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Advanced ADEPT 48V affordable hybrid on path to meet future ultra-low vehicle emissions

- Ricardo-led ADEPT programme aims to demonstrate technology capable of providing near full-hybrid equivalent fuel economy at significantly lower cost
- ADEPT consortium successfully applies advanced mild hybrid technologies with 48V ‘intelligent electrification’ to a Ford Focus project demonstrator
- Results of almost three years of intensive development and road and laboratory testing of ADEPT technology will be revealed at LCV2016

Following almost three years of intensive testing, development and validation of advanced mild hybrid technologies with 48V ‘intelligent electrification’ applied to a Ford Focus project demonstrator, the ADEPT (advanced diesel-electric powertrain) consortium partners have announced that the project is on course to meet the stringent air quality and ultra-low emission requirements expected of near term next generation vehicles.

The ADEPT project is led by Ricardo in a research partnership including the Advanced Lead Acid Battery Consortium (ALABC), Controlled Power Technologies (CPT), Faurecia Emissions Control Technologies UK Ltd, Ford Motor Company and the University of Nottingham. The final results will be presented at the UK’s premier low carbon vehicle event LCV2016 on 14-15 September, where industry executives, government officials and the media will have an opportunity to drive the vehicle.

The consortium aims to demonstrate the advanced 48V mild hybrid powertrain architecture, capable of delivering near full hybrid-scale diesel fuel efficiency and reduced CO₂ emissions, through a highly cost-effective package, without compromising increasingly stringent European exhaust emission regulations, which currently require cars to meet Euro 6b air quality standards in terms of NOx, PM and CO.
In addition, the integration of hybrid and emissions control systems has the potential to deliver up to a 10-12 percent reduction in fuel consumption, equivalent to sub-80g/km of CO₂ emissions (NEDC). Crucially, the technology can be delivered at lower costs than a more traditional approach of optimizing each system separately. Initial analysis shows that costs (based on Ricardo’s estimation) of less than €80 per gram of CO₂ reduction for every kilometre travelled is feasible through ADEPT technology. Ricardo believes the above package is very competitive with other fuel economy solutions such as full hybridization.

The concept of intelligent electrification enables highly aggressive engine downsizing and down-speeding beyond what might normally be possible other than through more expensive hybridization approaches. This is achieved through the use of torque assist from electrically harvested energy, temporarily stored in a 48V advanced lead-carbon battery with a high rate partial state-of-charge capability similar to a supercapacitor, in combination with 48V electrified ancillaries.

With sophisticated electronic control of the powertrain systems, torque assist can be used to ensure that performance is maintained – or improved upon – throughout the duty cycle while also reducing fuel consumption. By basing the system on 48V electrical architecture, the ADEPT project aims to achieve a highly optimal cost and performance trade-off, including ultra-low emissions, while also delivering significant fuel savings.

**ADEPT powertrain architecture**

The baseline vehicle for the ADEPT research and development programme is based on an already downsized and competitively fuel-efficient diesel Ford Focus ECOncetic 1.5TDi, homologated with carbon dioxide emissions of 88g/km.

Key features of the vehicle systems include CPT’s water-cooled SpeedStart switched reluctance belt starter generator (BSG), capable of delivering in excess of 12kW of regenerative braking, as well as near instantaneous and near continuous torque assist levels of over 7kW – sufficient to enable significant engine down-speeding in addition to a highly capable start-stop functionality.
Further energy recovery is achieved from CPT’s exhaust mounted 48V turbine integrated exhaust gas energy recovery system known as TIGERS. Rated at 2.4kW, TIGERS is capable of providing further power recuperated from the exhaust downstream of the turbocharger. The exhaust gas is diverted to the TIGERS unit via two bespoke emissions control valves developed by Faurecia Emissions Controls technologies for the ADEPT project. Again, the recovered energy is stored in the advanced lead-carbon battery pack, providing a high power, high endurance, easily recyclable, lithium-free energy storage solution at a competitive cost.

