Innovate UK

Results of Competition: Faraday Battery Challenge: Innovation Feasibility Studies Round 3

Competition Code: 1809_FS_MMM_ISCF_FARADAY_R3

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
CDO2 LIMITED	Printed sensors for EV battery current density imaging	£108,579	£76,005
ACELERON LIMITED		£48,024	£33,617
BRILL POWER LIMITED		£86,523	£60,566
CENTRE FOR PROCESS INNOVATION LIMITED		£99,167	£99,167
PEACOCK TECHNOLOGY LIMITED		£112,176	£78,523
University of Strathclyde		£19,731	£19,731
University of Sussex		£25,406	£25,406

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
Use the Competition Code given above to search for this competition’s results

Project description - provided by applicants
The growth in the electrification of transport, including electric vehicles (EVs), has been driven by lithium-ion batteries. However, to make the next-generation of vehicles cheaper and more efficient, we need to be able to monitor, diagnose and respond to batteries in real-time. This project aims to combine new types of sensors to feed data into a battery management system (BMS) that will be able to react to the changing state of battery health and charge and improve operational safety. This could lead to an increase in battery life of up to 60%. Crucially, we will look at producing sensors that are robust, sensitive and significantly cheaper than those commercially available. Our goal is that the sensors will be deployed into battery modules at low cost and adopted by industry. Eventually, they may become a requirement for new car certification and help to improve consumer safety, confidence and uptake of EVs. To verify the feasibility of our approach, our consortium covers a range of commercial and academic expertise that will build sensors into a prototype battery pack.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
WARDELL ARMSTRONG INTERNATIONAL LIMITED	Securing Domestic Lithium Supply Chain for UK	£231,852	£162,296
CORNISH LITHIUM LTD		£159,164	£111,415
The Natural History Museum		£106,439	£85,151

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Project description - provided by applicants
The transition to electric vehicles (EVs), and consequent changes to the supply chain, manifests some significant challenges given that manufacturing of cars, trucks and other vehicles is a vital part of the UK 's industrial base. If the country is to maintain its current market share of car production of over 1.5 million units p.a., it is estimated that this will require at least 75,000 tpa of LCE (Lithium Carbonate Equivalent): roughly a third of current global annual supply. Whilst global supply of LCE is expected to rise rapidly much of this additional supply has already been secured by China for its burgeoning battery manufacturing industry and it is therefore increasingly important that the UK investigates possible domestic production of raw materials required for battery manufacture. This project will utilise existing expertise within the consortium to assess the feasibility of extracting and converting a supply of lithium from indigenous sources in order to provide a secure supply of a vital battery material, enabling the UK to become a world-leader in batteries for EVs. Developing such a supply chain is of paramount importance given competition from Asia. Potential sources of lithium and other battery raw materials have been identified in the UK and Europe, and offer potential for the UK to secure a domestic supply of a significant proportion of the lithium a thriving EV industry requires. A fully-integrated domestic supply chain will offset the risks of the UK vehicle industry being destroyed by competition from Asia. This project will leverage existing knowledge to create innovative solutions for the current raw materials gap that exists in the supply chain. The project consortium will assess various processing methods for lithium sources, and the feasibility of locating such a plant within the UK. The project will build on recent work by consortium members during the European-funded FAME project and will assess the viability of taking feedstock from Cornwall, and potentially Europe, and producing a central concentrate for conversion to battery grade lithium chemicals. The FAME project, which focussed on the processing of European lithium ores, was led by Wardell Armstrong International with feedstock characterisation by the Natural History Museum, two of the consortium members for this feasibility study. The third member, Cornish Lithium, is the only company actively exploring the potential for lithium production from novel sources in Cornwall. They bring a highly experienced commercial team with extensive industry and investment banking experience.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
GRANTA DESIGN LIMITED	Intelligent enterprise Data Management platform for BATtery manufacturing - IDMBAT (or HESTIA)	£242,606	£145,564
INTELLEGENS LIMITED		£107,656	£75,359
University of Birmingham		£148,325	£148,325

