

*EVS30 Symposium*  
*Stuttgart, Germany, October 9 - 11, 2017*

## **EV R&D - a key pillar of a modern industrial strategy**

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### **Executive Summary**

The automotive sector faces huge challenges to remove pollutant and carbon emissions, meet legal commitments, address societal challenges and remain highly competitive in global markets. The UK's organisations are building on world-class research, development and manufacturing capability to capitalise on the technology led disruption that zero emission vehicles have created. A coordinated response in the UK is accelerating the delivery of new low and zero emission technologies to vehicle markets and achieving success through a succession of collaborative industry investments between industry, UK Government and academia. The rapid technological changes being driven in vehicle propulsion are generating new opportunities and forging the establishment of new supply chains for economic growth.

Since 2009, the UK's automotive industry has been the fastest growing across Europe, with an increasing-demand for UK-made cars, a supportive business environment and a relentless desire to innovate. Government and industry co-operation has led to a huge expansion in R&D activity with electrification and the pursuit of zero emissions strikes the heartbeat of this automotive renaissance. The UK now builds one in every 5 of the EU's electric cars, as well as the batteries packs that power them. Our unmatched track record in Formula 1 has provided the natural home to the new global electric racing series Formula E.

As the UK plans to leave the EU, it aims to shape a new future built on the foundations of a modern industrial strategy. Electric vehicles could be the key to harnessing industrial opportunities from new energy technologies with vehicles not simply cutting pollution and drivers' running costs, but by integration with the electricity system they can provide storage and demand flexibility. A collaborative approach that delivers a clear industrial strategy powered by electric vehicle R&D will deliver maximum value for everyone.

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## **1 Introduction**

The UK Government has a very clear and bold ambition for all our cars and vans to be effectively zero emission by 2050. We are on track to deliver this aim, with the UK consistently amongst the leading global markets for ultra low emission vehicles (ULEV). In 2016 and the first half of 2017, the UK was the largest new ULEV market in the European Union, building upon 94% growth in 2015. Ultra low and zero emission vehicles present a huge opportunity for the UK's thriving automotive sector to exploit and grow as the global transition takes hold. It is already supporting new jobs and growth as well as securing environmental benefits.

The UK's automotive sector has undergone a renaissance in recent years and UK skills and facilities place it in a unique position to emerge as a global leader in EV development, design and manufacture. Last year, the UK manufactured 1 in 5 EVs sold in the EU and is home to Europe's only mass market automotive traction battery production facility at Nissan in Sunderland. There are now over 200 dedicated companies in the UK's EV sector with annual growth in turnover of 5.3%. Already a leader, the UK plans to use a new industrial strategy to rapidly accelerate the pace of change over the next five to ten years. This ambition is backed up by over £2bn of support for EVs including around £750m of specific grant support for EV R&D to 2020.

The Office for Low Emission Vehicles (OLEV)<sup>1</sup> is working to position the UK at the forefront of EV development, manufacture and use. It is home to a rapidly expanding infrastructure that supports the ever increasing numbers of plug-in and hydrogen fuel cell EVs on UK roads – now over 100,000. There are more than 11,000 publicly accessible chargepoints across the UK, including the largest network of rapid chargers in Europe and a growing number of publicly accessible hydrogen refuelling stations.

