The NEWSLETTER

SMMT INNOVATION AND TECHNOLOGY

December 2011

R&D Funding Update

BY Luke Hampton, Technology and Innovation Officer, SMMT

R&D Tax Credits Update

The Chancellor has responded to industry calls to reform the R&D tax credit system, announcing the change to an 'above the line' credit in the Autumn Statement to encourage R&D activity by larger companies. The Government will consult on the detail at Budget 2012 and will ensure that SME R&D incentives are not reduced as a result of this change. The reform will signal the UK's international competitiveness, generate more investment in UK R&D, safeguard jobs and affirm the country's status as a prime location to base high-skill operations. Further details on the Chancellor's Autumn Statement and how UK Automotive will benefit is available here.

Green Bus Fund

The Government has announced an extension to the Green Bus Fund with a £25million third round of funding. Initially launched in 2009, the fund allows bus operators and authorities to invest in low carbon technology for their buses. The two previous rounds of funding totalled £47million and helped put 540 new low carbon buses on the roads. The fund is listed in our Funding and Support document available here.

TSB: Additional Investment to Accelerate Commercialisation of Low Carbon Vehicle Technologies

The TSB have announced a funding call, IPD7, for the commercialisation of low carbon road transport technology. The £25million fund includes £19million of OLEV money, with projects estimated to receive between £500,000 and £5million. Emphasis is being put on developing current UK capabilities and increasing the UK commercial gain from low carbon vehicle technology. An initial networking event will take place on the 10 January 2012 to help build consortia for projects, whilst the competition itself will open on 20 February 2012. Full details are available here.

TSB: Advanced Manufacturing Supply Chain Initiative

The government has announced a new initiative to improve the global competitiveness of the UK advanced manufacturing supply chain. The fund, with a ceiling of £125million, aims to support the growth and development of UK supply chains whilst encouraging new suppliers to manufacture in the UK. The fund could be used for R&D, skills development and/or investment in equipment, depending on the project. Suppliers are being encouraged to submit joint proposals that show potential to benefit the whole of their supply chain. Applications will be taken from early 2012 onwards. More information is available here.

TSB: Boosting Innovation in Manufacturing Competencies

In the New Year, the TSB and Engineering and Physical Sciences Research Council (EPSRC) will be opening an R&D call for projects to develop new production processes that can be used in a wide range of industrial applications. The £6million government fund will focus on production processes that can add value, through improved production techniques, resource efficiency and advanced product manufacture across different sectors. The competition opens on 16 January 2012 and the deadline for registration is the 22 February. A briefing event will be held in London on 25 January 2012. Full details are available here.

The SMMT Funding and Finance List details over 50 sources of grants, loans and support. To access the latest version please click here.

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The NEWSLETTER

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Vehicles Powered By Air

By Professor Peter Bruce, University of St Andrews & Dr. Laurence Hardwick, University of Liverpool

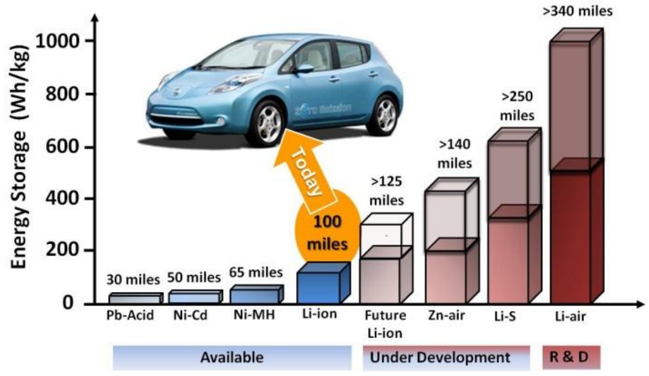
There is no Moore's Law in energy storage, where silicon chips double the number of processors every two years. Historically improvements in energy storage for battery technology have been on a much gentler developmental curve. Our research is based on studying new battery chemistries that can offer industry disruptive increases in energy storage, of which one of the most promising is the lithium-air battery.

The Li-ion Battery

The rechargeable lithium-ion battery offers the highest energy density of all current commercial batteries. It has been one of the major technological success stories over the last two decades. Advances in materials chemistry that have been demonstrated in the laboratory continue to be exploited in new and emerging Li-ion battery technology. The Li-ion battery has transformed portable electronics and is key to the electrification of transport. Its exploitation in electric vehicles (EVs) is now being realised with examples that include the fully electric Nissan Leaf, Mitsubishi i-MiEV, and plug-in hybrid Vauxhall Ampera. Existing EV battery packs have lower energy density than the cells that you find in mobile phones, so significant progress in EV performance and driving range, due to advances in Li-ion batteries, are expected over the next few years.

