LC-BAT-8-2020: Next-generation batteries for stationary energy storage

Specific Challenge: Stationary applications such as utility grids and industrial sites require storage applications that have the ability to combine high power and heavy use, going through multiple deep cycles per day, with a long lifetime and maximum safety. In addition, future battery systems should have optimal sustainability throughout the entire supply chain, including the substitution of critical raw materials, second-life, and recycling. Current generation Li-ion batteries, despite their success in e-mobility, may not be the ultimate solution for stationary storage; in addition, the growth of Li-Ion battery market is not enough to meet the demand for stationary and e-mobility applications. Interest in next-generation Li-ion and non-Li-ion batteries (for example molten salt, metal-air, lithium-sulphur, new ion-based systems) for these applications is growing, but many fundamental and technological obstacles remain to be overcome. This challenge is in line with the identified priorities in the context of the SET-Plan.

Scope: The objective is to develop and validate or demonstrate innovative next-generation battery technologies for large-scale stationary energy storage that have a low cost, high safety, high depth of discharge, and high cycle life and efficiency. Development must include the integration of sensors and/or battery management electronics in the cell, and the potential for upscaling the battery systems. The battery systems should have optimal sustainability throughout the entire supply chain, including the substitution of critical raw materials. A key issue is the design of an efficient production process with minimal environmental impacts across the whole life-cycle, including recycling. Solutions must be validated or demonstrated in a relevant environment. Since cost is the most important driver for grid scale electricity storage, targets for key performance indicators such as capital cost, storage cost and end-of-life cost should be set. "Balance of plant" components should be included in cost estimates.

The activities are expected to bring the technology from TRL 4 to TRL 6 (please see part G of the General Annexes).

The Commission considers that proposals requesting a contribution from the EU of between EUR 6 and 8 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact: Project results should put the energy storage cost on the path to fall below 0.05 €/kWh/cycle by 2030.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-BAT-9-2020: Hybridisation of battery systems for stationary energy storage

Specific Challenge: Advanced batteries are expected to play a major role in electricity grid management in systems with a high share of renewable electricity. The need for simultaneously

providing multiple services (e.g. artificial inertia, frequency regulation, renewables balancing, load levelling, backup power and longer-term energy storage) requires compromises between power needs and energy needs. Hybrid battery systems can provide the ability to optimise power/energy performances by the combination of different technologies. Such hybrid systems would reach better business cases by mixing the contribution to different services and/or products. This challenge is in line with the identified priorities in the context of the SET-Plan [1].

Scope: The objective is to develop and demonstrate optimised innovative battery storage systems based on hybridisation. The resulting storage system can be engineered either by the twinning of distinct systems, or internal hybridisation of cells and control systems. Focus should be on cell and stack design, on advanced battery management systems and on high-level, hybrid storage control systems. The hybrid storage systems may for example be optimised for one or more of the following applications:

- Stand-alone provision of services to the interconnected pan-EU grid
- Provision of services to island grids
- Provision of services in weak distribution grids
- Provision of services in private grids such as industrial parks
- Provision of load levelling for EV charging service stations.

The activities are expected to bring the technologies from TRL 4 to TRL 6 (please see part G of the General Annexes). The battery systems should have optimal sustainability throughout the entire supply chain, including the substitution of critical raw materials. The systems should be demonstrated in a relevant environment and at a scale that allows future business cases to be developed.

The Commission considers that proposals requesting a contribution from the EU of EUR 3 to 4 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact: Increased competitiveness of electrical energy storage by balancing power needs with energy needs, providing a more efficient system with a longer and better performing lifespan, and by optimising balance-of-plant and installation costs. Project results should put the energy storage cost on the path to fall below 0.05 €/kWh/cycle by 2030.

Type of Action: Research and Innovation action

[1] https://setis.ec.europa.eu/sites/default/files/set_plan_batteries_implementation_plan.pdf

LC-BAT-10-2020: Next generation and realisation of battery packs for BEV and PHEV

Specific Challenge: To accelerate the mass market take-up of battery electric vehicles (BEV) and plug-in hybrids (PHEV), it will be necessary to increase the density of battery packs in terms of weight and package space in order to improve range and decrease weight. Moreover, shorter charging times for BEVs through high-power charging will enable travelling over longer distances, imposing further challenges on cooling needs. Higher performance of battery pack raises safety issues which require more robust and flexible advanced Battery Management Systems (BMS). A special attention shall be given to battery pack sustainability through the whole lifecycle – from material choice and pack manufacturing, to battery pack reuse and recycling.

