Technology Strategy Board
Driving Innovation

Results of competition: IDP8 - Disruptive technologies in low carbon vehicles II

Total funding available for this competition was £11.7m, provided by the Technology Strategy Board and the Office for Low Emission Vehicles (OLEV).

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
ACAL Energy Limited (lead) Revolve Technologies Limited Lotus Cars Limited	Globally innovative and novel platinmum free cathode fuel cell technology for automotive applications	£1,428,628	£830,920

Project description (provided by applicants)

This 24-month project, is a collaboration between two SMEs ACAL Energy Ltd (AE) and Revolve Technologies (RT) with globally renowed Lotus Engineering (LE). This project will take ACAL Energy's industrial level fuel cell technology and deliver a TRL4-5 vehicle compatible prototype power module, suitable for small car vehicle classes (B/C class), install it in a test cell connected to a HiL rig and complete a virtual drive program, designed to demonstrate the highly disruptive nature of the globally innovative, platinum free, liquid redox cathode technlogy FlowCath®. Current conventions for fuel cell electric vehicles (FCEV) at commercial scale are limited to larger and high end priced vehicles due to system level cost expectations and power to weight challenges.

The previous Technology Strategy Board funded feasibility project, showed that the unique, patented FlowCath® approach enables overall system costs of <$38/kW (up to 40% below the very best global forecasts for mass application) and ground breaking savings in the system balance of plant (including reduced battery requirements), durability and performance. With Revolve and Lotus Engineering's exceptional capability and proven track records in vehicle led R&D, the outcome of this project is designed to enable a breakthrough in the range of vehicle applications where fuel cell power trains can be used thereby accelerating the opportunity for wide scale take up of this ultra low carbon technology.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Aeristech Limited (lead) Intelligent Energy Limited IC Consultants Limited	Compact, efficient, low-cost turbomachine compressor for automotive fuel cell systems	£566,125	£374,507

Project description (provided by applicants)

This project aims to make turbomachine compressors available to the fuel cell industry. This requires aerodynamic, electrical, and mechanical innovations, but if successful it will provide the most low-cost, compact, efficient, and scalable compressor for automotive fuel cell systems. The project will use an aluminium, turbomachine-type compressor with volume automotive manufacturing tolerances, direct-coupled to a variable high-speed motor with no transmission. This represents a step-change from roots and screw-type compressors. The project must also design the compressor to cope with a wide flow map to suit fuel cell requirements, as well as to operate without oil contamination to the fuel cell.