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Project description - provided by applicants
Responding to the growing battery manufacturing market and significant technical challenges, IDMBAT will address a substantial gap in the market by developing software solutions for battery manufacturers to reduce fabrication and development costs while improving key batteries metrics. This will be achieved by combining the proven benefits of a systematic, enterprise approach to materials information, with new artificial intelligence (AI) capabilities for predicting optimum process parameters from complex interdependencies. The consortium is led by Granta Design (Granta) , the world largest company and R&D organisation operating in the materials information technology market. University of Birmingham (UB, Prof. Emma Kendrick) brings in battery technical leadership and will host a small-scale manufacturing facility to generate data. Intellegens (INT), a fast-growing micro SME, will develop cutting edge artificial intelligence algorithms for process parameter prediction. The proposed feasibility study endeavours to: -De-risk scaling up innovative technologies across the battery value chain (including cell materials and components, cells, modules and packs, manufacturing processes) by means of intelligent, systematic information management approach which reduces future costs of reproducibility by ensuring full traceability and enables predictions and comparisons; -Remove technical and commercial barriers to cell manufacture in the UK (advancement in battery metrics, reduced costs of trials and experimentation, reduce use of materials resources); -Support the overall goal of the Faraday Battery Challenge to make the UK the go-to place for the research, development, scale up and industrialisation of cutting-edge battery technology by building upon existing UK industrial and academic leadership.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
AMTE POWER LTD.	UK - Gigawatt Hour Cell Manufacturing Facility Feasibility (Giga Factory)	£249,711	£174,798
HSSMI LIMITED		£101,388	£101,388

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Project description - provided by applicants
This collaborative innovation project is focused on assessing the commercial feasibility of establishing a scalable Battery Cell Manufacturing Facility in the UK, with the capability to ramp up to a Gigawatt hour worth of cell production (35m units) of mixed pouch and cylindrical cells by the year 2024\. This is driven by the strategic need to establish the UK as a global leader in the development and manufacture of battery cells for electric vehicles. This project will result in the delivery of a business case and manufacturing blueprint for the proposed GigaFactory that will enable AMTE Power to advance their production and supply chain readiness of their battery cells towards the level of capability, scale and cost per Kwh required by the UK's burgeoning EV sector and it's global demand. The project is being led by AMTE Power and delivered in partnership with HSSMI. The project will take place over 12 months and deliver the following as part of the study: * A market assessment that provides an analysis into the size of the market, projected growth, target demographics, partnership and collaboration opportunities and competitor analysis * A building and site specification for the Gigawatt facility, addressing: building requirements, required machinery and equipment for fit out, labour requirements in the build and operation of the facility, supply chain requirements and an assessment of the potential impact such a facility would have on land, zoning laws and the surrounding environment and local habitats. * An Economic assessment of where to locate the facility, taking into consideration the cost benefits in relation to: access to suppliers, knowledge partners, customers, a local skills base, and the availability of regional economic incentives. It will also take into consideration the resultant environmental and socio-economic impacts the facility will have on local habitats, town and communities, the supply chain and the surrounding environment. * The definition of a manufacturing strategy that addresses: factory layout, manufacturing specification, production management, logistics (internal and external), Bill of Processes, warehousing, automation, ICT systems, development of smart factory concept, reject strategy and end of life management of the manufactured battery cells. * A factory design concept, illustrated in 3D and accessible through Virtual Reality, that demonstrates the size, fit and flow of the facility. Total Project costs are £350,895

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
ANAPHITE LIMITED	Scaling-up the Production of Graphene-Metal Oxide Composites as Li-ion Battery Materials (GRAMOX)	£349,846	£244,892
University of Warwick		£149,622	£149,622

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
This project is led by Anaphite Limited (UK), a start-up materials science company developing graphene-based nanocomposites for applications in energy storage, photocatalysis and thermal management. Warwick Manufacturing group (WMG) at Warwick University is an academic department with world-leading expertise in research and application of smart, connected, autonomous and electrified transport. This project also exploits state-of-the-art materials characterisation facilities at the National Physical Laboratory (NPL). This project aims to create graphene-metal-oxide nanocomposite materials for applications as electrodes in next-generation lithium ion batteries.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
HOMEODYNAMIC AUTONOMY LIMITED	Technical Feasibility Study (TFS) of Battery Remanufacturing for Electric Vehicles (BATREV)	£158,043	£110,630
ASPIRE ENGINEERING LIMITED		£114,498	£68,699
J D WHITEHOUSE ENTERPRISES LTD		£75,260	£52,682
RECO TURBO LIMITED		£86,094	£60,266