Besides research on advanced electro-chemistries and cell manufacturing, which are not part of this topic, the integration of battery rechargeable cells into battery packs plays an important role. However, the manufacturing of battery primary cells and their electrochemistry influences their shape and thermal behaviour and hence also the way how they can be integrated into modules and battery packs.

Advanced concepts of BMS relating to hardware and software enabling cell/module/pack communication need to be developed in order to maximise the performance of the final battery system used in vehicles. Safety and modularity aspects must be taken into account when increasing battery pack energy density. When aiming at large-scale production of high-density battery packs, manufacturing processes of modules, and their easy and efficient integration into packs need to take into consideration the choice of materials and requirements related to safety, quality, and fast and cost efficient fabrication. Also, health and environmental aspects of advanced battery pack materials shall be considered over the lifecycle including cases of failure, and reuse/recycling.

Scope: Proposals will have to address all of the following technical areas:

- Design of advanced battery packs and systems satisfying lightweighting, crashworthiness, electrical and thermal requirements using advanced lightweight materials improved packaging, integration and modularity while considering aspects of manufacturing and dismantling (including their automation), reuse (second life) and recycling/sustainability.
- Development of specific solutions and processes for the sustainable dismantling and recycling of battery pack/modules and their materials, components and sub-systems taking into account safety and automation.

- Flexible advanced battery management systems capable of being used on different types of packs and mid-sized vehicles with different use patterns, and underlying provision to be used in second life applications.

- Advanced functionalities of battery management systems to enable control of modules and packs and their remote maintenance and troubleshooting, software updating and other functions.

- Special attention shall be given to high voltage systems compatible with high-power ultra-fast charging and related implications, including insulation, advanced models (including for instance data mining and big data on existing databases) for monitoring thermal state and estimation of application-dependant State of Health (i.e. in first and second use).

- Development and qualification of future performance-related test procedures of developed functionalities under real-world conditions, incl. extreme environmental conditions.

- Concept validation of battery performance functionalities at full scale shall be demonstrated through pack integration into an existing vehicle (no vehicle development can be included in the scope) which shall also serve as a benchmark of achieved performance.

- Development and qualification of future safety related test procedures e.g. venting/management of gases, battery failure warning signals, thermal propagation.

- Developed module concept scalability to heavy duty vehicles of busses would be beneficial, but not obligatory. Same applies to concept transfer from BEV to PHEV and vice versa.

The Commission considers that proposals requesting a contribution from the EU of between EUR 8 and 10 million would allow the specific challenge to be addressed appropriately

Expected Impact:

- 20% reduced battery system weight at constant electric vehicle range for mid-size battery electric car.

- 25% shorter recharging time with a 150kW charger compared to best in class electric car available on the market in 2018. The demonstor must have the same battery capacity as a reference car and meet the useful life of battery mentioned below.

- Extended useful life of battery to 300 000 km in real driving referring to a mid-size passenger car using improved battery balancing and thermal management during high-power charging/discharging.

- The combination of these improvements with new components and functionalities on the vehicle (LC-GV-02-2018 and on infrastructure side coming from topics LC-GV-01-2018, LC-GV-03-2018)) should allow the development of new concepts for affordable FEVs which enable long duration trips (e.g. 700-1000km day trips across different Member States) with not more than respectively 60-90 minutes additional travel time in comparison with ICE vehicles and without additional degradation impact on the FEV powertrain including the battery when used for max 10% of the charging events.

- Considerably improved knowledge on module and pack sensorisation and thermal management.

Type of Action: Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-BAT-11-2020: Reducing the cost of large batteries for waterborne transport

Specific Challenge: Large battery packs are increasingly deployed to improve the efficiency and to eliminate emissions from waterborne transport. However waterborne transport batteries can be up to ten times more expensive than an automotive battery of equivalent capacity and their high cost is an important barrier to increasing the deployment of both hybrid and fully battery electric shipping. Unlike for other transport modes, the space, weight and consequently power density of waterborne transport batteries is usually of secondary importance within the systems total life cycle cost. Several factors contribute to the cost difference including production processes, safety certification, fire suppression, economies of scale and assembly costs. The challenge is to substantially reduce the cost of large waterborne transport battery systems and cells for both marine and inland waterway transport applications.