The best that will be achieved with Li-ion batteries is a 2-3 fold increase in stored energy. To remove the "range anxiety" with a driving range greater than 300 miles, radical new approaches are needed to help bring battery electric vehicles to the mainstream. A step-change increase in battery energy density is therefore required for the long term future of electric vehicles. One possibility is the lithium-air battery; it has the highest energy storage of possible alternative chemistries (see below).

Figure 1. Energy storage for some rechargeable battery chemistries and estimated driving ranges



For future technologies, ranges of anticipated energy storage are given. The values of driving ranges are based on the minimum energy storage for each technology and scaled on the energy storage of the Li-ion cells (140 Wh/kg) and driving range (100 miles) of the Nissan Leaf.

Lithium-Air Chemistry

The lithium intercalation cathode in a typical Li-ion battery (Fig. 2.) is replaced by one based on porous carbon. In a lithium-air battery, on discharge, lithium ions formed at the anode are transported across the electrolyte and into the pores of the porous carbon cathode. Here they react with oxygen entering from the air and electrons from the external circuit. They form lithium peroxide (Li_2O_2), in the case of "non-aqueous Li-air", or lithium hydroxide (LiOH), in the case of "aqueous Li-air", of which both examples are also illustrated in Fig. 2. Non-aqueous Li-air employs an electrolyte which is based on an organic solvent and is water free, whilst aqueous Li-air has an electrolyte made up of salt water.

Remarkably for both examples of Li-air, these reactions have been found to be reversible, $2Li + O_2 \leftrightarrow Li_2O_2$, or $2Li + 0.5O_2 + H_2O \leftrightarrow 2LiOH$, making an attractive rechargeable energy storage device. The increase in energy storage on migrating from Li-ion to Li-air is reasonably straight-forward. It arises because, Li_2O_2 or LiOH in the cathode can store more Li, and hence charge, than $LiCoO_2$ (Li-ion batteries) per unit mass and Li metal stores more charge per unit mass than a graphitic (LiC_6) anode.

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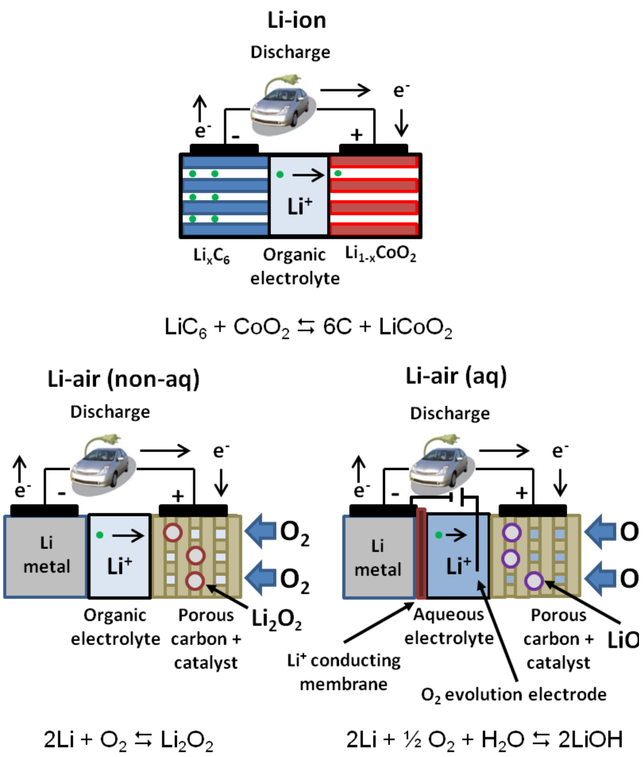
Oxygen, the "reactant", is free (it is an infinite resource, and not yet taxed!) and the main constituent of the air-cathode of practical cells is carbon, both of which represent advantages in minimising the cost of the battery compared to Li-ion equivalents.

Figure 2. The Li-ion battery and the non-aqueous and aqueous Li-air battery



Diagrams detail the differences between Lithium battery chemistries.

