supporting electro mobility and other applications** and HORIZON_CL5-2021-D1-01-05 (Manufacturing technology development for solid-state batteries (SSB, Generations 4a - 4b batteries). Projects should also take stock of the outcomes of the projects under call LC-BAT-1-2019 (Strongly improved, highly performant and safe all-solid-state batteries for electric vehicles).

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-02-02: New Approaches to Develop Enhanced Safety Materials for Gen 3 Li-Ion Batteries for Mobility Applications (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.
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Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- Advanced Li-ion batteries with enhanced safety behaviour.
- Advanced materials which lead to improved cyclability (15% increase in cyclability by 2030 compared to 2019 base levels) and operational lifetime (a doubling of lifetime by 2030 compared to 2019 base levels), whilst maintaining competitive performance for cost, energy and power density with state-of-art advanced materials for Li-ion batteries.
- Improved sustainability and recyclability, in line with the recycled content, recycling efficiency and material recovery targets included in the proposed Batteries Regulation¹²³.
- A defined concept for demonstrable, highly sustainable, circular manufacturing for the selected advanced materials at Gigafactory scale, with sustainability measured in terms of recognised economic, environmental, social and ethical metrics.
- The improvement in safety has to be demonstrated at representative cell level for mobility applications by direct comparison with SOA Gen. 3 cells tested at the beginning of the project.
- A EUCAR Hazard Level of 3 or other equivalent mobility standard should be validated.

Scope: This topic aims at developing safer materials for high-performing cells by targeted modification in main cell components, namely the cathode, anode, separator and electrolyte. Solutions to common safety hazards have to be covered through a comprehensive design of new materials for at least three of following components:

- New cathode materials with no exothermal decomposition/reactions, reduced probability for oxygen and other gasses release, and preventing corrosion at current collector. Development can include the following approaches/strategies at different levels:
 - o Doping strategies or surface coating materials leading to more robust and effective cathode electrolyte interphase (CEI).
 - o Design of high-capacity cathode materials based on safer chemistries (e.g. stabilized Li-rich layered oxides, disordered rock salts, polyanionic materials...).
 - o Design high-voltage cathodes and high voltage anodes in order to combine them in a high energy cell, with sufficiently high operating voltage to avoid stripping/plating of lithium.

¹²³ COM(2020) 798 final, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

- Innovative approaches of cathode structuring to mitigate heat generation, including with toxic gas releases, in abuse conditions.
- New stable anode materials and electrode designs with non-swelling, or low degree of expansion over the whole cell lifetime, with no decomposition/exfoliation, high resistance against Li-dendrite formation – specially at high anode rate capabilities, and favouring the formation of a thermally stable, and low-resistivity SEI. Development can include the following approaches/strategies at different levels:
 - Design and development of new systems with higher standard potential compared to lithium stripping/plating. (High SiO_x, Si/C, etc. content).
 - Surface coating materials for more robust and effective SEI.
 - New approaches to minimize material/anode swelling and expansion during cycling, including anode manufacturing (polymeric and ceramic coating-based approaches, etc.) and structuring the anode-current collector interface.
- New electrolyte formulations with shear thickening, flame retardant and over-charge/discharge properties, maintained high ionic conductivity, broad electrochemical stability i.e., voltage-operating window, and high onset point for Li-dendrite formation, SEI decomposition and CEI effectiveness. Development can include the following approaches/strategies at different levels:
 - (Multi-)functional additives for SEI and CEI stabilisation and protection on anode and cathode such as flame-retardant additives or solvents, ionic conductivity boosters, stability window promoters, etc.
 - Addition of selective particles (i.e. oxides, etc.) to hinder mechanical abuse and improve shear thickening behaviour.
- New separator materials with flame retardant and improved ion transport capabilities, high melting point, and mechanical stability
- New binder materials with thermal, mechanical and electrochemical stability (self-healing systems), low ionic and electrical resistance, improved adhesion and cohesion, and preventing swelling and porosity reduction in electrodes.

Projects need to justify the relevance of the selected components which will be addressed and how the new materials, and the combination of them, will lead to better safety outcomes. To the extent possible the safety and sustainability of developed materials should be assessed in alignment with the Commission Recommendation on safe and sustainable by design chemicals and materials¹²⁴.

¹²⁴ Commission Recommendation (EU/2022/2510) establishing a European assessment framework for ‘safe and sustainable by design’ chemicals and materials.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with the USA.

Projects may collaborate and/or contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-02-03: Creating a digital passport to track battery materials, optimize battery performance and life, validate recycling, and promote a new business model based on data sharing (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>The Joint Research Centre (JRC) may participate as member of the consortium selected for funding.</p>
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible</p>

	costs.
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Expected Outcome: Stakeholders engaged with the battery value chain need to be provided with accurate, reliable and immutable battery information e.g. related to ESGE (Environmental, Social, Governance & Economic) indicators and monitor thermal runaway at any stage of the value chain. Furthermore, the proposed Batteries Regulation¹²⁵ and future regulations will extend the due diligence to all domains of the battery value chain in the upcoming years. The EU Data Strategy is setting a clear architectural approach to federated data and is enabling a great opportunity to boost the EU dataspace on batteries.