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
The main motivation for the BATREV Technology Feasibility Study (TFS) is addressing the business need for remanufacturing warranty-return & damaged/worn/EoL Electric Vehicle Batteries, (EVBs), the variety & quantities of which are increasing exponentially as vehicle manufacturers compete fiercely in the EV market. The main states-of-the art address high-volume/low-variety EVB-remanufacturing markets, i.e. (i) high-cost fixed-automation, and/or (ii) robots with limited intelligence which is insufficient for technical fitness-for-purpose for small-batch production & frequent change-overs. This provides an immediate and growing BATREV business opportunity as current technologies cannot cope with EVB-disassembly's adverse health & safety conditions, varying levels of wear, corrosion and damage, and part identification/location uncertainty created through in-service maintenance/up-grading/component degradation. BATREV-outputs will be at virtual-demonstrator-level, i.e.: (1) TFSPLAN & TFSSIM database tools of RRE simulation assets enabling (i) creation & visualisation of RRE-scenarios, (ii) RRE mechanical-characteristics, (iii) end-effector motions, (iv) scalability and manufacturability data-collection & output to TFS. (2) TFSOPT AI-enabled tool for optimised RRE Planning & QCDE characteristics. The UK economy benefits from BATREV by providing routes to high levels of import substitution by originally-imported engines being remanufactured in the UK and being substituted by UK OEMs for new imported engines. The Technical Feasibility Study of Battery Remanufacturing for Electric Vehicles (BATREV) project will undertake a feasibility study to identify the scalability, manufacturability and capability of using autonomous robots and autonomous operations planning systems to undertake the remanufacturing of EVBs, i.e. battery-to-component disassembly, operations planning of component repair & reconditioning processes and component-to-battery reassembly. Providing a clear understanding of the processes needed to scale-up will be a primary aim of the BATREV project particularly in terms of: (1) De-risking scaling-up of the innovative autonomous Robot Remanufacturing Engineer (RRE) technology and autonomous operations planning methods. (2) making scaling-up faster and less costly, and (3) providing a clear route to scale-up of RRE technology. BATREV TFS will examine RRE scale-up and its effects on UK competitiveness, and numbers and size of EVB remanufacturers. Social benefits arise through improved job security and employment opportunities from increased organisational growth rates through greater robot enabled productivity. Quality of life impacts inside/outside the consortium are derived from competitive advantage improvements. Environmental and economic benefits arise from (1) reuse of battery components where materials are ~65% of costs, (2) reduced waste, landfill, pollution, CO2 emissions, and (3) reduced lead times hence less factory light & heat energy/EVB-unit, and (4) less energy costs through less factory space requirements.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
JOHNSON MATTHEY PLC	Cathodes, Anodes, and Solid-state Electrolytes for Lithium Ion Batteries (CASE LIBs)	£248,019	£124,010
TALGA TECHNOLOGIES LIMITED		£116,860	£81,802
University of Sheffield		£133,824	£133,824

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
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Project description - provided by applicants
Solid state batteries have the potential to realise significant improvements in energy density (dense material layers) and cycle life (no solvent decomposition) while enabling faster charging and offer improved safety (no flammable solvents). Whilst numerous automotive manufacturers are known to be researching solid state batteries, thus far the technology remains at low technology readiness level and is considered to be several years from commercialisation. This is in part due to handling, processing, and scaled production of the electrolyte materials, as well as ensuring suitable interaction at the electrolyte/active material interface to mitigate persistent issues such as high impedance and mechanical fatigue. This project aims to address these industrial and fundamental challenges by bringing together three leading organisations that are at the forefront of battery materials and ceramic processing innovation. Johnson Matthey (one of UKs largest battery companies and a leading global cathode material manufacturer) Talga Technologies (a SME with extensive experience in graphene production and R&D), University of Sheffield (ceramics group with advanced ceramics processing capability).