The Future of Li-Air Batteries

Li-air batteries hold considerable promise, but they are currently in the realms of research and one cannot expect disruptive technology to go from "concept" to "market" over a period of just a few years. The key challenges to be overcome include:

- Improvement of the cycle life of the battery, with minimal capacity fading
- Development of external membranes which allow ONLY the passage of oxygen though them
- Enhancement of the round-trip efficiency by developing catalysts to promote chemical reactions in the battery
- Increasing power density by utilising nanotechnology to create optimum porous cathodes

Our research encompasses testing and creating new electrolytes for the non-aqueous Li-air battery that are more stable and therefore offer higher cycle life. Early results are encouraging. To improve cycle life further we are working to better understand all the unwanted side-reactions that take place within the air-cathode which gradually consume the electrolyte. Numerous modern spectroscopic and analytical techniques are also employed in order to better understand the fundamental underlying chemistry. Powder x-ray diffraction, infrared and Raman spectroscopies have been used to identify and characterise Li_2O_2 and its reaction intermediates, as well as side-reaction products. Electron microscopy allows us to look at the size and morphology at the nanometre scale of the grown solid discharge product Li_2O_2 within the porous carbon air-cathode. Intelligent electrode design, which offers higher power, is also under investigation. It can be obtained by utilising carbons with controlled hierarchal porosity. These allow efficient transport of oxygen to all the pores, before growing amounts of solid products, either Li_2O_2 or LiOH, block the electrode channels.

Despite the many challenges facing Li-air batteries, our society needs high energy density storage devices, more so than ever before. Li-air batteries are among the few contenders that can exceed the stored energy of Li-ion batteries and therefore will remain of great interest to battery researchers for many years to come.

For further information please contact Peter Bruce at pgb1@st-andrews.ac.uk or Laurence Hardwick at laurence.hardwick@liv.ac.uk

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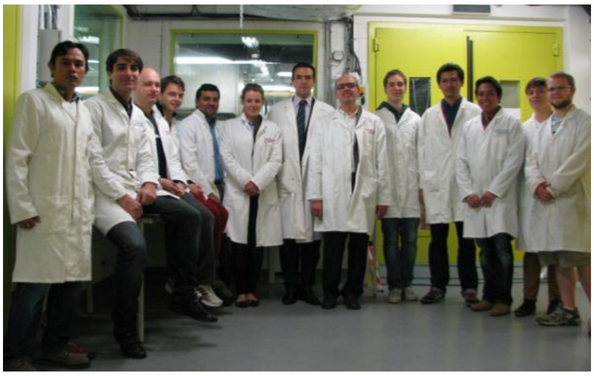
Turbocharger Research at Imperial College: From Downsizing to Unsteady Energy Recovery

By Dr. Ricardo Martinez-Botas, Imperial College London

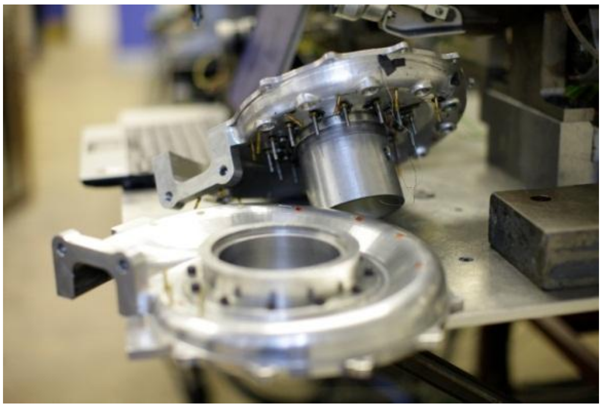
The continued drive to reduce fuel consumption and CO2 emissions from automotive vehicle engines is placing an ever increasing demand on air charging systems for internal combustion engines. Novel solutions beyond the current state-of-the-art have been of primary importance in enabling the automotive industry to meet with the increasingly stringent emissions standards (moving from Euro 5 to Euro 6 in September 2014), yet the scope for improvement remains significant.

At Imperial College London, the Turbocharger Research Group led by Dr Ricardo Martinez-Botas aims to address this. The Group explores the development and advancement of innovative technologies for energy efficient air management in internal combustion engines through computational and experimental techniques. These technologies include active flow control, electric turbo assist and boosting for highly downsized engines.



The Turbocharger Research Group at Imperial College in the newly refurbished facilities, South Kensington Campus.

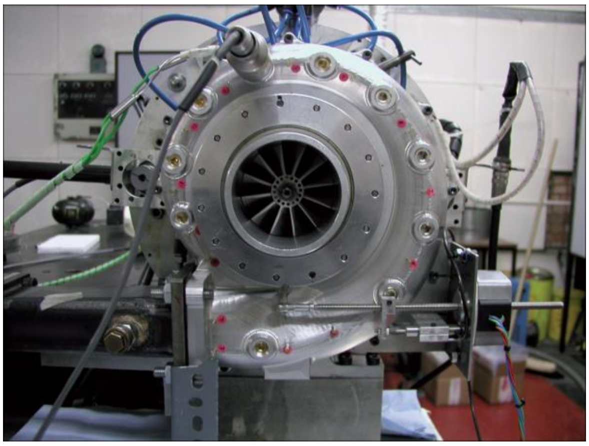
A widely adopted air charging technology is the Variable Geometry Turbocharger (VGT). The benefits accrued by this technology for exhaust gas flow control to the turbine are significant and VGTs have already had a significant impact on the design of diesel engines. They offer significantly improved transient response combined with increased turbomachinery efficiency over a wide operating range when compared to a fixed geometry turbine (FGT) with wastegate. In addition, VGTs have successfully entered the gasoline engine market and continue to capture market share.