The availability of shared, interoperable, and trusted data for improving recycling and second life application might promote new business, assuring workforce and transportation safety. Indicators such as SoH (State of Health), SoS (State of Safety), SoP (State of Power) should be calculated in accurate, reliable, immutable, and standardized way, based on historical data (usage profile, working temperatures, etc.) of the battery or cells.

The project is expected to contribute to the following outcomes:

- A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependencies for critical raw materials by promoting resource efficiency.
- A Digital Product Passport (DPP), a proper tracking and blockchain solution, DLT (Distributed Ledger Technology)-solution or an equivalent solution that allows for built-in data authenticity verification, along the value chain, with no data duplication, avoiding data manipulation assuring privacy by design, with a low power consumption and promoting data interoperability.
- A set of transparent calculation methods for the relevant battery indicators stored in the DPP, which can be used as a base to set future standards.
- A demonstration of new business models in the different parts of the battery value chains and of circular data extraction, based on data sharing.
- The improvement of the battery transportation and workforce safety.
- A solution which has been tested throughout the entire battery value chain.
- At least 2 real life pilots capable to exploit data generated by DPP and to test two of the innovative solutions proposed.

The project is also encouraged to address some of the following outcomes:

- Improvement of the recycling efficiency (more than one material).

¹²⁵ COM(2020) 798 final, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

- Promotion of sustainability and circularity through the adoption of 4R methodological approach Reduce, Repair, Reuse, Recycle.
- Boost of the use of recycled and reusable material to reduce energy usage/CO2 footprint.
- Increase of competitiveness of the European battery industry across the value chain (from mines and refiners to cell manufacturers to cell integrators).
- Streamlined compliance with the proposed Batteries Regulation and EU federated dataspace.

The project outcomes are expected to:

- Be applicable to 3 or more use cases among the main transport or mobile applications (such as road, waterborne, airborne and rail transport, as well as non-road mobile machinery and industrial applications), with the aim to maximize the impact on the European industry.
- Also be applicable to stationary energy storage applications.

Scope: The project is expected to:

- Promote the adoption of a downstream development and implementation of a battery pack Digital Product Passport (DPP) at minimum subset design system level addressing raw materials (at least anode and cathode critical raw materials), cells and modules, which is both scalable and energy efficient.
- Be able to facilitate real-time data recognition for different indicators and at local device - even when the battery ceases to be part of the Energy Storage System (ESS).
- Consider the key performance indicators proposed by Batteries Europe or by the dedicated Partnerships, reflected in the Partnership Strategic Research Agenda (SRA), to guide the technology developments on the application segments and use cases that will be selected. Contribute to the related regulation standards.
- Engage a variety of stakeholders along the whole battery value chain to assure the continuous traceability and assure that accountability will not be lost from raw or recycled raw material to first and second life and recycling.

The suggested blockchain, DLT, or equivalent, solutions are requested to demonstrate trustworthy tracking. The project is encouraged to:

- Validate its interoperable data sharing strategy by adopting a unique battery data space and testing of interoperability between different subsystems (mobility, energy, etc.) is encouraged.
- Develop a safety second life-battery certification protocol, and hazard alerts system to assure liability and protection during transport, and second use.

- Validate new business models, capable to demonstrate improvement in remanufacturing, repurposing and recycling.
- Aim for cross-sectorial applications
- Focus on the lithium-ion battery chemistries currently on the market - or reaching the market in the short term, with the potential to quickly adapt to next-generation battery chemistries and assess its safety tracking.

Projects need to be compliant with the following EU strategy and regulations framework:

1. Green Deal and in particular Circular Economy Action Plan's Sustainable Product Initiative,
2. the EU Digital strategy's Circular Electronics Initiative and,
3. the EU Data strategy,
4. Upcoming regulation on Batteries.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Proposals should interface with the project(s) funded under the topic DIGITAL-2021-TRUST-01-DIGIPASS "Digital Product Passport: sustainable and circular systems" and notably its activities regarding batteries. They should also establish cooperation and complementarity with the selected proposal under the topic HORIZON-CL4-2022-RESILIENCE-01-05 "Technological solutions for tracking raw material flows in complex supply chains", which is tracking raw material flows for batteries value chains and others.

They should furthermore establish collaboration with the partnership "Battery Passport" under the Global Battery Alliance¹²⁶. In order to achieve the expected outcomes, international cooperation is encouraged, in particular with the USA, Japan and South Korea.

Proposals could consider the involvement of the European Commission's Joint Research Centre (JRC) whose contribution could consist of providing added value regarding various aspects of battery sustainability, performance or safety.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

Call - Cross-sectoral solutions for the climate transition

HORIZON-CL5-2024-D2-01

¹²⁶ <https://www.globalbattery.org/battery-passport/>

Conditions for the Call

Indicative budget(s)¹²⁷

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹²⁸	Indicative number of projects expected to be funded
		2024		
Opening: 07 Dec 2023 Deadline(s): 18 Apr 2024				
HORIZON-CL5-2024-D2-01-01	RIA	16.00	Around 8.00	2
HORIZON-CL5-2024-D2-01-02	IA	21.00	Around 7.00	3
HORIZON-CL5-2024-D2-01-03	RIA	5.00	Around 5.00	1
HORIZON-CL5-2024-D2-01-04	RIA	10.00	1.50 to 2.50	5
HORIZON-CL5-2024-D2-01-05	RIA	20.00	Around 20.00	1
Overall indicative budget		72.00		

General conditions relating to this call

<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.