Scope: Proposals can address either the battery cell or the battery system (racks, battery management system, fault detection and any integrated fire suppression) or both the cell and battery system.

All the following aspect should be addressed:

- With respect to waterborne transport, research and develop a large battery system and/or battery cell that is substantially cheaper with respect to existing system.
- Work should be applicable to battery systems of at least 1 MWh capacity.
- Prove the technology and manufacturing processes through system trials and testing.
- Address production process efficiency.
- Address the requirements for type approval from relevant authorities including a comprehensive risk based safety assessment.
- Undertake a cost benefit analysis to convincingly demonstrate the cost savings in comparison to current state of the art waterborne battery technology.
- Assess end of life and disposal strategies.
- Develop a convincing business case and consider potential financing models.

The Commission considers that proposals requesting a contribution from the EU of between EUR 8 and 12 million would allow the specific challenge to be addressed appropriately.

Expected Impact: The principal impact should be to substantially reduce the lifetime cost of large waterborne battery systems and to enhance the competitiveness of European industry within the waterborne battery market. Cut greenhouse gas emissions from waterborne transport. Increase the European skills base in large battery technology and manufacturing processes. Support European jobs and growth. Increase confidence in waterborne battery technology investment. Towards most short range freight and ferry services becoming zero emission.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETBAT: A large-scale research initiative on Future Battery Technologies

At the dawn of a new, connected, green era - represented by autonomous vehicles, smart cities, smart grids based on renewable energy sources, drone aircrafts, robotic devices, - reliable and safe batteries with ultra-high performance are becoming essential. Novel cross disciplinary approaches empowered by digital technologies can accelerate research on the next generations of smart, safe and high-performing batteries. They will provide Europe with a competitive advantage in the fast growing market of electro-chemical energy storage and will be key for the development of a world-class European industry capable of addressing the needs of many sectors, including e-mobility and renewable energy storage.

This call kick-starts the support to a large scale research initiative on Future Battery Technologies.

Proposals are invited against the following topic(s):

LC-FETBAT-01-2020: Novel methodologies for autonomous discovery of advanced battery chemistries

Specific Challenge: The performance and durability of existing batteries are limited due to insufficient knowledge in managing the complex and dynamic processes taking place in the materials and in particular at the interfaces/interphases within the battery cell. The long-term challenge is to integrate advanced multi-scale computational modelling, materials synthesis, characterization and testing to perform closed-loop autonomous materials findings and interphase engineering that would accelerate by at least a factor of 5 the discovery of new battery chemistries with ultra-high performances.

Scope: The target is to develop a pilot materials platform for computational and experimental material characterization that would pave the way towards the development of a full-scale autonomous battery Material Acceleration Platform (MAP) enabling closed-loop materials discovery, automated characterization, device-level testing and addressing aspects related to

manufacturability and recyclability. The pilot MAP should deliver a complete blueprint of the targeted autonomous material discovery platform and demonstrate key features such as: the ability to use modeling, simulation and machine learning techniques to determine optimal materials composition, the ability to autonomously direct an automated material synthesis robot in optimizing selected battery materials and the ability to perform autonomous analysis and interpretation of experimental data and of deriving previously unknown structures and compositions. The pilot MAP should demonstrate the potential of this novel approach on a specific test case targeting the optimization of specific advanced or emerging battery chemistries. It should be sufficiently flexible to be adaptable for future disruptive battery chemistries, concepts and technologies and for integrating aspects like manufacturability, ageing, degradation and recycling of importance to the entire battery lifecycle. Proposals should be specifically targeting battery interfaces such as the Solid Electrolyte Interphase and the Cathode Electrolyte Interphase that are critical for the battery functionality, as well as controlling their formation, composition and morphology.

The Commission considers that proposals for Research and Innovation Actions of a 3-year duration and requesting a contribution from the EU up to EUR 20 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals of another duration and/or requesting other amounts. . Up to one project will be selected for funding under this topic.