Additionally, the electric motor must tolerate highly variable input voltage, reflecting the variations in fuel cell voltage, so that the motor can run directly from the fuel cell's terminals without the need for an additional load on the fuel cell's output DC/DC converter. The project will be led by Aeristech who will apply its proprietary and patented technology in variable high-speed motors for turbomachine direct drive to this unique, oil-adverse, variable-voltage application. Imperial College will provide a compressor design capable of constant boost across a range of mass flows. Intelligent Energy will integrate the electric booster into their fuel cell and fuel cell controller, then carry out performance tests. The project will conclude with a turbomachine compressor working on a fuel cell. Following completion of the project, the system will continue to be refined, improved, and exploited by the partners.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Caterpillar UK Engines Co Limited (lead) Ford Motor Company Limited Lubricants UK Limited Oxford Lasers Limited University of Nottingham	SLIDE: Savings at Lubricated Interfaces Deliver Efficiency	£1,260,360	£812,216
Project description (provided by applicants)			
Caterpillar UK Engines Company Ltd, in partnership with Ford Motor Company Ltd, BP, Oxford Lasers Inc. and Nottingham University, will launch a 2-year program of research in which the basic principles of friction will be re-examined using a novel test rig which will replicate conditions in conventional powertrains, specifically, between the piston rings and the cylinder liner walls. The consortium aims to extend the capabilities of this novel, but practical, test rig to fully validate the new friction models that will be derived. Further, the outcome of this work will include the development of a lubricant formulated to interact with the topography and material of the cylinder and piston rings. In the long term, if all powertrain bearing surfaces are considered, it is believed that a significant improvement in fuel economy is possible by the reductions in friction that will be demonstrated in this project. This research programme, scheduled to start in late 2013, is enabled by an £812,000 grant from the UK government's Technology Strategy Board, and builds on an earlier programme, led by Ford, which was also co-funded by the Technology Strategy Board. The programme of research will be performed across the consortium members' facilites in Peterborough, Basildon, Reading, Oxford and Nottingham.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Cella Energy Limited (lead) MIRA Limited Productiv Limited Coventry University	Hydrogen for Long Range Electric Vehicle (LREV)	£1,110,176	£597,616
Project description (provided by applicants)			
The project addresses the challenge of existing hydrogen vehicle prototypes that use high pressure 700bar tanks; a barrier to the acceptance of hydrogen is perceived risk, cost and mass which a high pressure approach cannot address. In the EU-27 70.9% of all transport Green House Gases emissions are attributed to road transport and transport contributes ~24% of the UK's CO2 emissions. The UK H2Mobility roadmap[2], recently reported, shows that the total CO2 emissions for a Fuel Cell Electric Vehicle (FCEV) can be 75% less than the equivalent diesel vehicle and on a path to zero-carbon by 2050. According to the New Automotive Innovation and Growth Team (NAIGT) and UK Automotive Council roadmaps hydrogen will be the fuel that ultimately drives the transport sector starting with demonstration projects (2010-2020) followed by roll-out (2020-2030). As NAIGT identify, their roadmap is predicated on a breakthrough in storage, and the key to regulatory and consumer acceptance is going to be safety and cost.To date, high pressure hydrogen solutions have been examined for FCEVs. Our new fuel, a solid that stores hydrogen, can safely be handled in air, requires no high pressure, and can be flowed like a liquid, has the potential to drastically reduce cost and complexity of hydrogen refuelling infrastructure as well as overcoming safety concerns associated with high pressure tanks. The output of this project will be a 5kW in vehicle demonstrator utilising this new source of hydrogen.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Cella Energy Limited (lead) University College London MIRA Limited Productiv Limited Unipart Eberspacher Exhaust Systems Ltd	Hydrogen-diesel co-combustion	£594,694	£350,106
Project description (provided by applicants)			
There are reports that suggest that the addition of small quantities of hydrogen can improve the efficiency of the operation of a diesel engine and reduce the emission of particulates and perhaps even NOx. However, the published work is inconclusive and there is no systematic study available in the open literature. In this project we will perform a thorough study at the department of mechanical engineering at UCL in an effort to realize these benefits, optimize the engine efficiency and reduce emissions. In a separate project Cella Energy, the Motor Industry Research Association (MIRA) and Unipart are developing a safe solid-state hydrogen storage system as part of an existing Technology Strategy Board project. In 'Co-Combustion', once UCL have determined the optimum operating conditions, tests will be carried out using this system; first at UCL and then in a 2 litre diesel engine 'mule' vehicle at MIRA. The innovation is three-fold: Firstly, the deployment of a novel hydrogen storage system; secondly, the scientific and technical study embarked upon will resolve many of the remaining questions underlying how hydrogen injection augments ICE diesel efficiency, and thirdly, a unique commercial opportunity to fast track the hydrogen economy - this resides in the critical decision to charge a penalty fee for those vehicles entering a low emission zone with non conforming emissions. Initially this technology will be used to reduce emissions from older diesel vehicles, but ultimately it is hoped that it will be incorporated into new vehicles to augment or partially replace the technology that is currently used to filter diesel engine exhausts, particularly in Low Emission Zones such as London.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Faradion Limited (lead) Williams Grand Prix Engineering Limited Oxford University (Dept. Engineering Science)	Low cost sodium-ion batteries	£847,000	£479,000
Project description (provided by applicants)			