The ADEPT powertrain includes a range of electrical ancillaries powered from the 48V system rather than directly from the engine, including for example, the vehicle air conditioning compressor. In addition to powering these ancillaries and facilitating a significantly improved start-stop functionality, ADEPT’s 48V architecture also provides significant levels of torque assist from the BSG to offset fuelling to the engine for improved fuel economy, and to increase overall powertrain torque capability for enhanced vehicle performance.

The control strategies deployed have been developed based on extensive vehicle systems simulation work. This has enabled the core powertrain and aftertreatment system, as well as the 48V BSG, ancillaries, battery pack and exhaust energy recovery system, to be operated in a seamless manner, while also providing a valuable computer-aided engineering (CAE) capability to explore further potential avenues of development and optimization opened up through intelligent 48V electrification.

**Completion of development – testing ongoing**

Following the announcement of the ADEPT project in September 2013, initial integration and development tests were carried out by the ADEPT team on an early ‘functional integration’ prototype, which was revealed at the LCV2014 show. This enabled the project to carry out de-risking of components and systems, and also provided a platform for evaluating control concepts.

The final ADEPT demonstrator vehicle, which has now been completed, provides the fullest implementation of systems to be carried out by the team. At the LCV2016 show, the final results of ongoing vehicle road and laboratory tests will be revealed for the first
time. The project partners also intend to make the vehicle available for ride and drive demonstrations at LCV2016.

“We are really pleased to have achieved this important milestone of completion of the ADEPT demonstrator prototype,” commented Ricardo Innovations MD Thomas Gutwald. “While much development attention is currently focused on full hybrids and battery electric vehicles – including by Ricardo and its customers – I firmly believe that the concept of ‘intelligent electrification’ will have an extremely high level of mass market appeal, providing arguably a greater overall fuel and carbon emissions saving in the near to medium term due to its highly cost-effective focus on the combination of near-market, available technologies. We look forward to sharing the results of the road and laboratory testing that is currently ongoing with the ADEPT vehicle, at the LCV2016 show in September.”

The ADEPT research project is jointly funded by the UK Government’s Office for Low Emission Vehicles (OLEV) implemented through the UK innovation agency, Innovate UK, with matching contributions from the participating partners.

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Controlled Power Technologies is an independent, clean-tech, company, based at Laindon in Essex and in Coventry in the West Midlands with subsidiaries in Germany and the USA, which specialises in the development of cost-effective CO2 reduction measures for the global automotive industry. Its core competencies include low voltage power electronics, advanced control software and the application of safe low voltage switched-reluctance machines (SRMs) to a vehicle powertrain and driveline, providing intelligent electrification of the propulsion system with near full hybrid vehicle capability. CPT is at the forefront of practical exploitation of SRM technology in vehicle applications and has already issued a number of patents in machine design and construction in the UK, Europe, USA, India, Korea and Japan. For more information, visit www.cpowert.com.

Advanced Lead Acid Battery Consortium (ALABC) is an international research body comprised of lead producers, battery manufacturers, equipment suppliers, application developers, and research facilities organised to enhance the performance of lead batteries for a variety of markets, including hybrid electric vehicle (HEV) applications. A program of the International Lead Association, ALABC pools the resources of its global membership in order to perform specific research on advanced lead batteries that otherwise would not be possible by any single entity. For more information about the ALABC visit www.alabc.org.

The University of Nottingham has 43,000 students and is “the nearest Britain has to a truly global university, with a “distinct” approach to internationalisation, which rests on those full-scale campuses in China and Malaysia, as well as a large presence in its home city.” (Times Good University Guide 2016). It is also one of the most popular universities in the UK among graduate employers and the winner of ‘Outstanding Support for Early Career Researchers’ at the Times Higher Education Awards 2015. It is ranked in the world’s top 75 by the QS World University Rankings 2015/16. More than 97% of research at The University of Nottingham is recognised internationally and it is 8th in the UK by research power according to the Research Excellence Framework 2014. It has been voted the world’s greenest campus for four years running, according to Greenmetrics Ranking of World Universities.

Faurecia Emissions Control Technologies (FECT) is one of the four divisions that comprise the Faurecia organisation, and is the global market leader in the supply of emissions control systems to the automotive Industry. With total sales of €7.4bn, FECT employs over 21,000 people in 25 countries including 1,900 engineers and technicians at its 7 global R&D facilities.

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