The project partners shall make provisions to actively participate in the common activities of the large scale research initiative on Future Battery Technologies and in particular: coordinate technical work with the other selected projects of the call H2020-FETBAT-2020; and contribute to the activities of the Coordination and Support Action defined under the topic BATFLAG-04-2020.

Note that special Grant Conditions will apply for projects granted under this topic. Please see under Call Conditions.

Expected Impact:

- Demonstrate a fundamental paradigm shift in the materials discovery process for clean energy materials, yielding to a significant acceleration in the development cycle for future battery materials and technologies, which cannot be achieved using conventional Edisonian type trial-and-error approaches.
- Demonstrate the potential to achieve a 5-10 fold acceleration in the materials discovery process, e.g. through a reduction in the number of required experimental trials.
- Demonstrate the ability to improve the performance of the selected battery interfaces with the developed methodologies.

Type of Action:

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-FETBAT-02-2020: Sensing functionalities for smart battery cell chemistries

Specific Challenge: Today, battery performance monitoring and control basically takes place only at the module or battery pack level via a battery management system (BMS). To gain a full supervision and thus control of the battery system and to increase their quality, reliability and life (QRL), it is necessary to monitor in operando the battery performance and control of their state of health (SoH), state of charge (SoC), state of energy (SoE), state of power (SoP) and state of safety (SoS). The challenge is to incorporate smart functionalities into the battery cell for following in time and space different relevant cell component parameters such as temperature variations, interface and interphase dynamics, structural changes by the integration and development of various sensing technologies so as to facilitate control of individual cells within the battery system.

Scope: The target is to develop a proof of concept for the establishment of successful sensing technologies capable of monitoring changes within a battery cell under various operation conditions, including their use under extreme weather conditions, as a first step towards the development of a wider range of sensing technologies capable of monitoring of cells from various emerging battery chemistries. The proof of concept should focus on the sensing technologies and the integration of sensors in liquid electrolyte cell technologies since it is deemed to be the technology of choice for short to medium term. Proposals should aim at smart functionalities incorporated into the battery cell and relying on the integration and development of various sensing technologies to transmit information out of the cell, in order to facilitate control of individual cells within the battery system. Sensors could be used to simultaneously measure with high sensitivity and resolution changes in multiple parameters, such as chemical composition, strain, temperature, pressure, and concentration of dissolved cations, and this at various locations and for diverse components within the cell, under different use cases, especially during high power charging. They must consider the adaptability of sensors to the targeted cell environment in terms of chemical and electrochemical reactivity, thermal design and foresee boundary manufacturing constraints. Additional constraints such as cost and recyclability of the battery with embedded sensor technology should also be tackled. Data processing within an advanced battery management system (BMS) and the synchronization with sensor data coming from the module and the pack level, incl. provisions for conflicting data management, is another essential aspect. Advancements towards standardisation of the BMS could also be included. With this regard, collaboration shall be ensured with the topic LC-BAT-10-2020: Next generation and realisation of battery packs for BEV and HEV.

All results shall demonstrate significant improvements compared to the state-of-the art technologies, incl. benchmarking to initiatives or projects supported under national funding schemes.

The Commission considers that proposals for Research and Innovation Actions of a 3-year duration and requesting a contribution from the EU of EUR 2 and 4 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals of another duration and/or requesting other amounts.

The project partners shall make provisions to actively participate in the common activities of the large scale research initiative on Future Battery Technologies and in particular: coordinate technical work with the other selected projects of the call H2020-FETBAT-2020; and contribute to the activities of the Coordination and Support Action defined under the topic BATFLAG-04-2020.

Note that special Grant Conditions will apply for projects granted under this topic. Please see under Call Conditions.

Expected Impact:

- Increased quality, reliability and life (QRL) of the battery system by maximizing the performance and safety of the complete battery system over its lifetime, including forecasting the remaining lifetime under different use cases, especially the suitability for possible "second life" usage.
- Assured best possible performance and lifecycle for a range of applied cell types at lowest cost
- Industrial opportunities for exploiting new concepts and technologies for integrating multifunctional sensor capabilities in the battery cells and for optimizing the performance of the complete battery systems
- Better identification of defective cell components, allowing replacement of components or introduction of local targeted repair mechanisms, such as self-healing, in future cell design and chemistry generations.
- Improved knowledge on different factor (use patterns, ambient temperature etc.) impact on battery performance and characteristics.
- Provide the foundations for collecting large amounts of data that can be used for autonomous discovery of future battery chemistries and for development of advanced modelling approaches to improve current chemistries with a view of optimizing cell performance for mobility applications (linking with topic LC-BAT-6-2019)

