Innovate UK

Results of Competition: **Faraday Battery Challenge: Innovation Feasibility Studies - Round 2**

Competition Code: **1801_FS_TRANS_BATTERY_R2**

Total available funding is £2 million

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
DEREGALLERA LTD	Feasibility project to dramatically extend 1st life via next generation battery management systems	£332,643	£232,850
University of Hertfordshire		£129,854	£129,854
University of South Wales		£35,066	£35,066

Project description - provided by applicants
Growing adoption of electric vehicles in the automotive industry has led to surge in demand for high output batteries. The power profile of typical EV use is harmful to the electrochemical process of any battery. Hybridisation of high power-density supercapacitors with high energy density batteries has been shown to dramatically prolong battery life, by shielding the battery from the majority of small charge/discharge cycles. In this project, Deregallera will partner with the University of South Wales, and the University of Hertfordshire to develop a feasibility demonstrator system, which will be tested with input from industry stakeholders. The University of Hertfordshire - Automotive Engineering group offers a focus on innovative technologies associated with the alternative propulsion technologies such as fuel cell technology and electric vehicles. They also provide expertise in automotive design, vehicle dynamics and engine testing and mapping. Collectively the group has extensive experience in the automotive and motor-sport sectors. The Centre for Automotive and Power Systems Engineering (CAPSE), based at the University of South Wales, has a wide range of testing/evaluations using their EV Energy Storage and Drive train R&D Facilities, which include battery, ultra-capacitor, fuel cell, fly wheel and other energy storage technologies. This facility has over one mega-watt of testing capacity and houses Wales's only 4 wheel drive direct hub dynamic chassis rolling road system.

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3M UNITED KINGDOM PUBLIC LIMITED COMPANY	Preliminary Feasibility Study of Lithium Ion Battery Safety (PreLIBS)	£49,344	£24,672
Health and Safety Executive - Science Division		£200,013	£200,013
JAGUAR LAND ROVER LIMITED		£69,941	£34,971
LIFELINE FIRE AND SAFETY SYSTEMS LIMITED		£117,326	£82,128
POTENZA TECHNOLOGY LIMITED		£35,655	£24,959
University of Warwick		£45,481	£45,481

Project description - provided by applicants

The Faraday Challenge (FC) Round 2 is designed to support the creation of a viable UK electric vehicle (EV) battery supply chain with an emphasis on safety of Lithium Ion Batteries (LIBs). A major known concern relating to the use, transportation and storage of LIBs is the need to "eliminate _thermal runaway_ risks for enhanced safety". PreLIBS (Preliminary feasibility study into Lithium Ion Battery Safety) aims to develop an understanding of key areas linked to this area. The study will act as a precursor for further research.

It is envisaged that the industrial benefits would include:
* Manufacturers taking Lithium-Ion battery safety responsibly and benefiting from enhanced solutions to address Thermal Runaway and subsequent Thermal Propagation mitigation strategies
* The ability to predictively model fire propagation would allow the optimisation of solutions -- delivering lighter weight and lower cost without reducing safety
* Encouragement of an increased uptake of EVs, providing greater efficiencies in use over ICEs
* UK LIB safety testing at HSL would give UK manufacturers an early advantage in taking these technologies to market
The PreLIBS team is made up of a consortium with members from Jaguar Land Rover (JLR), Warwick Manufacturing Group (WMG), Health and Executive, Science Division (HSL), Warwick Fire, Potenza Technology, Lifeline Fire and Safety Systems Ltd (Lifeline) and 3M UK PLC (3M); knowledge and expertise would be pooled to navigate the challenge. A review of existing literature would be conducted with a focus on Standards & Regulations. Data from a preliminary body of test and modelling work, which would provide initial guidance for sensing and mitigation solutions, considering a variety of potential materials.**Key deliverables from the PreLIBS study would include:**
* **Guidance on navigating and evidence to inform the standards**
* **Analysis of sensing and detection methods**
* **Evaluation of material effects in thermal runaway**
* **Cell and cell group data to inform modelling and material design**
Industry, including battery manufacturers and organisations using batteries in their products, is actively seeking information about how to integrate battery safety into their products, processes, and procedures. These concerns need to be addressed now to ensure that safety issues do not become barriers to the effective and safe deployment of LIB technology for EVs.