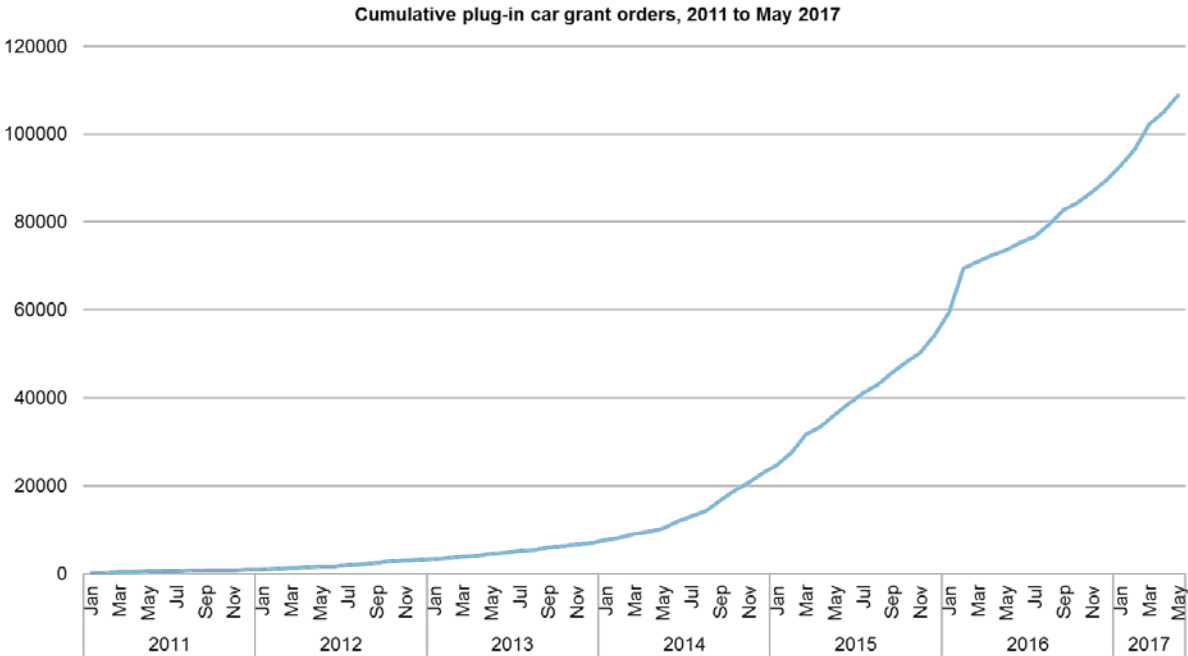


Figure 1 Cumulative ULEV orders in the UK between January 2011 and May 2017

## 2 UK is a centre of excellence for zero emission propulsion development

Stimulating innovation and supporting industry-led match-funded collaborative R&D is a key supply-side policy that promotes and drives economic benefits from the global shift to EV. OLEV co-ordinates EV R&D activity right across the UK working with a range of partners in industry and academia to build on the UK's existing world class capability and generate economic opportunity. We have a relentless focus on developing the UK EV industry and supply chain, boosting economic growth in the resurgent UK automotive industry and reducing pollutant and carbon emissions from road vehicles. The UK is home to globally recognised and growing expertise in electric machines, power electronics, lightweighting, energy storage and management.

<sup>1</sup> <https://www.gov.uk/government/organisations/office-for-low-emission-vehicles>

## 2.1 Industrial investment

To date the UK Government has committed funding in excess of £850m (USD \$1,100 million) in support of activity in this area with funds at least match funded by UK industry partners. Funding is delivered through Innovate UK<sup>2</sup> – the UK’s national innovation agency - who work across UK government, business and research community to stimulate and support business-led innovation. Investment is deliberately targeted at collaborative research and development projects and is delivered through a series of open ‘competitions’ with assessment criteria set following stakeholder engagement and input from industry and government. Project bids are assessed independently by a panel of automotive experts. All projects require some private funding.

The UK Automotive Council<sup>3</sup> was established in 2009 to enhance dialogue and strengthen co-operation between UK government and the automotive sector. Their Technology Group analyses evidence and advises on UK automotive R&D investment opportunities – fostering the development of a stronger UK engineering, supply and manufacturing base. Their consensus technology and product roadmaps have driven an understanding of the research challenges the sector faces and identified ‘sticky’ technologies that offer the opportunity for UK to develop competitive advantage and attract new direct inward investments. A recent study highlighted the long-term trend for reshoring and a growing UK supply chain. Local parts content on UK manufactured cars was just 36% in 2011 but had increased to 44% by the end of 2016<sup>4</sup>.

The Advanced Propulsion Centre UK (APC UK)<sup>5</sup> is now established as the propulsion centrepiece of the joint industry and government strategy for the automotive sector. Formed in 2013, it will channel £1bn (UD \$1,525 million) into the UK automotive industry over the next decade. The UK automotive industry is now at the heart of productivity growth in the UK following a strategic step change in Government support and investment alongside a collaborative approach between all partners. The APC facilitates partnerships between those who have good low carbon propulsion ideas and those who can bring them to market.