¹²⁷ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

¹²⁸ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

A competitive and sustainable European battery value chain

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D2-01-01: Advanced sustainable and safe pre-processing technologies for End-of-Life (EoL) battery recycling (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: The pre-treatment process is the first and indispensable step in recycling Lithium-ion batteries (LIBs), which significantly affects the recycling rate of the spent devices and the extraction rate of the high-value metals in the subsequent metallurgical processes. The batteries also contain toxic chemicals, which should be preventatively separated to promote environmental protection and sustainability. Moreover, the pre-treatment processes also help to reduce the scrap volume and allow the separation of the battery components.

Projects are expected to contribute to all of the following outcomes:

1. A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependencies for critical raw materials by promoting a circular economy.
2. The direction of the EU battery industry towards the zero-waste concept by developing holistic, materials and energy efficient recycling processes that can increase the content of recovered mass and by improving the cooperation between recyclers and battery manufacturing through a vertical integration strategy, for those cases where battery and/or component repurposing is not a viable option.
3. The circularity of battery materials, where also non-metallic elements (electrolyte, solvent, salts and polymers) are recycled back to use (as raw materials or valuable chemicals). The “cradle to cradle approach” will be addressed through waste pre-treatment by safe and sustainable separation and recovery.
4. Environmentally beneficial processes for battery pre-treatment (pre-processing and separation) of the main elements to decrease the CO₂ footprint and other emissions of the recycled materials.
5. Safe technologies aimed at improved recovery yield, increased quality and purity level of the recycled/recovered materials, improved impurity removal.

Scope: The current EOL LIB recycling technologies are focused on improving the recovering efficiency of Cobalt that is the most valuable material. However, other no-Co battery contents need to be extracted in one go to develop recycling processes with economic, societal and environmental perspectives. They, for instance, include low-density plastics, metal shells and foils, binders, separators, organic solvents, Li salt, anode active materials. Successful separation methods have the potential to enrich the constituent of targeted materials and improve the profit for recycling.

In recent years, several pre-treatment processes were tested at least at lab-scale (usually mechanical, thermal and chemical options). The goal is to develop and integrate new advanced pre-processing concepts that enable more efficient and safe technologies for recycling EoL LIBs. Substantial improvements should be achieved in the processes environmental and economic viability and in the circular economy, narrowing the sustainability gaps in the whole battery recycles pre-treatment.

The following pre-treatment concepts are expected to be addressed:

1. Battery sorting at component level that should be more efficient, accurate, also including recommendations for the standardisation of labelling of battery components, due to the huge variation of physical configurations, cell types and chemistries, with the aim of re-using the suitable components.
2. Advanced pre-processing methods including (but not limited to) physical, mechanical, dry, thermal and aqueous pre-treatment methods that allow improved pre-concentration while minimising as much as possible waste side products.

3. Process design enabling the recovery and valorisation of anode materials.
4. Electrolyte valorisation through the development of sustainable and safe processes for the recovery of Li-salts.
5. Separation of all the strategic battery materials that should be integrated into existing/innovative recycling processes to mitigate potential effect of impurities.
6. Recovery of electrode current collectors (Al and Cu) that should be improved by developing more efficient separation methods of the metal foils from the electrode materials and easier removal of the organic binder.
7. Other recoverable not-active materials from the EoL battery (solvent as EC, DEC, DMC, binders, separator).
8. Pre-assessing concepts by their life cycle sustainability and safety impacts and studying overall techno-economical solutions for recovery systems in order to minimize cost, environmental impact and system losses.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Pre-treatment should not impede on second life, according to the principles of the waste hierarchy.

The topic will generate insights that may be of use for on-going research and innovation on new recycling processes and concepts from topic HORIZON-CL5-2023-D2-01-02.

Projects may collaborate and/or contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08.

Proposals could consider the involvement of the European Commission's Joint Research Centre (JRC) whose contribution could consist of providing added value regarding various aspects of battery sustainability.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D2-01-02: Non-Li Sustainable Batteries with European Supply Chains for Stationary Storage (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately.

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<i>project</i>	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 21.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs. Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹²⁹ .

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependencies for critical raw materials.
- Development of post-lithium cell chemistries with target cell- and system-level cost, safety, energy density and power metrics suitable for the selected stationary energy storage markets.
- Credible projected storage costs of less than 0.05 €/kWh/cycle by 2030, particularly for applications with a (minimum) storage durations of up to 8 hours.