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LINA ENERGY LTD	LiNaMan - Sodium Battery	£119,088	£83,362
CENTRE FOR PROCESS INNOVATION LIMITED		£79,989	£79,989
Lancaster University		£35,361	£35,361

Project description - provided by applicants

LiNa Energy is founded upon a novel (patent filed Oct 2017) sodium metal chloride planar cell which unlocks the high power/energy density potential of an established sodium battery chemistry whilst giving many additional product advantages such as vastly improved safety (compared to Li-battery), and reduced product complexity. In addition, the unique LiNa chemistry negates the requirement for expensive and difficult to source cobalt.

The main objective of this project is to take the LiNa concept and apply modern material engineering to demonstrate successful operation. Working alongside LiNa are the Centre for Process Innovation (CPI) and Lancaster University. The consortium will use their considerable skill and expertise to design, develop, manufacture and test the first ever LiNa cell. As defined in the LiNa patent, a central theme of the project is to densify a sodium conducting separator on a planar metallic support. All partners are proven world-leaders in this field. This project also addresses manufacturing scale up by applying modern manufacturing methodologies and techniques.

Project success will enable LiNa to demonstrate to already engaged third-parties the enormous potential of LiNa's unique battery. These include a major; electrode material supplier, automated manufacturing equipment supplier, two battery manufacturers and a battery Integrator. All these companies have provided letters of support for LiNa Energy. These companies (and others) will be increasingly targeted as the project progresses as they have expressed considerable interest to see demonstrable results. We will discuss how the technology can be integrated into the next generation of BEV with beneficial impact on vehicle architecture, cost, performance and safety.

Successful achievement of the project milestones will have major economic impacts. These could be realised though the establishment of joint ventures between the partners to exploit IP generated in the project, through to partnerships with current and extended collaborators through future rounds of the Faraday challenge and possibly EU H2020 (and beyond). Protection of IP will be achieved using standard agreements typical within the Faraday Challenge to maximise the swift impact of the research. Both direct and indirect beneficiaries of the project's success could add to the wealth of the nation through the manufacture, sale and servicing of products which contain aspects developed using the results of this project.
The project will complement existing Faraday Challenge projects by adding a strand currently missing from the portfolio and support the UK in a fresh sodium technology ideally suited to automotive applications.

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GRANTA DESIGN LIMITED	A holistic battery design tool: From materials to packs (MAT2BAT)	£118,415	£71,049
DENCHI POWER LIMITED		£69,518	£48,663
Imperial College London		£139,904	£139,904

Project description - provided by applicants
Battery pack designs vary significantly depending on applications and requires careful consideration of the selection of suitable cells as well as materials to make packs such as housings and coolant systems. The increasing diversity of cell chemistries and the already expansive material selection choices for structural components, means that the design space for battery packs is extremely broad. There are several computation tools which aid detailed design of battery packs, however, there are seldom tools which have a holistic view of the battery pack design process from chemistry selection to pack design. The MAT2BAT project will combine Granta's experience of developing material selection design tools with Imperial College London's and Denchi Power's battery knowledge to develop a holistic design tool to explore a growing design space to enable innovative designs. In a time when there is a lack of skilled battery engineers, the MAT2BAT tool will aid in the accelerated development programmes of battery packs for both students and non-battery engineers alike to fill the skills gap.

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CDO2 LIMITED	Current Density Imaging in EV battery modules	£121,302	£84,911
INEX MICROTECHNOLOGY LIMITED		£120,121	£84,085
Queen Mary University of London		£99,655	£99,655
University of Sussex		£114,195	£114,195