Turbocharger turbine volute designed, tested and evaluated at Imperial College.

A fundamental issue that has not been addressed to date is the mismatch between the reciprocating engine and the turbine. Regardless of the engine operating conditions, the inlet flow to the turbine comprises a highly pulsating flow field with widely varying pressure and mass flow rates, which are not ideal for optimal turbine operation. Even with the advent of VGTs this mismatch has not been addressed at all, since existing VGT mechanisms apply a steady-state nozzle setting to capture the cycle averaged pressure and flow energy in the exhaust.

An Active Control Turbocharger (ACT) is one solution to this challenge and is the central topic of one of our projects recently granted EPSRC funding. The concept is a novel application of VGT, where the nozzle is able to alter the inlet area at the throat of the turbine inlet casing (volute) at the same frequency and in phase with the incoming exhaust pulses. The initial development used a simple nozzle system that consisted of a cylindrical sleeve section, translated axially to control the turbine inlet area. This system achieved significant improvements in turbine power extraction in relation to a fixed VGT of up to 7%.



Mixed flow turbine installed in the turbocharger test facility, the ability to perform unsteady tests allows the evaluation of the pressure changes during the engine exhaust period across different locations in the volute.

Along similar lines, it is worth noting that current engine simulation codes rely on user-input turbine maps to predict the performance of turbocharged engines. These experimentally obtained maps are limited in range as they are typically obtained through the use of an aerodynamically limited turbine loading device, the compressor. In order to extend the range of the map for simulation, several fitting techniques are utilized in order to obtain the values of efficiency and mass flow over the entire range of pressure ratios for all speeds. Here at Imperial College London, we have compared the predicted turbine maps obtained from narrow ranges of pressure ratio with more reliable, wider maps obtained experimentally for the same turbines by replacing the compressor with a high speed dynamometer at the same position. The outcome of this investigation can be used to improve the fitting of efficiency and mass flow rate curves in engine simulation software.

Energy recovery is a key goal for fuel efficient internal combustion engines. Imperial has a turbine test facility capable of steady and unsteady operation. For this purpose, the group has developed a state-of-the-art eddy current dynamometer which has a much wider test range than traditional gas test stands. The dynamometer works on the principle of eddy current braking by incorporating 14 magnets onto a rotor. The rotor spins co-axially to a set of stationary water-cooled conducting plates known as stators, which are located, either side of the rotor. The turbine maps that can be obtained cover a range which is around four times the width of standard maps (velocity ratio ranging from 0.3 to 1.1, pressure ratio going from 1.0 to 3.0 and power capability ranges from 500W to 60kW).

Work at Imperial College funded by the TSB under the project Hyboost is focused on developing a method to enhance energy extraction from the exhaust gases of this highly boosted downsized engine. It can be described as an electric turbo-compounding unit that can be fitted downstream of the main turbocharger. The extra energy recovered by the turbine is made available to the vehicle. It can be used to feed batteries that can supply energy to electric units such as superchargers, stop/start systems or other electric units. A design method was successfully applied to the turbine rotor and volute for the low-pressure turbo compounding application. A newly turbine design was developed to recover latent energy of discharged exhaust gases at low pressure ratios (1.05 - 1.30) and to drive a small electric generator with maximum power output of 1.0 kW. The design operating conditions were fixed at 50000 RPM and 1.1 pressure ratio. Commercially available turbines are not suitable for this purpose due to the very low efficiencies experienced when operating in these pressure ranges. The efficiency of the turbine in this extreme condition has been shown to be greater than 70%, opening the way for engine implementation.

In summary, there is a need to achieve a quantified reduction of CO2 emissions through improvements in engine/turbocharger matching through the reliable integration of flow unsteadiness into the design and selection process for turbochargers. This implies a closer relationship between OEMs and turbocharger developers is needed to address the key boosting technologies and unsteady considerations associated with their application in the light of the more complex systems proposed. To achieve high levels of downsizing and hence fuel economy, boosting systems have become a key enabling technology.

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Commitment to R&D Drives New Technology Forward

By Dr. Pete Barrass, Vice President of Engineering, Sevcon

With environmental and energy supply factors continuing to prompt burgeoning international interest in hybrid and electric vehicles, there is intense focus on the development of new electric vehicle drivetrains and component technologies that are capable of meeting modern automotive sector demands in terms of vehicle cost, performance and reliability. At Sevcon, a long-established EV motor controls specialist, R&D has always been a commitment of ours.