¹²⁹ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Set out a clear route to a feasible, European-based supply chain that reduces reliance on critical raw materials, substituting with abundant, non-toxic, inherently safe raw materials and minimises the impact of possible international trade disruptions and customs tariffs, taking account of the requirements for a range of stationary storage use cases.
- Demonstration of system operated in end-user conditions for at least 3,000 hours.
- Projected product cycling life 5,000 cycles in conditions operating conditions typical of the selected application.
- A battery storage solution, that works safely and efficiently across a wide range of ambient conditions.
- A defined concept for demonstrable, highly sustainable, circular manufacturing for the selected battery type, with sustainability measured in terms of recognised economic, environmental, social and ethical metrics.

Scope: Non-lithium-based batteries have the potential to provide solutions for integration of renewables by providing energy storage solutions, either stand-alone, or as part of larger grid. Proposals are invited for projects which advance the development of non-Li battery systems, show their potential to be manufactured at scale at a cost the market will bear, and which meet regulatory requirements (including regulations for the recycling/re-use of batteries).

Projects may target any stationary storage applications, from a few kWh in small-scale domestic behind-the-meter units, to many MWh in large utility-scale front-of-meter installations.

Whilst stationary storage packaging constraints may not be as stringent as mobile applications in terms of volume and mass, total cost (€/kWh/cycle) and safety are critical to proving technological and commercial viability. Safety concerns become especially prominent as installation sizes increase due to the huge amount of stored chemical energy.

This topic is open to all non-lithium battery chemistries.

Projects are expected to:

- Develop and demonstrate sustainable and safe non-lithium battery solutions from abundant, non-toxic raw materials, capable of deployment in a large share of stationary energy-storage markets aligning the safety and sustainability assessment with the Commission Recommendation on safe and sustainable by design chemicals and materials¹³⁰.
- Develop and demonstrate an innovative non-lithium battery technology with energy density and power metrics suited to stationary energy storage applications; and

¹³⁰ Commission Recommendation (EU/2022/2510) establishing a European assessment framework for 'safe and sustainable by design' chemicals and materials.

- Prove the battery system's sustainability and compatibility with a European supply chain.
- Risks will be demonstrably managed to the lowest possible level and within standard acceptable societal limits for toxicity and safety.

Projects are encouraged to:

- Develop new materials that improve techno-economic performances and/or the ability to meet sustainability targets.
- Show how cell and system design and material improvements optimise techno-economic performance by defining (i) technical and commercial targets, and (ii) quantified success criteria/KPIs by which progress toward achieving the targets may be evaluated during both development and validation phases of the project.
- Demonstrate a credible commercial and technical path, from end-of-project outcomes to a stationary-energy-storage product, and which takes account of future manufacturing and recycling requirements.
- Provide evidence of current and future sustainability, viable European supply chains and rigorous analyses of the complex sustainability and recyclability issues including compatibility with regulation, including recycling regulations.
- Demonstrate minimal towards no maintenance requirements.

BMS development is within scope where relevant but should not be the main focus of the project. In any case, developments of the BMS need to take into account the renewable energy directive and any pending amendments, notably for the requirements for real-time access to the data of the BMS.

Projects which, in addition, demonstrate the suitability of the solution under development for other emerging energy storage markets, such as motive power for off-road and transport applications with similar system requirements are encouraged.

Projects focussed on materials discovery for novel chemistries are out of scope. However, material refinements of known chemistries undertaken to achieve performance, sustainability, safety and cost targets are in scope.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Proposals should indicate to which chapters of the Strategic Research and Innovation Plan for chemicals and materials¹³¹ they will contribute.

In order to achieve the expected outcomes, international cooperation is encouraged for use cases, particularly with India, Africa and Australia.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D2-01-03: Development of technical and business solutions to optimise the circularity, resilience, and sustainability of the European battery value chain (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 5.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected contribute to all the following outcomes:

- A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependencies for critical raw materials by promoting a circular approach to manufacturing and resource efficiency.
- Advancing circular and sustainable design and business practices relating to advanced batteries and associated value chains.

¹³¹ https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-materials-and-chemicals_en

- Improving the life cycle sustainability performance of batteries produced in the EU, both in terms of reducing environmental impacts and maximising socio-economic benefits, including increased closed-loop practices.
- Enhancing European strategic independence in terms of battery raw materials, the competitiveness of European industry, and maximising socio-economic benefits at the EU level and beyond.
- Supporting the achievement of established EU recycling efficiency targets for 2030 and beyond.

Contribution to the following outcomes is optional, depending on the scope of the project:

- Enabling tools and best practice for multiple industry sectors in order to improve the European industrial ambitions and global leadership beyond batteries.
- Improving batteries and their materials/components circularity through the promotion of more material efficient designs by enabling longer material/component lifetimes, improving added-value remanufacturing, refurbishing (including exchangeable battery systems), repairing and recycling and ultimately decreasing the cost of using secondary materials/components in batteries.