Type of Action:

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-FETBAT-03-2020: Self-healing functionalities for long lasting battery cell chemistries

Specific Challenge: Increasing our daily dependence on batteries calls for increased efforts in ensuring their quality, reliability and life (QRL). While sensing is the natural instrument to monitor and control QRL, it can also serve to identify defective components and local spots in the cell that need to be repaired by injection or addition of self-healing functions.

Scope: The target is to deliver a proof-of-concept for the realization of battery cells with the proper repairing additives and to elucidate the modus operandi of the specific self-healing functionality by advanced analytical tools. Proposals should aim at developing innovative auto-repairing approaches for cell components such as mechanisms for on-demand administration of molecules that can solubilize a resistive deposit or at injecting self-repairing polymers to restore a defective electrode within the battery. They should lay the foundation for a sound scientific platform on battery self-healing relying on chemical/physical tooling. Whatever the pursued approach, it will have to comply with the electrochemical environment of the targeted cell environment, be readily adaptable to battery cell mass production processes and not hinder subsequent recycling process. The competitive advantage over alternative approaches like replacement or recycling or second-use should be demonstrated.

The Commission considers that proposals for Research and Innovation Actions of a 3-year duration and requesting a contribution from the EU of EUR 2 and 4 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals of another duration and/or requesting other amounts.

The project partners shall make provisions to actively participate in the common activities of the large scale research initiative on Future Battery Technologies and in particular: coordinate technical work with the other selected projects of the call H2020-FETBAT-2020; and contribute to the activities of the Coordination and Support Action defined under the topic BATFLAG-04-2020.

Note that special Grant Conditions will apply for projects granted under this topic. Please see under Call Conditions.

Expected Impact:

- Increased quality, reliability and life (QRL) of the battery system by extending the lifetime of the battery cells and maximizing their performance
- Industrial opportunities for exploiting new concepts and technologies for integrating self-healing capabilities in the battery cell.

Type of Action:

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-FETBAT-04-2020: Coordinate and support the large scale research initiative on Future Battery Technologies

Specific Challenge: To network and coordinate the large scale research initiative on Future Battery Technologies and its contribution to the broader efforts of the European research and innovation stakeholders in battery technologies foreseen at European level and in the Strategic Energy Technology (SET) Plan[[See https://ec.europa.eu/en/topics/technology-and-innovation/strategic-energy-technology-plan]].

Scope: Proposals are expected to coordinate the research activities and the stakeholders participating in the initiative; to facilitate communication, dialogue and cooperation on cross-cutting topics; to monitor the initiative's progress and maintain its roadmap; to provide support to its governing bodies; to promote and communicate the objectives of the initiative and its achievements, including by ensuring media presence and public visibility, by engaging with industry and society and by participating or organising outreach events; to identify training and education needs and promote European curricula in future battery technologies. In particular, proposals should identify and coordinate relevant efforts for modelling and data sharing, standardisation, IPR actions in cooperation with other relevant initiatives at European level. They should also help networking and collaboration with other relevant national and international activities in the field.

It is expected that such an activity is driven by representatives of the relevant actors of the field (e.g., from academia, RTOs and industry).

The Commission considers that proposals for Coordination and Support Actions of a 3-year duration and requesting a contribution from the EU of up to EUR 2 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals of another duration and/or requesting other amounts.

Note that special Grant Conditions will apply for projects granted under this topic. Please see under Call Conditions.

Expected Impact:

- Fostering the technological, economic and societal impact of the initiative and paving the way to industrial exploitation of future battery technologies in key energy or transport application domains
- Well-coordinated European initiative on future battery technologies, involving all relevant stakeholders and linked with relevant international, national and regional programmes.
- Spreading of excellence in future battery technologies across Europe, increased awareness of European activities and availability of European curricula in the field.
- Increased synergies and collaboration between the relevant research and innovation stakeholders in Europe as well as with major initiatives that already exist or are under preparation.

Type of Action:

The conditions related to this topic are provided at the end of this call and in the General Annexes.