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
INTERCAL(UK) LIMITED	Assessment and development of the novel Intercal-Indra Battery Management System "i-BMS"	£98,004	£68,603
INDRA RENEWABLE TECHNOLOGIES LIMITED		£149,945	£104,962
University of Warwick		£71,897	£71,897

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Project description - provided by applicants
WMG (University of Warwick) are collaborating with battery management experts Intercal (UK) Ltd and EV integrators Indra Renewable Technologies Ltd in the third phase of evaluation and development of a novel battery management system (the "i-BMS"). This patented technology has been developed through proof of concept and initial field trials with the aid of two previous Innovate grants. The technology signals a radical departure from prior art by eliminating the need for routine balancing of the cells. This important feature offers scope for a greatly simplified battery pack design and thereby opens up opportunities for cost savings, greatly improved pack maintainability and end-of-life re-use. A major potential benefit identified in completed trials is the potential for very early fault detection, which has major safety and reliability benefits. Tests have shown that, by eliminating all cell balancing currents, the i-BMS can be configured to provide sensitive detection of the first signs of anomalous behaviour by any cell in the pack, thereby allowing timely intervention before any risk of failure or fire develops. The current study will combine advanced modelling and simulations by WMG to evaluate the i-BMS performance, coupled with a supplementary programme of laboratory tests and field trials led by Intercal and Indra respectively. Taken together, these will, if successful, validate the functionality of the i-BMS, including comparison of the pack's usable energy capacity, degradation rate and diagnostic capability alongside conventional BMS solutions. The project will also explore the opportunities provided by the elimination of complex cell balancing circuits, to simplify modular assembly, maintenance and end-of-life repurposing of battery packs. The partners' objective is to develop the technology to a state where it will be available for licensing to third parties for application in automotive, grid storage, aviation and marine battery applications, a growing global market currently in excess of $1Bn annually.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
UNIPART LOGISTICS LIMITED	Project DETAIN: Designing an intelligent EV battery storage facility capable of the DETection and contiAINment of thermal runaway	£89,073	£44,536
ASPIRE ENGINEERING LIMITED		£95,009	£66,506
HORIBA MIRA LIMITED		£187,956	£93,978
INSTRUMENTEL LIMITED		£84,750	£42,375

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Project description - provided by applicants
Project DETAIN brings together the expertise of Unipart Logistics, Aspire Engineering, HORIBA MIRA, and Instrumentel, to develop an 'intelligent' high voltage battery storage solution to mitigate the risks associated with thermal runaway. The consortium have an ambition to use intelligent systems to DETect and contAIN thermal runaway: DETAIN. Project DETAIN draws on the varying expertise, responsibilities and growth ambitions of the consortium to review industry-wide requirements and develop an intelligent storage facility to provide the end-to-end Electric Vehicle supply chain with a sustainable alternative to sacrificial storage and the 'let it burn' approach. The Faraday Challenge has set a target to eliminate thermal runaway at pack level by 2035\. Until that is achieved, the batteries that are designed and built will still be susceptible to thermal runaway, particularly when damaged or faulty, and will need to be safely stored. Project DETAIN aligns with the supply chain need to better manage the batteries currently in production and enable the imminent growth predicted. The project also supports the Faraday challenge for recyclability, as safe and effective storage solutions will be key to development of efficient remanufacturing, reuse for End-of-Life and recycling. To detect thermal runaway there will be three areas of focus: 1) BMS thermal runaway detection algorithms for next generation hardware, 2) externally mounted (on battery) thermal runaway detection systems, and 3) distributed sensor networks for battery storage facilities. To contain thermal runaway, Project DETAIN will investigate automation, fire suppression materials, and combinations of the two, to deliver an effective unmanned containment response when thermal runaway has been detected. The project has additional focus on the safety, legislative and regulatory requirements to ensure solutions being developed are approved by relevant Insurance bodies, and the testing requirements to approve the solution. The feasibility study allows the consortium to fully investigate the potential of an intelligent battery storage facility and understand the requirements to deliver a proof of concept. Project DETAIN's objectives are to: * Complete a holistic analysis of the state-of-the-art processes, products and technology to detect and contain thermal runaway, * Predict how an connected, intelligent storage solution could function in line with safety and insurance requirements, * Produce a gap analysis to identify further developments required, * A design and plan for the proof of concept facility, * Specify the testing facilities required to measure the efficacy of the proof of concept.