Scope: Proposals should cover at least two of three scope categories (business models, cross-industry tools, sustainable design) and at least three bullet points in total:

- Business models
 - o Definition of assessment approaches for sustainable business models, including value proposition, value creation and delivery and value capture including environmental, social and economic dimensions. This activity will include analysis of best practice examples for sustainable business models.
 - o Development of sustainable business methods for technical, economic, and environmental evaluation of cycle life options: retrofit, second life, and recycling.
 - o Development of new business models and social innovations that promote the sustainable mobilisation of resources.
 - o Development of business methods to address outstanding issues, such as on-liability, across applications.
- Cross-industry tools
 - o Quantitative methodologies and tools that enable understanding whether recycling or second life is the preferred sustainable option, and at which level (pack, cell, electrode, material) recycling should be deployed.

- o Optimisation of design and operation using LCA. Using high-quality data, exploring trade-offs between i) impacts at fabrication stage, ii) design for durability, iii) energy usage, iv) other functional aspects such as optimal sizing, hybridisation, electronic management, thermal management.
- o Development of a central data information system and database (users of resources can see who offers which type and amount of battery system) and prototype Europe-wide information system for accident vehicles and their available battery systems for re-use.
- Sustainable design
 - o Innovations in battery design and architecture at all levels (system, pack, cell) supporting dismantling and recycling at the end of life. These could include the choice of materials and assembly methods and should not compromise the performance.
 - o Design of innovative sourced materials for improving sustainability in batteries by sustainable processes that avoid toxic/dangerous solvents and require controlled environments.
 - o Research and design of batteries from recycled materials and fully recyclable.

Cooperation with complementary projects launched specifically in the Cluster 5 work program and specifically, in the Destination “*A competitive and sustainable European battery value chain*” is required. Examples of collaborative activities includes information sharing, promotion of results at thematic transnational events, conferences and open webinars.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Projects may collaborate and/or contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08.

Proposals could consider the involvement of the European Commission's Joint Research Centre (JRC) whose contribution could consists of providing added value regarding various aspects of battery sustainability.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D2-01-05: Furthering the development of a materials acceleration platform for sustainable batteries (combining AI, big data, autonomous synthesis robotics, high throughput testing) (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 20.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Admissibility conditions</i>	The conditions are described in General Annex A. The following exceptions apply: The page limit of the application is 60 pages.
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 3-4 by the end of the project – see General Annex B.

Expected Outcome: Batteries have complex and dynamic processes taking place in and between materials and at the interfaces/interphases within a battery cell. For each new battery chemistry explored, new challenges in understanding these processes are revealed. To accelerate the finding of new materials and their combinations for both existing and future battery chemistries the iterative and fragmented trial and error approach used today needs to be replaced since it is slow and insufficient.

To accelerate the discovery of battery interfaces, materials and new sustainable concepts with high energy and/or power performance there is a need to develop a fully autonomous and chemistry neutral Materials Acceleration Platform (MAP) for battery materials and interfaces. This is a key and long-term challenge for European battery community. The aim is to integrate advanced multi-scale computational modelling, materials synthesis, characterisation and testing to perform closed-loop autonomous materials findings and interphase engineering that would accelerate by at least a factor of five the discovery of new battery chemistries with ultra-high performances.

Building upon the shared data infrastructure, standards and protocols developed in the BATTERY 2030+ initiative, this call topic addresses the need of increasing the level of autonomy in the MAP-based discovery and development process. The proposal should also cover the contribution and collaboration to the BATTERY 2030+ large scale initiative.

Project results are expected to contribute to all of the following expected outcomes

- Develop new tools and methods for significantly accelerating the development and optimisation of battery materials and interfaces, in order to increase the competitiveness of the battery material and cell industry in Europe.
- Demonstrate a fully autonomous battery-MAP capable of integrating computational modelling, materials synthesis and characterisation of both Li-ion and beyond Li-ion chemistries.
- Scale-bridging, multi-scale battery interface models capable of integrating data from embedded sensors in the discovery and prediction process, e.g. to orchestrate proactive self-healing.
- Community wide state-of-the-art collaborative environment to access data and utilise automated workflows for integrated simulations and experiments on heterogeneous sites, e.g., exploiting European HPC architectures and Large-scale facilities in collaboration with LENS and LEAPS.
- Demonstrate a robotic system that is capable of material synthesis for inorganic, organic or hybrid compounds following standard synthesis routes via automated characterisation of intermediate and final products and autonomous decision-making.
- Deploy predictive hybrid physics- and data-driven models for the spatio-temporal evolution of battery interfaces and demonstrate inverse design of a battery material/interface.

Scope:

- Infrastructure tools for secure remote data access, data analysis and predictive modelling: Develop a FAIR¹³² data infrastructure for raw and curated experimental and modelling data, which can be accessed remotely and securely by relevant stakeholders, including industry. Develop the software infrastructure required to operate this platform, also with regard to future reproducibility and further exploitation of the results of the research activities. The software should provide specific access right and allow remote data access, complemented by distributed workflows using software-agnostic workflow engines that provide rapid-prototyping. Inverse materials design using hybrid physics- and data-driven battery interface genome models should also be demonstrated.