The project will demonstrate the use of sodium-ion technology in low cost batteries for applications in transport and the storage of renewable energy. If it is succesful, it will enable a faster adoption of electric vehicle and renewable technologies. The project is a collaboration between three partners namely Faradion Ltd., Williams Advanced Engineering and Oxford University.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Fusion Innovations Limited (lead) University of Birmingham Potenza Technology Limited Randle Engineering Solutions Limited	Eco Revolution R – Low Carbon Emission Variable Rolling Resistance Wheel	£991,068	£710,959
Project description (provided by applicants)			
The Eco low Rolling resistance tyre or ECORR, project is a follow on from a successful IDP6 feasibility project of the same name. The project focus is a tyre which can adapt it's profile and stiffness dynamically, allowing it to operate in a very low rolling resistance mode, or in a performance grip mode when cornering or braking/accelerating. Analysis undertaken by the University of Birmingham (UOB) as part of the feasibility study concluded that the technology was capable of a step change 7.5% CO2 reduction compared to a vehicle running on conventional pneumatic tyres, and in addition had the potential to improve cornering grip, reduce tyre manufacturing costs, NVH and provide inherent run flat capability. Future development will see ECORR become a fully integrated dynamic component of the Low Carbon Vehicle. To enable this the IDP 8 project has built a consortium between Fusion Innovations, UOB, Potenza Technology and Randle Engineering capable of developing the concept design through to a physical demonstrator and undergoing on vehicle testing (TRL 5). The tyre concept and a supporting generator technology for inflation are both the basis of patent applications. ECORR applies to the majority of conventional wheels, and it is envisaged that full vehicle integration will further enhance operational benefits.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
HiETA Technologies Limited (lead) Delta Motorsport Limited City University University of Bath	Selective Laser Melting for Engines (SLaME)	£1,267,685	£912,388
Project description (provided by applicants)			
The SLaME (Selective Laser Manufacture for Engines) project is designed to exploit the 3-D design freedoms enabled by Selective Laser Melting, a metal powder bed fusion version of Additive Manufacture, in developing SLM components for new lightweight, ultra efficient engines for vehicles, with the aim of contributing to step-change reductions in CO2 emissions. The outputs will include microturbines with SLM components for range extenders for electric vehicles and for Exhaust Energy Recovery engines to convert high temperature waste exhaust heat from the vehicle's main internal combustion engine to electrical or extra shaft power; a "scroll" engine with SLM components, based on mass produced scroll compressor technology, to act as an Exhaust Energy Recovery Engine for lower temperature exhaust heat up to 400C; and SLM components for internal combustion engines designed to improved cooling and air flow, leading to higher efficiencies.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Libertine FPE Limited (lead) Nidec SR Drives Manufacturing Limited University of Brighton	Libertine waste heat recovery unit	£968,923	£644,231
Project description (provided by applicants)			
Libertine is developing novel power generation technology with the potential to substantially improve the efficiency of heavy goods vehicles by recovery of exhaust waste heat to permit engine downsizing and/or serve auxiliary power loads. Further automotive applications in heat recovery and low carbon power generation are anticipated. At the heart of Libertine's technology is an innovative linear expander-generator which integrates a low friction free piston mover with a high efficiency linear generator. In the first automotive application, this expander-generator will be incorporated into small scale (15-30kWe) waste heat recovery systems converting 10-20% of waste heat to power. Nidec SR Drive will contribute to the program with the development of a linear switched reluctance generator and associated controls that will be evaluated in a test cell environment to determine the feasibility of such machines as a thermally-tolerant, magnet-free alternative to present linear machine designs, many of which incorporate permanent magnets.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
McLaren Automotive Limited (lead) McLaren Electronic Systems Limited Oxford University (Dept. Engineering Science)	M2SRM	£1,267,358	£823,727
Project description (provided by applicants)			
The electrification of road transport enables lower carbon emissions. However, conventional motors are not optimised for both weight and cost. This project aims to develop a new variation of switched reluctance machine that has the potential to meet both requirements. The power electronics required will be co-developed to ensure an integrated cost effective package. This project has the potential to make a significant impact on the cost reduction of electrified vehicles.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
MIRA Limited (lead) Dearman Engine Company Limited Air Products Public Limited Company Loughborough University	COOL-E	£1,494,947	£893,159
Project description (provided by applicants)			
The Cool-E project will develop a cost-effective, low carbon system for recovering waste heat to useful power, using the Dearman Engine and liquid nitrogen (LN2) as a fuel. The project will be based on application of the system to a refrigerated truck, a promising early market with potential to offer 80-90% reduction in CO2 emissions from refrigeration, and payback in 12 months of operation. However, the project will also validate the installation of an LN2 system and Dearman Engine on a moving vehicle for the first time, supporting further applications such as waste heat recovery from internal combustion engines (ICEs) for propulsive power, and zero-emission propulsion. These applications will be studied analytically with validation from the vehicle work, to develop a vision for routes to market. Though widely used in industry (and available through existing infrastructure), LN2 is only just beginning to attract widespread interest as an energy vector. John Hayes, former Energy and Climate Change Minister recently wrote that “liquid air has the potential to open a global market worth tens of billions of pounds”. This project brings together world class engineering partners with global reach from the private sector and academia alongside representatives of early adopters to ensure both rigour and market fit.			

