Climate Change and (In)Security Project Briefing Note

Electrification of Military Land Platforms

There is a global push for more hybrid and electric cars on our streets as part of efforts to reduce greenhouse gas emissions. With the new generation of 'green' cars gaining more appeal among users, car makers are investing in the development of better designs that can not only replace their petrol and diesel dependent forerunners, but also offer better performance, safety and driver experience. This signals to an important point often missing in discussion on the need for UK Defence to reduce dependency on diesel and petrol fuelled vehicles, and invest in new technologies.

Army Headquarters is currently funding a Technology Demonstration (TD) programme to covert three in-service platforms to Hybrid Electric Drive (HED) formats. This project aims to assess the potential benefits of hybridisation using currently available technologies. In parallel, the Ministry of Defence (MOD) research programme is developing concepts for future electric drive platforms. This briefing note seeks to highlight that the use of hybrid electric drive vehicles for the British Army (and others) can be a 'win-win' scenario, in which, not only will there be environmental benefits, but also significant capability benefits.

HED Technology Demonstrators

Under the HED TD project three current in-service vehicles have been converted to a hybrid electric drive format: MAN SV truck, Foxhound and Jackal. These are now undergoing trials and being assessed against the standard platforms. The vehicles are all 'series electric' platforms in which an engine-driven generator produces electrical power that can drive motors or recharge batteries. When required, the motors can be powered by the batteries alone. The vehicles have different configurations, with the MAN SV using two motors driving the front and rear axles, the Jackal with four in-board motors and the Foxhound with four hub motors. A key requirement for these demonstrators was that the installation of electric drive should not impact on other aspects of performance, such as payload and ground clearance. Initial indications are that fuel savings of up to 20% are possible, depending on the type of use. The fuel savings come from running the engine at a constant efficient speed and using regenerative braking to generate electricity. Testing of emissions have shown reductions in nitrogen oxides (NOx) by around 20%, carbon dioxide (CO^2) by around 23% and carbon monoxide (CO) by around 50%. This shows that the environmental benefits are proportionally greater than the fuel savings.

As well as reducing the logistical drag, capability benefits include:

- Improved mobility due to the high low-speed torque and improved drivability of e-drive vehicles;
- Increased survivability from silent running using batteries; and
- Increased levels of on and off board power, including longer periods of silent watch.

Figure 1: Installation of electric drive on a MAN SV truck (Courtesy RBSL)

Future Land Platforms

The current demonstrators are based on modifications to existing platforms. For new build platforms, further improvements in fuel efficiency, and hence emissions reduction, will be possible by using engines that are optimised in power output and designed for very efficient constant speed running. Further fuel savings can be accrued from energy harvesting technologies, for example, using exhaust heat or suspension actuation. Some studies have suggested that these techniques, coupled with lightweight materials, more efficient tyres, and other measures, could give fuel savings of up to 70%.

New build platforms can also exploit the packing benefits of electric drive systems to reduce overall volume and use the inherent system redundancy of electric drive systems to improve mission availability.

The Defence Science and Technology Laboratory (DSTL) is carrying out concept studies and technology risk reduction for future armoured fighting vehicles to exploit the capability benefits of electric drive. The use of electric hub motors removes the design constraints of a mechanical propshaft and so opens up freedoms for suspension design. Very long travel suspension systems enhance off road mobility and provide ‘stand-off’ against mine blast, but allow a low silhouette when required. Novel suspension solutions that allow the wheel track (the width between the wheels) to be varied are being explored; these provide increased stability when cornering at speed or on side slopes, but allow the vehicle to be compact for transport or operating in urban areas. The suspension concepts also allow multi-wheel steer. As well as enhancing agility, multi-wheel steer can provide benefits on difficult terrain allowing vehicles to steer out of ruts or adopt a crab steer motion which means each wheel follows a different line and hence reduces soil disturbance and the development of ruts.

Figure 2: Advanced long travel active suspension system concept (Courtesy QinetiQ)

Battery technology continues to improve in terms of aspects such as power storage, operating temperature range, and safety. As such, in the future, reliance on solutions for on board power generation can be reduced. DSTL is also undertaking research into clean bio-generated fuels that will reduce emissions. In the future fuel cells using alternative fuels could become viable as the main power generating source on armoured vehicles. Due to the long in-service life of armoured vehicles, modular solutions are being explored that will allow new power generation and battery cell technologies to be exploited as they mature. The long-term goal must be to field all electric vehicles that rely solely on on-board battery power; however, for these to be viable, clean methods for generating electricity in forward bases must be developed so that the vehicles can be recharged.

Conclusion

The HED demonstrator programme is highlighting the environmental and capability benefits of electric drive systems. Parallel work is developing battlefield mission definitions and other requirements that will support the procurement of electric drive vehicles. Other Defence Lines of Development aspects such as training and support impacts are being explored along with safety implications. With the rapid maturation of electric drive technologies the question is not 'will military vehicles be electric drive' but 'why would they not be in light of the significant benefits'. In the longer term the trend will be towards very capable 'all electric' platforms with very high levels of mobility enabled by the flexibility of electric drive.

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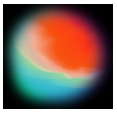
*This briefing note is written in the author's personal capacity and should not be taken as reflecting the opinions or policies of the CCI Project, Reuben College, or CHACR.



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