Traditionally, our electronic controllers have been used to channel power efficiently from the battery to motors used in industrial and utility vehicles such as fork lift trucks, mining vehicles and airport ground support trailers. In recent years, our expertise in electric powertrains and motor con trol technology has put us in the rapidly growing on-road low carbon vehicle market. During this change of market emphasis, the importance of a continuous commitment to R&D has been crucial in helping the company keep pace with emerging technologies, new engineering innovations and the changing requirements of customers.

In the latest example of this approach, we recently secured over £500,000 in matched funding from the government-backed Technology Strategy Board (TSB) for new research into the development of the next generation of electric drivetrain systems.

Sevcon is leading a team that includes Cummins Generator Technologies of Lincolnshire and Newcastle University's Power Electronics and Drives Research Group. Between us, the team members combine leadership in the development of new electric motor technologies with the supply of the electronics that drive the new electric vehicles and the manufacture of engines for many of the world's commercial vehicles. The collaboration will work specifically on the development of a highly innovative 'no rare earth metals' electric drive system using advanced switched reluctance motor technology.

The market for electric cars and commercial vehicles is expected to grow five fold over the next decade from less than 2 million EV's sold in 2010 to an estimated 49 million by 2020.
But this £120 billion global industry will be held back unless alternatives can be found for the rare earth metals such as neodymium and dysprosium that are currently used in the motors that drive the engines.

The project being undertaken by the Sevcon-led group will look to overcome this situation by developing a new type of drivetrain that replaces the reliance on rare earth metals with new motors using steel. Steel is not only cheaper and less damaging to the environment, but also much more widely available – a key factor in meeting the expected rise in demand for more sustainable forms of transport. The advanced design being developed by the team will also replace traditional electronic control systems with new technology based on cutting edge power electronics. As well as providing sufficent vehicle power, the innovative drivetrain system will also be designed to be both cost competitive and suitable for high volume manufacture.

Preparatory work on the research programme has already started and it is anticipated that the project should be ready for volume production within four years. This is an exciting, cutting edge project in a market sector that has great potential.

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In total in the latest round of awards, the Technology Strategy Board and the Department for Business Innovation and Skills (BIS) jointly agreed to invest £10 million in grants to sixteen collaborative research and development projects that focus on achieving significant cuts in CO_2 emissions for vehicle-centric technologies in low carbon vehicles.

As part of this aim, the Sevcon-led project will help to provide a highly innovative solution for the automotive sector and in doing so will help to sustain the company's technological leadership in a competitive market. Further details are available at www.sevcon.com.

Health Checks and Pollen Readings from the Comfort of your Car

By Alison Wakeham, NPARU, University of Worcester

Recently an article appeared in a national daily broadsheet with the headline that glucose monitoring and pollen readings could soon be in our cars. I was immediately drawn to the article because of my work on bio-sensor technology, forecasting and with allergens at the National Pollen and Aerobiology Unit (NPARU), University of Worcester.

The car company involved in this project is linking up with Medtronic, a U.S medical technology company that manufactures glucose biosensor monitoring devices, to enable you to monitor your glucose level whilst driving, thus avoiding hypo- or hyperglycaemic excursions. The technology is there and with the explosion of rapid point-of-care tests available, your car can become your medical diagnostic laboratory, hosting a myriad of tests including early flu diagnosis. Glucose monitoring is one medical innovation in an automotive setting that could prove beneficial to the driver and improve road safety.

The pollen monitoring system suggested is to be trialled in the US and will provide an 'Allergy Alert' app for the user's smartphone to communicate via the cars infotainment software, giving users voice-controlled access to location-based pollen forecasts. This is similar to the national UK daily pollen and fungal spore forecast with hay fever alerts provided by ourselves at the NPARU. As we already have the necessary information, this could readily be deployed by the UK automotive industry in the manner described above. With our expertise in antibody and DNA based diagnostics, and in-house development of rapid point-of-care tests, we are interested in providing real time systems where fungal spore and pollen aeroallergen level can be measured interactively within the 'in-cabin' car environment. This approach would translate very well to all areas of public transport.

Research by the NPARU has shown that the number of 'hay fever' sufferers has increased in recent years and the trend is likely to continue. Approximately 20% of UK residents now suffer with a pollen or fungal spore allergy, and what was once considered a childhood affliction is now showing itself in more people over 40 years in age than under.