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Nissan Motor Manufacturing (UK) Limited (lead) City University Dynamic Boosting Systems Limited Tata Steel UK Limited	Low Cost Laminated Electric Flywheel	£957,021	£647,972
Project description (provided by applicants)			
The project addresses a key area within HEV systems by developing a low-cost Flywheel Energy Storage System (FESS) for mass production that can achieve a significant reduction in transport related CO2. The consortium is led by a high volume vehicle OEM and includes a global materials supplier, SMEs and an academic institute specialising in flywheel technology. The consortium will develop a novel system with low run down losses delivered into a compact package space suitable for incorporation into the vehicle architecture. The project will consist of detailed design, prototyping and test stages and will be carried out by consortium partners who will require the support and development of UK suppliers allowing for the transfer of key skills. OEMs will support both SME and academia to develop their capability to support the automotive industry in a potential high volume environment.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
PAB Coventry Limited (lead) Impression Technologies Limited Lotus Cars Limited Innoval Technology Limited Imperial College London	Ultra-light Car Bodies (UlCab)	£1,117,026	£740,070
Project description (provided by applicants)			
The aim of this project is for a consortium of industry leaders, Lotus Cars, Innoval, PAB Coventry, Impression Technology and Imperial College to develop an enabling technology for significant reduction in carbon emissions from automobiles and therefore help preserve a healthy world environment through pollution reduction. There are two major ways this can be achieved; through making engines and power trains more efficient and therefore transforming a greater proportion of fuel into motive power and by reducing the weight of cars and thus reducing the amount of fuel necessary in normal driving situations. This project is focusing on the second option around body structures as these account for about 30% of overall car weight. The aim is to establish a proven manufacturing route for the manufacture of one-piece aluminium alloy sheet metal components that will be a cost-effective substitute for current steel parts. Several manufacturers are already using aluminium alloy parts in their car bodies, but these cannot substitute directly for steel and are usually made of several relatively simple shapes attached to each other, which makes them expensive and does not achieve the weight reduction inherent with aluminium . Two techniques will be combined in one process; tailor-welded blanks and HFQ (a newly patented hot forming process for enhancing the formability of aluminium alloy) This combination of two novel forming techniques new to aluminium alloy manufacture will enable sophisticated one-piece parts to be made, which are ecomomically viable,eventually for all classes of car and achieve the ulitmate in weight saving of 50 to 60%, compared with steel designs.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Ricardo UK Limited (lead) QinetiQ Limited University of Brighton	HeatWave II	£705,124	£394,123
Project description (provided by applicants)			
HeatWave combines an innovative application of fuel reforming applicable to the global on highway transport market, to generate syngas to improve overall engine efficiency. This novel system architecture deploys UK centric technological building blocks by which, as shown in the recently completed Technology Strategy Board funded feasibility study, a step change improvement in overall engine efficiency, at favourable cost benefits compared to competitor systems, could be acheived. The study showed that the potential benefit for the HeatWave approach could be a 5% fuel consumption benefit on heavy duty vehicles, at a reduced cost compared to competitor technologies. HeatWave II will produce the next level of system validation to deliver a proof of concept demonstration of the technology. To deliver this validation, the programme has been proposed around three activities which answer key risks identified in the feasibility study: Develop refomer process, demonstrate at suitable scale; validate effect of reformate on engine performance through engine testing; develop vehicle systems			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Ricardo UK Limited (lead) University of Brighton Hiflux Limited	Split Cycle Engine	£670,636	£430,381
Project description (provided by applicants)			
The split cycle engine represents a disruptive shift in engine technology that has the potential to radically increase the indicated thermal efficiency of a reciprocating internal combustion engine. The recent 'Cool-R' feasibility study, completed in December 2012 and co-funded by the Technology Strategy Board, suggested that the novel application of cryogen injection and isothermal compression, along with the recuperation of exhaust heat, offers the potential for a game-changing level of indicated thermal efficiency of over 60% for heavy duty diesel engine on-highway applications.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Ricardo UK Limited (lead) University of Bristol GE Aviation Systems Limited Semelab Limited	Low cost novel GaN inverters for 48V automotive applications	£1,045,201	£647,273
Project description (provided by applicants)			
The drive for high efficiency, low cost power converters in automotive applications lends itself well to the use of Gallium Nitride (GaN) power devices. GaN devices are highly efficient, can be switched at speeds significantly greater than that of silicon and this can be capitalised on to minimise external circuit size in inverters and power converters. This project will look at providing an agnostic view of power GaN devices, looking at their characteristics, behaviour and properties and it will consider new and novel converter topologies in which they could be best exploited. Consideration will be made for the thermal behaviour and module designs for their deployment into the automotive market. The cross-sector applications of this technology will be exploited and dissemination through conference, industrial seminars and appropriate mediums will be conducted. Practical testing of the developed inverters will be used to validate the simulation and modelling work. The characteristics of the GaN devices in motor inverters will be shown and practical assessment of the inverter system conducted.			