¹³² FAIR (Findable, Accessible, Interoperable, Reusable)

- Automated high throughput characterisation and integrated experimental and computational workflows: High throughput, multimodal operando experimental techniques using standardised battery cells and established protocols should be optimised to perform effective screening of new materials and on-line diagnosis of realistic devices. A central objective is to establish, structure, operate and dynamically refine such facility platform to harmonise, mutualise and optimise the global demand for battery characterisation. This includes automated experimental and computational workflows and modules for data acquisition and multimodal/multiscale analysis. Particular attention should be paid to battery interfaces and direct observation of interfaces under dynamic conditions, which are key to improve the performances and the lifetime of batteries.
- Autonomous synthesis robotics and orchestration software: The transition from low/no automated robotics for the synthesis of battery materials requires several R&I steps towards fully autonomous systems. Within the scope of this proposed call are partially autonomous systems following standard synthesis routes for inorganic and organic battery materials, especially also multi-step and high-temperature synthesis, that so far are challenging to automate for high throughput. AI-based orchestration and optimisation software modules and packages specifically targeting battery materials and interfaces are also central to the scope.
- Inverse design and AI-assisted scale-bridging models for multiple time- and length-scale processes: To develop scale-bridging models correctly describing the multiple mechanisms occurring at atomistic scale and the mesoscopic scale on the cell level. The new model approaches should be able to incorporate data from the advanced sensing in virtual design optimisation and battery control algorithms for SoX estimation. Sensitivity analysis and uncertainty quantification of the developed SoX models is also a requirement to assess the robustness of the developed models. These models should achieve a challenge based rational balance of accuracy and computational effort. They should accurately describe the actual state of the system, but also enable diagnosis and prediction, e.g., when self-healing procedures should be initiated. Multiscale Modelling approaches should be developed for the control of safety between BOL (Beginning Of Life) and EOL (End of Life) of a battery system by different uses and diagnosing the safety state of a battery system by innovative methods.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

Emerging breakthrough technologies and climate solutions

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D2-01-04: Emerging energy technologies for a climate neutral Europe

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 1.50 and 2.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to **all** of the following expected outcomes:

1. Demonstration of knowledge and scientific proofs of the technological feasibility of concepts on high risk/high return (i.e. high technological and economic risks) technologies for transition to climate neutral economy by 2050 and beyond.
2. Assessment of environmental, social, and economic benefits to contribute to R&I strategy, as well as the EU climate and energy targets.
3. Contribution to establishing a solid long-term dependable innovation in Europe.

Scope: This topic focusses on the development of novel bottom-up technological solutions with breakthrough potential across all parts of the **energy sector value chain**, as well as all energy-related aspects in the **transport sector**.

Projects supported under this topic **should** consider at least **one** of the following areas:

- Energy distribution and transmission.
- Long-term energy storage.
- Novel energy generation/conversion methods.

The **following areas should not be covered**, as they fall within either partnerships or other calls:

- Renewable energy technologies covered under the call D3-1-49 on ‘Next generation of renewable technologies) and renewable hydrogen production.
- Batteries and especially long-term electricity storage technologies, covered under D3-2-17 as well as flow batteries.
- Material research.

The proposal should: i) present a robust research methodology including ambitious yet realistic conversion efficiency targets to be validated in the lab ii) establish the technological feasibility of the proposed concept iii) include a proper assessment of environmental, social, and economic benefits and iv) consider the applicability of the proposed technology in various sectors.

Proposals are expected to fulfil the following conditions:

In developing its concept, the proposal **should** address the following aspects:

- Low environmental impact (e.g. on climate change and pollution) quantified based on Life Cycle Assessment (LCA) framework.
- Barriers to the deployment of such technologies, including issues related to social acceptability or resistance to new energy technologies, related socioeconomic and livelihood issues globally.

Prospective life cycle approach to be done with the relevant information that can be gathered at such TRL level.

Call - Cross-sectoral solutions for the climate transition

HORIZON-CL5-2024-D2-02

Conditions for the Call

Indicative budget(s)¹³³

Topics	Type of	Budgets (EUR	Expected EU contribution per	Indicative number
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¹³³ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

Horizon Europe - Work Programme 2023-2024
Climate, Energy and Mobility

	Action	million)	project (EUR million) ¹³⁴	of projects expected to be funded
		2024		
Opening: 07 May 2024 Deadline(s): 05 Sep 2024				
HORIZON-CL5-2024-D2-02-01	IA	8.00	Around 8.00	1
HORIZON-CL5-2024-D2-02-02	RIA	15.00	Around 5.00	3
HORIZON-CL5-2024-D2-02-03	IA	16.00	Around 8.00	2
Overall indicative budget		39.00		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

A competitive and sustainable European battery value chain

Proposals are invited against the following topic(s):

¹³⁴ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

HORIZON-CL5-2024-D2-02-01: Sustainable high-throughput production processes for stable lithium metal anodes for next generation batteries (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.

Expected Outcome: As Li metal anodes will be needed for the Gen 4b, Gen 4c and Gen 5 batteries, it is important to create a European production chain for their manufacturing, in order to guarantee secure supply chains for the next generation battery producers with a focus on high performance and recyclability for Gen 4b, Gen4c or Gen5 cells.