Pollen filters have been fitted in cars as standard for a number of years, however, many hay fever sufferers will know (including me) that a more effective system is required. As Richard Shortis, Managing Director of Wilco Direct, commented recently "the frightening statistic is that if you sneeze when driving at 70mph, you'll be driving blind for nearly 80 metres due to the automatic reaction to close your eyes. That's one end of a football pitch all the way to the opposite penalty area. This highlights the need to ease hay fever symptoms when driving."

The role of the car air filter is to trap particles of dust, pollen and fungal spores. Reports suggest that the vibration of the moving car and the air-flow through the filter leads to allergen leak into the cabin. Scientific studies have reported moderate to abundant outdoor birch and grass pollen concentrations in vehicles equipped with air filters.

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We have to understand that pollen and fungal spore allergens are not solely associated with the grain or spore itself. Pollen and fungal aeroallergen fragments (<1µm) can be present in high concentration in the absence of whole pollen particles or fungal spores and at a level high enough to induce an allergic reaction in sensitised individuals. General solutions to stop dust and pollen are all very well but what you really need is an efficient system that will not only filter out the allergenic pollen and fungal spores but also deactivate the sub microscopic free allergenic particles.

At NPARU we have the facilities and scientific capability to move this and other areas forward for the automotive industry. NPARU has been in existence since 1994 and in recent years expanded considerably. In 2009 a £9m investment has seen the unit re-housed in a new purpose built building with specialist laboratories and a large climatic test chamber with smaller sub chambers. Simulation of worldwide conditions can be achieved and reproduced under laboratory control, which could help inform any design and product development process. Within the large chamber, micro chamber and smaller Remote Air Controlled Systems (RACS) units, we can use gas chromatography mass spectrophotometry (GC-MS) and thermal desorption (TDS) to monitor compounds and pollutants given off from materials held at different conditions. These could be Volatile Organic Compounds (VOCs), formaldehyde emission etc. The TDS is mobile and can be used for off-site monitoring.

The department has an approximate 50 / 50 split between research and commercial duties. Although best known for its national pollen and fungal spore forecasts its research and consultancy on aerobiology, with a strong emphasis on air quality and health is recognised both nationally and internationally.

If you would like additional information on the National Pollen and Aerobiology Research Unit please visit our website www.pollenuk.co.uk or contact Alison Wakeham at a.wakeham@worc.ac.uk, 01905 542 287.

JLR Drives World-Class Innovation with the First Luxury Plug-in Hybrid 4x4

By Kate Owen, Media Co-ordinator, SMMT

Earlier this year, SMMT awarded JLR industry's prestigious innovation award for it's 4x4 plug-in hybrid diesel-electric concept vehicle, the Range_e, a world first that was unveiled at the Geneva Motor Show earlier this year.

The Award, sponsored by GKN Driveline, was launched in 2010 and seeks innovative automotive concepts and technologies which have the potential to transform the automotive industry.

The announcement of this year's winner comes at a time when the global automotive industry is seeing a surge in transition towards ultra-low carbon automotive design and engineering. As vehicle manufacturers focus on increasing fuel efficiency, cutting emissions and going beyond the improvements made to conventional petrol and diesel powertrains, it's evident that the race towards long-term sustainable motoring is well underway.

While low carbon technologies all have the potential to become viable alternatives to traditional power trains, significant research and development is required – which is where the

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Range_e excels. As one of the aspects that impressed this year's panel of judges, was the 12 month development cycle from concept to highly advanced vehicle prototype, demonstrating that JLR has achieved with the Range_e what some automotive counterparts have taken 2-3 years to achieve.

In 2009 JLR entered the Range_e into the UK's largest trial of electric and ultra-low emission vehicles, CABLED (Coventry and Birmingham Low Emission Vehicle Demonstrator) consortium, designed to show real word performance of trials of ultra-low carbon vehicles.
The technology is currently deployed on five Range Rover Sport vehicles and fleet assessment as part of the project is still ongoing.

While the make-up of the Range_e is highly-efficient and technologically advanced, the prototype has been designed with the consumer at the heart of the proposition. The vehicle has been built on an existing Land Rover platform and has an electric motor integrated into a state-of-the-art ZF 8-speed auto transmission, which is mated to a V6 diesel engine.

The Range_e has four operating modes; EV (a HV battery is used to drive the vehicle electrically using the motor), parallel hybrid boost mode (the engine and electric motor deliver torque together for maximum performance) parallel charge mode (the HV battery is charged while the ICE drives the vehicle) and regenerative braking mode (the HV battery is charged via the regenerative braking system and during deceleration, the engine is automatically switched off and braking torque is provided by the electric motor operating as a generator).