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Sunamp Limited (lead) Zytek Automotive Limited University of Edinburgh	Heat Store & Processor for Emissions Reduction (HESPER)	£978,659	£587,187

Project description (provided by applicants)

Sunamp pioneered and patented the Heat Store and Processor (HSP) architecture which combines Phase Change Material (PCM) for thermal storage and heat upgrading. In the HESPER project (Heat Store and Processor for Emissions Reduction) developed in the IDP8 framework Sunamp Ltd, Zytek Automotive Ltd and University of Edinburgh intend to demonstrate via tests of HSP at the vehicle sub-system and system levels that:

1.CO2 emission from internal combustion engine (ICE) used in conventional, start/stop, hybrid and plug-in hybrid vehicles can be drastically reduced by thermal pre-conditioning of the cylinder head and catalytic converter;

2. range extension and homogeneity (specifically in variable weather conditions) for electrified vehicles (HEVs, PHEVs, BEVs) can be achieved, avoiding electric battery oversizing;

3. fuel cells startup in cold climate can be facilitated and stresses on electrochemical components reduced;

4. the overall system related to thermal management can be drastically simplified;

5. materials at the core of the technology are safe in automotive environments;

6. the technology can achieve Technology Readiness Level 5 for automotive applications.

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Vantage Power Limited (lead) R&D Vehicle Systems Limited	Next Generation Battery Thermal and Electronic Management Systems	£885,019	£531,011

Project description (provided by applicants)

This innovative development programme between RDVS and Vantage Power focuses on two core areas of interest in large lithium-ion traction batteries for vehicles: the thermal and electronic management. The novel cooling system will be able to substantially increase the lifetime of current installed hybrid vehicle batteries and also provide a fail safe mechanism against thermal runaway of lithium-ion cells - key innovations in driving the growth of hybrid and electric vehicles into the market. The new electronic management system will use a unique method of communicating cell data around the battery pack and in doing so will increase the safety of a high power lithium-ion battery substantially whilst also decreasing the assembly time by 30%.

Vantage Power Ltd are an award winning company in the niche low carbon vehicle industry. They are a provider of diesel-electric hybrid systems for retrofit into buses in the UK as well as to OE bus manufacturers.

RDVS are a leading supplier to the automotive OEM and Tier 1 market of electronic and electrical systems and services. They have extensive experience in electric, hybrid and fuel cell vehicles, both in systems development and volume production.

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Versarien Technologies Limited (lead) Dynex Semiconductor Limited Applied Materials Technology Limited	Integrated Power Modules for Hybrid and Electric Vehicles	£563,975	£317,406

Project description (provided by applicants)

A collaborative project will be undertaken between Versarien Limited, Applied Materials Technology Limited and Dynex Semiconductor Limited which will seek to develop a technology capable of providing world leading thermal management specifically for use in the power electronic modules of electric vehicles and plug-in hybrid electric vehicles. The project will last for 24 months and will be led by Versarien Limited. Over the course of the project a number of component technologies will be integrated to provide a step change over current industry performance. Challenges exist in order to integrate these technologies whilst making sure that the potential performance is maintained. Industry steer is being taken from leading technology players in the field to ensure that the specification of the proposed device is in line with the requirements of the wider industry and remains so throughout the duration of the project.

Without the assistance of the Technology Strategy Board, the project would not have been able to be undertaken and the participants are sure that the completion of such a project will provide an important step towards the UK being a global leader in the development and production of high technology components for the electric vehicle market, a market which is set to grow exponentially over the next 35 years.