The proposed project is expected to contribute to all the following outcomes:

1. Reduction of strategic dependencies for critical raw materials by promoting resource efficiency.
2. Energy consumption/carbon footprint of processing 10% lower than SoA.
3. Throughput of Li foil and/or electrode production to support cell manufacturing, including a technical pathway towards production at MWh/(sub-)GWh scale.
4. Ensure stability of Li during handling, processing and operation using coatings or other protective technologies (e.g. barriers/protective layers).

5. Processing of Li (Metal) and Li electrodes within cell assembly at industrial scale, including, but not limited to, high-quality cutting of the Li foil and/or electrode.
6. Homogeneous Li films with thickness below 20µm, contributing towards energy density levels of 400-500 Wh/kg.
7. The developed process should be compatible with recycling targets (with respect to purification of scrap with protective coating) and assure recyclability to more than 70% of Li metal in battery waste, (90% Li metal for production scrap).
8. The proposed project is encouraged to contribute to a competitive price of 75€/kWh at pack level.

A demonstration of the performance of Li at cell level in SoA benchmark cell (at least TRL5 with at least 1 Ah capacity). Validation in Generation 4b, 4c and/or Generation 5 cells is highly encouraged.

Scope: Proposals under this topic are expected to cover all of the following bullet points:

- Sustainable, cost-efficient and large-scale production of Li-metal foils and/ or electrodes, demonstrated up to pilot level during the project. Activities can include, but are not limited to, extrusion, comparison extrusion / electrostatic spray, rolling and co-rolling. However, extensive cell design and development are out of the scope as this topic focuses on the Li anode production.
- Control of the passivation of Li metal films, and to understand how the passivation is linked with the dry room conditions and requirements. The goal is to find the optimal way: high passivation and lower quality dry room, or low passivation and higher quality dry room, and how these selections are linked with cost, energy consumption and performance of the cells.

The project is expected to also guarantee safety of the Li film production and handling, which has to be demonstrated in a process that is compatible for large scale production.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Collaboration with other projects from calls HORIZON-CL5-2023-02-01 Advanced materials and cells development enabling large-scale production of Gen4 solid-state batteries for mobility applications and/or HORIZON-CL5-2024-02-02 Post-Li-ion technologies and relevant manufacturing techniques for mobility applications (Generation 5) is expected.

The project is encouraged to cooperate with projects stemming from call topic HORIZON-CL5-2023-01-01 Technologies for sustainable, low carbon and cost-efficient downstream processing and production of battery-grade materials.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D2-02-02: Post-Li-ion technologies and relevant manufacturing techniques for mobility applications (Generation 5) (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4 by the end of the project – see General Annex B.

Expected Outcome: This topic aims at developing:

- Generation 5¹³⁵ technologies for mobility applications;
- the relevant manufacturing techniques which are affecting performance, safety and costs;
- Cell designs which will allow for full and easy recyclability at the end of their life.

This topic also aims at evaluating the possible manufacturing compatibility with existing lithium-ion production infrastructure.

Projects are expected to contribute to at least one of the following outcomes:

- Conversion systems based on metallic anodes with enhanced safety, delivering on cost, performance, sustainability and recyclability, with clear prospects for the feasibility of the scale-up of the manufacturing processes.

¹³⁵ As defined in the Batteries Europe Strategic Research Agenda https://ec.europa.eu/energy/sites/ener/files/documents/batteries_europe_strategic_research_agenda_december_2020_1.pdf

- Metallic anode protection and/or activation for conversion systems (polymer, ceramic and hybrid electrolytes) with increased safety, cycle life and low cost.
- Post lithium-ion cells based on cations other than lithium with long cycle-life (Sodium-ion is excluded and covered by topic HORIZON-CL5-2024-D2-01-02).

In addition, projects are expected to contribute to creating rechargeable batteries that will work in realistic environments, are recyclable and with low environmental impact, and have safe manufacturing processes. To the extent possible the safety and sustainability of developed materials should be assessed in alignment with the Commission Recommendation on safe and sustainable by design chemicals and materials¹³⁶.

Translating these outcomes into indicative KPIs to guide the R&I efforts, projects are expected to show a credible technical pathway to achieve all the following targets by 2030 and beyond:

- A safe behaviour at cell level: expected EUCAR Hazard level below 4 for automotive; level 2 for aviation and waterborne applications;
- Specific energy at cell level targeting 500 Wh/kg, and volumetric energy density at cell level targeting 600 Wh/l;
- Charge and discharge with a C-rate between 2 and 10;
- 800+ cycles at 50%DoD or 400 cycles at >80%DoD;
- Cost at cell level < 75 euro/kWh.

Scope: Proposals should address improvements in sustainable materials designs¹³⁷ to reach the manufacturability and high safety of the selected technology.

Successful projects are expected to cover at least three of the following bullet points:

- Improvement of materials:
 - Scalable and manufacturable surface coating materials for metallic anode protection and/or activation (e.g. CVD, PLD, ALD...) to increase safety and cycle life.
 - Binders with high chemical and thermal stability to reduce toxicity and enable the use of water-based manufacturing processes.