Project description - provided by applicants
This project will assess and characterise new and existing techniques for measuring the current flow through EV batteries including based upon emerging quantum sensor technology. A new generation of battery management systems can be developed as a result of these measurement to enhance the life and performance of the battery pack in consumer vehicles. This will help improve the public perception and trust in this essential new technology. By maintaining an accurate and timely estimate of the state of charge, state of health and thermal properties of the battery, it will be possible to effectively eliminate the possibility of batteries overheating and causing fires, which remains an important consumer concern. The purpose of this project is to assess the feasibility of these new techniques, based upon quantum sensors, to be deployed within a battery management system (BMS). New data processing systems will be developed to assess battery performance and to provide real-time data for and to allow the BMS to maintain the optimal condition of the battery pack in an EV. The project will deliver a battery module demonstrator incorporating the new sensor suite, data processing software and BMS. We envisage that this sensor technology will be disruptive in managing EV batteries and could become a standard requirement of new car certification in order to improve consumer safety, confidence and uptake of EVs.

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MIRALIS DATA LIMITED	SAMBA - Smart Automotive Managed Battery Algorithms	£81,466	£57,026
MILLIAMP TECHNOLOGIES LIMITED		£85,259	£59,681

Project description - provided by applicants
SAMBA (Smart Automotive Managed Battery Algorithms) is a project seeking to develop an innovative health module that integrates with electric vehicle chargers and uses smart algorithm technology to help prolong battery life. Recent research shows that optimally charging and discharging the battery could improve its life by about 10% over a year. Electric vehicles (EVs) are often seen as a key driver towards a greener future and reduced air pollution. There are now almost 110,000 EVs on UK roads, and sales are set to rise sharply. "By 2030, we could see as many as nine million electric vehicles on the road," (Marcus Stewart, National Grid Energy Insights Manager). EV batteries are the crucial component in determining both the price and environmental impact of EVs, as they contain rare earth materials that are cost-intense to extract and difficult to recycle. Increasing the lifespan of EV batteries is therefore not only key to making EVs more economically viable, but also environmentally imperative. Additionally, with rising EV numbers comes a rising demand on the charging infrastructure in terms of available charge points and electricity generation. SAMBA combines cutting-edge smart algorithms, machine learning and innovative technology to optimise EV charging for battery health. Currently, EV owners would want their EV charged to full as fast as possible. This "ICE analogy" behaviour, however, often contradicts the process that would help prolong battery life. It also often results in charge being drawn from national grid at the least opportune times, both in terms of network demand and cost. The SAMBA health module optimises the charging process by smart switching of multiple electricity flows. SAMBA gets added to an existing EV charge point together with a local renewable energy generator (e.g. solar, wind) with its own local battery pack and a two-way connection to the the national grid. The algorithms then intelligently manage battery needs, e.g. discharge completely before recharging, in order to prolong battery life. The charge post's vehicle-to-grid capability ensures that the charge drawn from the car battery can also be fed into the grid to help meet peak demands and reduce energy costs. Similarly, surplus from the local energy source is fed into the grid. Crucially, the innovative software includes machine learning algorithms that predict charging patterns and manage battery life to always make the optimal choice between charging and discharging from the post's own generator, the grid and the vehicle.

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PST SENSORS EUROPE LIMITED	Printed Temperature Sensors for use in battery monitoring systems working within the cells/batteries	£118,870	£83,209
CENTRE FOR PROCESS INNOVATION LIMITED		£116,646	£116,646

Project description - provided by applicants
Increased safety and performance of electric vehicles is paramount to wider adoption by the public and the UK as a whole; it is also essential to achieving the goals set out in the automotive technology roadmap . A key way to improve safety and performance is to increase the amount of sensor information from the batteries, particularly temperature. PST Sensors offers this unique ability to print temperature sensors that can be developed into arrays that are conformable to a battery cell. Current methods of measuring battery temperature only allow for single point measurements mainly on the charging circuity, which does not provide the whole picture of the cells integrity. PST collaborating with CPI, will work together they to test the up-scaling potential of PST temperature sensors for use in battery monitoring systems. If each cell has its sensor array then the need to produce on scale is paramount, hence the need to use a cheap process like screen printing. Using such a sensors will dramatically reduce the chances of thermal runaway and allow for improved monitoring of the batteries. By improving the amount of information obtained from the batteries, PST envisage a longer life and increased range without altering the current design of EV. This will reduce the environmental impact of the EVs and their batteries further and bring their range on par with combustion engines.

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