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DEREGALLERA LTD	Advanced metamaterials for sodium-ion battery anodes – a scalability and economic feasibility study	£308,190	£215,733
University of Southampton		£128,954	£128,954

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Project description - provided by applicants
The cost of lithium-ion batteries is set to rise substantially in the near future, due to limited availability of lithium and the growing furore over "African blood Cobalt", a key material of automotive LIB. Sodium-ion batteries are a viable alternative but suffer from larger size and weight. This high risk feasibility study seeks to address this by investigating the potential of novel _metamaterial-carbon composites_ as high energy density, highly cyclable sodium-ion battery anodes to manufacture sodium-ion batteries with no significant energy density loss compared to lithium-ion batteries. We will theoretically screen 100,000+ metamaterials for suitability, and synthesise the most promising ones in nanostructured carbon-composite particles.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
PHOTOCENTRIC LIMITED	3D Printing of Solid State Batteries with Controlled Geometry	£220,366	£132,220
CENTRE FOR PROCESS INNOVATION LIMITED		£120,399	£120,399
JOHNSON MATTHEY PLC		£149,071	£74,536

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Project description - provided by applicants
This project aims to develop 3D printed batteries using Photocentric's novel 3D printing process, in which visible light emitted from liquid crystal (LCD) screens, is being used to selectively cure liquid photopolymer with a sub 10-micron accuracy. A major challenge of the 21st century is electrochemical energy storage, thus the production of more efficient batteries. Despite the progress achieved in this field, especially on the development and reliability of lithium-ion batteries, the main challenge remains to obtain batteries with high energy and power density, lightweight, safe and cost effective. The main hurdle for achieving improved battery performance is the current fabrication process include multiple, energy and labour-intensive steps, which has little scope for customisation such as changing geometry. The aim of this feasibility project is to use state-of-the art 3D printing to design and manufacture of battery materials for a variety of battery parts as well as solid state batteries for electric vehicles with accurate control of size, shape and porosity of electrodes to enable high energy density while minimising the overall size and weight. In collaboration with the Centre for Process Innovation (CPI) and Johnson Matthey (JM), we intend to develop 3D printable SSB materials and adapt our 3D printing method for fast and efficient fabrication of batteries. This technology will be tested on small-scale batteries as a proof concept and subsequently scaled up.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
ALP TECHNOLOGIES LTD	Advanced Battery Thermal Control and Thermal Run-Away Cascading Prevention System Using Thermal Phase Change Materials	£166,089	£116,262
Queen's University of Belfast		£46,712	£46,712

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Project description - provided by applicants
This project offers a solution for a low cost and highly efficient thermal management system for Li-Ion battery in electric vehicles while eliminating thermal runaway and cascading risks. This level of safety and performance is especially important in applications such as in electric vehicles due to requirements of high power, energy density, safety and cost. One of the key innovations to prevent thermal runaway and cascading risk while not affecting cooling ability is accomplished by phase change materials that are in solid state during normal operating temperature - allowing heat transfer with coolant. However, in extreme temperature conditions outside normal operation - as during thermal runaway - the same materials phase change to permeable form to allow coolant to directly halt thermal runaway of the affected battery cell. Therefore, this mechanism locally and precisely dissipate heat before critical "runaway" temperature hence cease any possibility of the "cascading effect" or chain reaction from affecting adjacent cells. Another important safety feature in our solutions is the low cost cell-level temperature sensors that can monitor temperature of individual cells to proactively manage any defective or problem cells. This approach also prevent any potential cascading effect to adjacent cells. This electronic system works in conjunction with the physical liquid cooling cycle to direct needed cooling to specific battery module. As a result, the thermal control system can act based on precise cell data within specific module which allow battery management to be predictive and proactive rather than reactive - making servicing and maintenance simpler and always targeted. Finally, the entire construction and engineering of this system take end-of-life treatment into consideration. The design enables assembly and disassembly in 2 minutes using simple and low cost components. This unique feature allows end-of-life recycling and reuse to be much simpler than other types of battery manufacturing and assembly processes. In fact, a key motivation for the design is that each module can be repurposed for other energy applications - such as solar storage - as EV battery pack has remaining capacity of up to 80% at the end of vehicle's useful life. In most situation, these module can remains useful for often up to a decade for a second life as renewable energy storage or backup devices.