¹³⁶ Commission Recommendation (EU/2022/2510) establishing a European assessment framework for 'safe and sustainable by design' chemicals and materials.

¹³⁷ The future Commission initiative for Safe and Sustainable by Design [Reference to updated industrial research site on Europa.eu to be added which will link to the relevant Commission documents. Already available 'Review of safety and sustainability dimensions, aspects, methods, indicators, and tools', under consultation 'Framework for the definition of criteria and evaluation procedure for chemicals and materials'.] will set a framework for assessing safety and sustainability of chemicals and materials and should be considered as a baseline for proposals.

- o Design and development of new cell technologies with higher capacities compared to Li-ion cells.
- o Improve and increase the electrodes-electrolyte compatibility with additives to increase over cell time.
- o Improve the understanding of the chemical and/or electrochemical reaction mechanisms using advanced techniques in the cells for Gen5 technologies developed.
- o Improve the insertion cathode with high charge-storage capacity.
- o Use of safe and non-toxic materials.
- o New efficient and sustainable catalysts that can promote polysulfide conversion in Metal-S batteries or the oxygen evolution/reduction reactions in rechargeable Metal-air batteries.
- Design and manufacturing:
 - o Innovative cell design ensuring high performances, low cost and ready for recycling.
 - o Develop relevant manufacturing processes and assess the possible manufacturing compatibility with the existing lithium-ion production infrastructure and production lines.
 - o Proof of concept possibly at small pilot line scale.
 - o Design production with low environmental impact, safe and healthy environment for workers, low energy consumption.

Projects are encouraged to demonstrate also techno-economic suitability of the solution for other emerging markets, such as motive power for off-road applications, or energy storage applications.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation and deployment (feasibility study, business plan).

Projects are expected to collaborate and contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08, including the definition of a long-term research roadmap for this topic.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D2-02-03: Size & weight reduction of cell and packaging of batteries system, integrating lightweight and functional materials, innovative thermal management and safe and sustainable by design approach (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Widespread electrification of mobile applications is necessary to achieve the goals of the European Green Deal. A competitive European battery value chain will have to deliver highly performant and safe battery systems in order to enable the necessary uptake of electrified mobility applications.

This topic focuses on delivering a safe and sustainable by design approach for batteries reduced in size and weight which will deliver the performance necessary for mobile applications. The objective is to ruggedise energy storage packs by enlarging the environmental and operational conditions in which they can operate, while maintaining a high level of performance and achieving a reduction in the size and weight of the battery pack.

Successful projects are expected to deliver on both following points:

- An increase of the net useful mass and volumetric energy density of the battery system between 10% and 30% compared to the state-of-the-art battery systems.
- The improvement of the safety by design measures throughout the battery lifetime and during operation.

Projects are furthermore expected to deliver innovative thermal management to

- Increase performance over the complete operational conditions

- Enable fast charging requirements 10%-80% in 10 minutes maximum.

The solutions should be demonstrated and validated at application level and should comply with all relevant standards (performance and safety). They are also encouraged to contribute to standardisation of measures for safe thermal management.

Scope: Projects should achieve size and weight reduction by integrating different technologies such as:

- Integration of advanced cell technologies/generations, sensing technologies,
- The use of lightweight and multi-functional materials (including, but not limited to, the use of nanomaterials) that are safe and sustainable by design in alignment with Commission Recommendation (EU/2022/2510) and lightweight structures for battery casing.
- Improvement of the cell to system ratio by adopting innovative packaging approaches to enable smart battery cell concepts. Approaches to reduce the complexity of HV and BMS architecture and substitution by alternatives.

To reach those targets, improvements in both components in the cell and in the pack will be considered.

Proposals are expected to also address innovations in the manufacturing processes that result in size and weight reduction of the packs.

In addition, projects are expected to improve battery performance and safety by demonstrating innovative thermal management systems, which enhance fast charging capability or high-power application during operational lifetime (heating and cooling).

Finally, projects should enhance the safety throughout the full battery lifetime and for failure conditions by developing and demonstrating safe by design measures, for example such as:

- Thermal propagation measures.
- Fire retardant properties.
- Mechanical properties ameliorations.
- Reliability, default propagation/thermal runaway modelisation and simulation.

The effectiveness of safety measures should be demonstrated by simulation at pack level.

The projects are to focus on the battery system level, i.e., on the integration of battery cells into a battery system (e.g., a battery pack), considering mechanical, electrical and thermal aspects.

The integration of battery systems into larger systems of application (e.g., into vehicles structure) can be part of scope (e.g. cell to casing integration) as long as it can be

demonstrated as a possibility to reduce overall packaging space, battery weight and battery performance improvement.

All solutions are expected to consider optimal design for manufacturing, end of life management and LCA analysis and disassembly.

The Commission initiative for Safe and Sustainable by Design¹³⁸ will set a framework for assessing safety and sustainability of chemicals and materials and which should be considered as a reference in the proposal.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with the USA.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

¹³⁸ See documents defining the SSbD framework and criteria on: https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-materials-and-chemicals_en