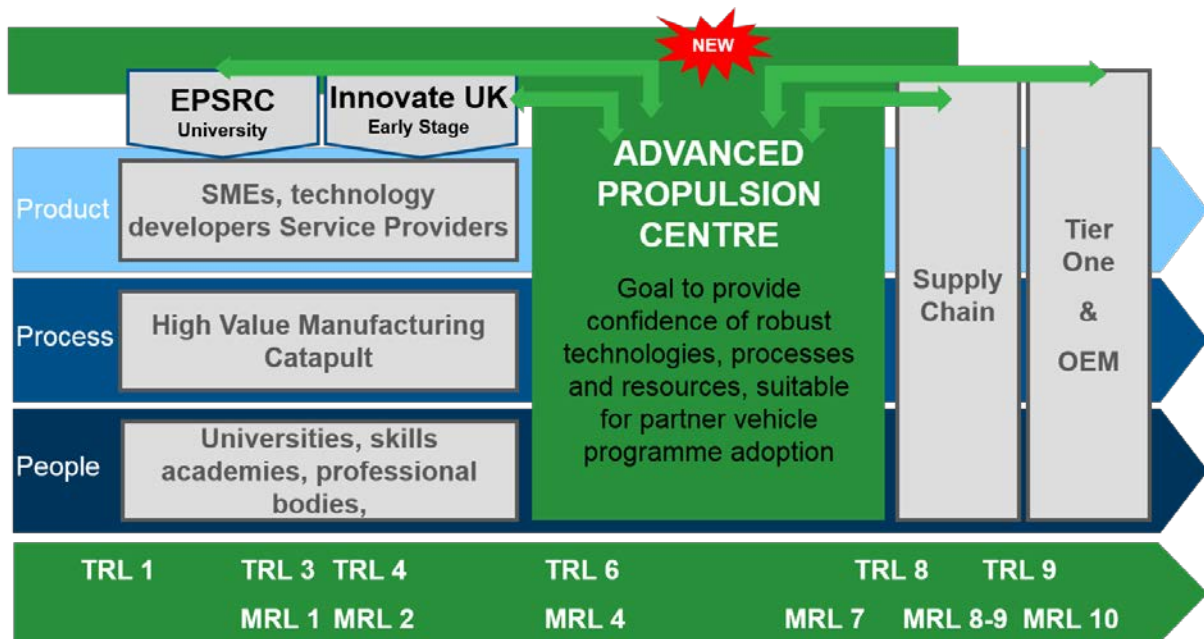


Figure 2 How the UK’s Advanced Propulsion Centre is positioned to bridge the commercial ‘valley of death’

<sup>2</sup> <https://www.gov.uk/government/organisations/innovate-uk>

<sup>3</sup> <http://www.automotivecouncil.co.uk>

<sup>4</sup> <http://www.automotivecouncil.co.uk/2017/06/automotive-council-news-release-growing-the-automotive-supply-chain-local-vehicle-content-analysis-2/>

<sup>5</sup> <http://www.apcuk.co.uk/>

### 3 EV R&D – a strategy for success

Early investments from Nissan (with its LEAF vehicle and traction battery production) and Toyota positioned the UK on the front foot and ahead of the rest in the global race for the development of new EV technologies. We are already seeing significant return on its investments in early market EV R&D. An impact review<sup>6</sup> of the Low Carbon Vehicles Innovation Platform in 2015 invited nearly 300 project partners who had benefitted from a cumulative £79m of public sector funding to evaluate its impact and future prospects. Projected sales and turnover results were used to calculate the potential return on investment (ROI) from the funds received. Based on 15 years of sales turnover forecasts and following adjustments for deadweight, displacement and leakage, the estimated ROI for every £1 invested in EV R&D by the UK is £8 in the medium term and £210 in the longer term. If supply chain benefits are included these figures rise to £14 and £34.