It can be recharged from a domestic mains supply, enabling it to be driven in pure electric mode in an urban setting and operate as a parallel hybrid, calling on the diesel engine when high torque is demanded by the driver. Perhaps most impressive is that the Range_e's technology has demonstrated 89g/km CO_2 with a zero-tail pipe emissions range of 23 miles in EV mode.

Commenting on the announcement of this year's winner, Paul Everitt, SMMT Chief Executive, said, "JLR has engineered and manufactured a highly-efficient and technologically advanced prototype vehicle that clearly demonstrates industry's commitment to lowering vehicle emissions and creating exciting products for demanding consumers."

Looking to the future, it is expected that mass-market electric vehicles, plug-in hybrids and fuel cell vehicles will play an increasingly large part in the automotive mix. These developments, subject to infrastructure and technology keeping pace with requirements, present significant opportunities for the UK, both in terms of overseas investment and further environmental advances.

SMMT's Award for Automotive Innovation will return next year to seek the UK's best automotive innovation of 2012.

Initial Results from the Ultra Low Carbon Vehicle Demonstrator Programme

BY Luke Hampton, Technology and Innovation Officer, SMMT

The Ultra Low Carbon Vehicle Demonstrator Programme, funded by the TSB, started in January 2009 and will continue until the end of 2012. This article provides initial findings from the demonstrator trails with a focus on results up to September 2011.

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The trials are focusing on the collection and analysis of user data (usage patterns and user perceptions) to increase the understanding of how to integrate ultra low carbon vehicles (ULCVs) into the UK market. The TSB has provided £25million of funding for 8 consortia across the UK to conduct the demonstrator trials. In terms of numbers the trials have put 340 innovative vehicles on the roads. Up until the end of September 2011 these had been used for 110,389 individual journeys covering 677,209 miles.

Demonstrator participants are all volunteers; however participant selection has ensured that both fleet and private drivers are included in the study. Vehicles have been exposed to multiple users and varying drive cycles throughout all seasons, including the harsh December of 2010. This has provided a wealth of valuable information to better understand user behaviour and perception.

Each participant completed a questionnaire prior to receiving their vehicle in order to measure their understanding and perception of ULCVs. Further questionnaires completed throughout the trials have proved useful in tracking opinion change. Key areas where perceptions have changed over the first three months are highlighted within the following sections.

Range Anxiety and Reality
A key discussion topic around ULCVs, EVs in particular, is the issue of range. In the preliminary question, 100% of users stated that they were more worried they wouldn't reach their destination with their trial car than their normal car. Once the trials started, this figure dropped by 35% within the first 3 months. Results from the MINI-E trial, indicate that after use of the vehicle only 53% of drivers felt limited by the range of their vehicle. While this may still seem a high proportion, when asked what range would be adequate for need, the average response was 150 miles, well below the range of many petrol tanks but above the furthest single journey trip made in the trials of 98.2 miles.

The average journey length across the trial was 6.5 miles which is comparable to that of the UK average trip distance of 7.0 miles. In the case of the MINI-E trial, this average was as high as 9.5 miles. The majority of users stated the vehicles could cope with their daily needs. In the MINI-E trial, for example, 79% of private drivers stated that 80% of their trips could be done exclusively with the vehicle. The most recent results from the TSB ULCV Demonstrator Programme showed that 83% of drivers felt their vehicles met their daily needs.

Charging Characteristics and Infrastructure
The frequency, timing and length of charge varied across the individuals involved in the trials. The variations between habits were largely dependent on personal routine and availability of charging infrastructure. In the case of frequency of charge, users fell into three distinct charging habits; those who charged whenever possible, those who charged at regular intervals, and those who charged when prompted by the vehicle's warning light. 64% of users stated they charged whenever they could. However, results from the MINI-E trial showed that on average, users settled into a pattern of charging every 2-3 days. There was a fairly even distribution across battery charge levels at the start of charge, including cars being charged when batteries had a +75% SOC

66.5% of users charging at home plugged in between 23:00 to 24:00 so benefiting from lower electricity tariffs. The high propensity for users with a Smart Meter to charge during low cost

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periods suggests that awareness of tariffs may be enough to drive off-peak charging.

A high frequency of charging was also documented between 08:00 to 09:00 suggesting users took advantage of charging at work. Not surprisingly fleet vehicles were charged intermittently throughout the day and maintained a high state of charge (SOC).

In the preliminary questionnaire, participants were asked when charging at home, what length of time would be considered acceptable for the battery to reach a full charge from flat. Responses suggested on average 5.5 hours would be acceptable, with 53% stating a charge period of more than 6.5 hours in length could be accommodated within their routine. This rose to 73% during their trials.