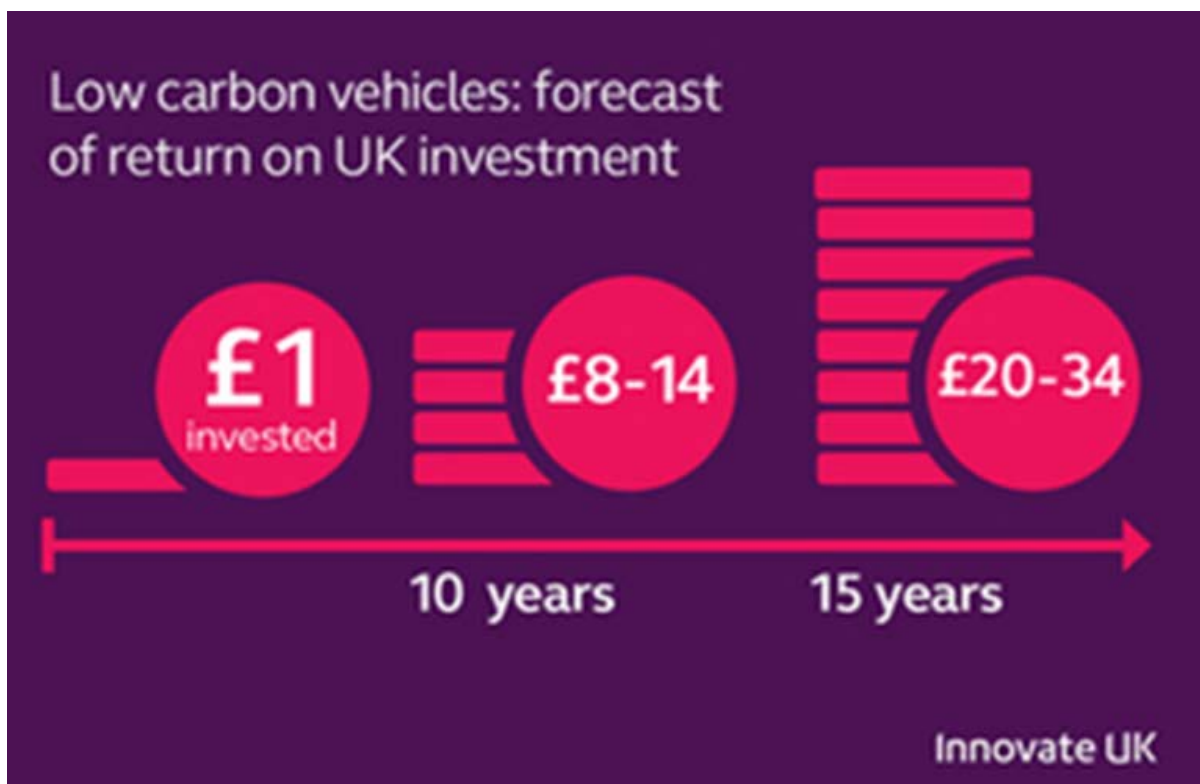


Figure 3 UK forecasted return on investment in EV R&D

Investment in EV R&D is also creating and protecting jobs. In the medium term (over the next ten years) around 5,000 jobs will be created and safeguarded with nearly 12,000 over the longer 15 year term. Again, taking account of the impacts of the supply chain increases this figure to over 20,000 jobs. Of course, moving technology towards full commercialisation takes a lot more than just winning public sector investment, but the successful completion of match-funded collaborative R&D projects can help deliver private capital investment – typically more than five times the initial value of grant funding if our projects are an indication.

<sup>6</sup> <https://www.gov.uk/government/publications/the-low-carbon-vehicles-innovation-platform-an-impact-review>

### 3.1 Spearheading future electric vehicle battery production

The battery system represents around 50% of the value of a battery electric vehicle creating a market forecasted to be worth around £50bn in Europe alone by 2030. For a variety of reasons, and as we have seen in the UK with Nissan's LEAF it makes complete sense to manufacture batteries in close proximity to EV assembly and production. Captured early enough, this demonstrates the opportunity of locking in future manufacturing activity and supply chain hubs for EVs. To fully realise this potential the UK is looking to build on its world-class research base in this area to transform UK battery capability. The Industrial Strategy Challenge Fund<sup>7</sup> is a cross-sectoral fund designed to accelerate commercial exploitation and ensure that scientific investment truly delivers long-term economic impact, jobs and growth across the UK. As policy is deployed to drive uptake, support for local industry seeking to meet the demand must be complementary.

The 'Faraday Challenge' will coordinate action to develop and manufacture automotive traction batteries for EVs. Funding of £246m delivered over four years will help business in the UK – or those attracted to the UK to participate in activity in three key elements: research, innovation and scale-up. A joined-up approach that links the entire battery manufacturing value chain across the UK will offers the best return on investment.

The challenge builds on OLEV's successful £10m Battery Prize, awarded in 2015 that began the development of battery technology for next generation EVs in the UK. OLEV identified a gap in the UK battery technology supply chain and capability – the design and manufacture of battery packs from cell-handling level – that could be uniquely filled through an industry-led and co-funded R&D project (rather than an inducement prize for innovation). A consortia led by Warwick Manufacturing Group won with the 'AMPLiFii' project - Automated Module-to-Pack Pilot Line for Industrial Innovation. The project brought together for the first time in UK the very best expertise in each area of battery technology and is build UK capability in development and commercialisation of high voltage automotive battery packs. It has created a brand new UK supply chain to deliver validated battery packs for automotive applications requiring volumes in the hundreds to thousands of units per year. These markets include bus, van, passenger car, and off-road vehicles.

The project has designed a flexible, scalable, modular battery architecture and aggregated demand at the component and subsystem level. This has allowed product development to achieve standards of quality, safety and robustness more typical of high volume production. Licensing arrangements have been agreed to encourage all thirteen project partners to exploit together after the project, and for future improvements to the systems to be incorporated for the use of all partners. The project will complete a range of battery packs designed and manufactured, and a pilot production line in autumn 2017.



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<sup>7</sup> <https://www.epsrc.ac.uk/newsevents/news/iscfoppsopen/>

### 3.2 UK in pole position

UK motorsport and high performance engineering enjoys an outstanding reputation all around the world with sales of £10bn per annum. The sector includes over 4,300 SMEs employing over 41,000 people, with some 25,000 highly skilled and highly valued engineers. These companies tend to invest over 30% of their sales turnover back into R&D, which makes them really important in the UK R&D eco-system and at the cutting edge of true innovation. Effective transfer of high performance capabilities from motorsport is bringing benefits to other sectors including defence, health marine and aerospace. The UK is home to more Formula 1 teams than any other country and has an unmatched record of success on the track. As a major player in the early development of the pioneering technologies that brought Formula E to the track in 2014, it now provides a natural home at Donington Park for research, development and testing as the global electric racing series attracts a new generation of motorsport fans and accelerates electric vehicle market and technologies.



Figure 4 A Jaguar Formula E car on test at Donington Park – the home of Formula E

Technology born on the race track has now found its way onto buses and diggers in the UK through Flybrid Automotive. They have exploited their racetrack expertise in ‘kinetic energy recovery systems (KERS)’ technology to develop fuel saving flywheel applications for buses and construction vehicles amongst others. A 2-year collaborative R&D project<sup>8</sup> that began in 2012 under Innovate UK’s Low Carbon Vehicle Innovation Platform delivered a production-ready flywheel hybrid bus that improved fuel consumption by over 15%.

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<sup>8</sup> <https://www.gov.uk/government/case-studies/success-story-f1-technology-finds-a-way-into-buses-and-diggers>

### 3.3 A modern industrial strategy

A modern industrial strategy that addresses long-term challenges can deliver economic growth by increasing productivity and driving growth across the whole of the UK. It is a crucial part of our plan post Brexit – a strategy to create the conditions where successful businesses can emerge and grow, backing them to invest in the long-term future of UK and compete globally. Underpinning its success is identifying our strengths to build on and committing to extend excellence for the long-term. UK excellence is evident and well recognised in the EV sector and we possess the key technologies, professions, research disciplines and institutions to give us a crucial early competitive advantages. But we cannot take this for granted and need to invest to continue to succeed as competition remains fierce. The UK remains one of the most competitive places in the world to start or grow a business. A modern industrial strategy must be about creating the right conditions for new and growing enterprise to thrive, not simply protect the position of incumbents.

## 4 Electric vehicles – a long term strategy for success in the UK

The transition to electric vehicles is now well underway and offers huge benefits from new investments in technology. Not just delivering environmental benefits in use, electric vehicles have the potential to provide electricity storage and demand flexibility to deliver benefits for the electricity system. By drawing these together and creating the right conditions for innovation and co-ordinated technology development, the UK is poised to harness this once in a generation opportunity and realise the benefits for decades to come.

### Author



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Bob works with OLEV to position the UK as a global leader in the design, development, manufacture and deployment of electric vehicles and associated technologies. His focus is on R&D investment, CO<sub>2</sub> regulation, energy networks and infrastructure deployment.

Bob joined OLEV in 2011 having previously worked with the Department for Transport and Ford Motor Company. He was awarded a Ph.D. in Biomechanical Engineering from Edinburgh University in 2002 having graduated from there with an Honours degree in Mechanical Engineering in 1997.