The shortest charge from zero SOC to a full charge during the trial was 6.5 hours, in line with what most drivers felt could be accommodated. Cars were often left plugged in for longer than charging required, it seems that charging may be influenced by habit and convenience, leaving a car in overnight rather than actual need.

In the pre-trial questionnaire, 78% of those surveyed stated public infrastructure was not needed to complete their daily trips. This figure rose to 91% after 3 months. Users were also asked whether they thought public charging infrastructure was essential for ownership and use of these vehicles. Pre-trial, 84% stated public infrastructure was essential, falling to 65% during the trial. Interestingly, after 3 months, 90% of drivers stated that suitable public charging sites would encourage them to purchase a ULCV. This suggests a disconnect between the perception that a public charging infrastructure is needed and the reality that it is going to be used.

On the whole, participants liked charging their ULCVs, with 95% of users classifying the activity of charging as “easy”. In a considerable number of cases, drivers described the process as offering an increased level of freedom in comparison to fuelling their conventional car. 86% of users actually preferred the process to visiting a petrol station.

Cost and Emissions Reduction

The demonstrator programmes have highlighted that savings in costs and emissions are possible from the use of ULCVs. The programme resulted in a real world average for energy consumption of across all the ULCVs involved in the trials of 0.195kWh/km, which equates to 139mpg in an equivalent petrol car, or 154mpg for diesel. This energy consumption figure results in an average running cost for these vehicles of 2.57p/km using the National Grid mix price. This is the price calculated using Defra and DECC 2010 Green House Gases conversion factors.

In the MINI-E trials, the average running cost for the vehicles over 6 months was £60, equating to less than 2p a mile. This is less than half the running cost of a 63 mpg conventionally fuelled vehicle (6.49p/km for petrol, 5.38p/km for diesel).

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Emissions are substantially reduced for a ULCV as well. The well-to-wheel calculated is 120.13 gCO2/km. This figure is based on the National Grid mix but could be reduced to zero with the use of renewable energy. This is less than the 170.63 gCO2/km emitted by the 2010 average UK new car, highlighting the environmental gains possible from the use of ULCVs.

Driver Experience
Feedback from users is that the vehicles are enjoyable to drive. 100% of those involved in the MINI-E trials thought their vehicles were fun to drive and liked the fast pick up and acceleration. 95% of private drivers found their vehicles were no more difficult to drive than their normal cars. 68% thought their vehicle was smoother than their normal car, whilst 97% would recommend one to a friend. The pre-trial survey showed only 16% of private drivers and 14% of fleet drivers expected their ULCVs to perform better than their normal cars. After 3 months of the trials 24% of private drivers and 26% of fleet drivers believed that their electric vehicle outperformed their normal car.

In Conclusion
These initial results from the demonstrator projects have revealed useful feedback on the experience of ULCV driving and ownership.
The programme shows that drivers adapt to using current ULCVs in a very positive manner. Vehicle usage and mileage closely match conventional daily driving patterns. The data from users indicated that the process of charging their vehicle is convenient and easy to use. The results also showed particularly positive feedback around fuel emission and cost savings.

The trials are ongoing and the above are only based on the first 3 months of use. Results from the first 12 months of trials will be made available in 2012. Following on from completion, a full review of the data collected will take place and we will update as more information becomes available.

EV Registrations Update

Plug-in Car Grant
The year to September period of 2011 saw 937 electric vehicles (EV) registered in the UK. In the same period, OLEV issued 786 plug-in car grants (25% of the value of the vehicle, up to £5,000). Disparity between the two is likely due to vehicles registered through the TSB ultra low carbon vehicle demonstrator programme being ineligible for the OLEV grant as they have already received government funding.

Table 1: Plug-in car grant and EV registrations

	OLEV	SMMT New Plug-in vehicle registrations YTD	
	Plug-In Car Grants Issued	*Plug in Car Grant Eligible*	*Pure EV*
Sep-11	786	910	937
Oct-11	N/A	993	1021

EV registrations in the UK stood at 0.06% of all registrations in the year to Oct 2011. This is of a similar proportion experienced in other European countries.

Alternatively Fuelled Vehicles
It is worth considering the entire market for ‘alternatively fuelled’ vehicles, those vehicles which are not just petrol or diesel. In the year to October 21,436 ‘alternatively fuelled’ vehicles were registered in the UK, a 9% increase on the previous year’s registrations. This is greater than the 2.6% increase over the same period for all new car registrations, perhaps showing growing consumer acceptance of technological variety.

2012 looks bright for EVs with new models being launched, among them plug-in hybrids and battery leasing options providing great consumer choice. There will be increases in charging infrastructure, a continued commitment from the government to support EV uptake and we hope no tragic disruptions to the supply chain. We look forward with optimism to the year ahead.

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