Electric vehicles for Australia

A Senate select committee* recently investigated the potential for uptake of electrically-driven vehicles (EVs) in the car, truck and bus sectors. The recommendations produced seem sensible. Here are some that I want to comment on:

3. *EV Targets should be set for uptake of EVs in the light passenger, light commercial and metropolitan bus sectors*. Targets would speed uptake. Will government subsidise EVs?
5. *A national public charging network should be established*. Slow EV chargers can provide between 3.5 – 22.0 kWh and fast chargers between 22.0 – 43 kW. In 2018 there were 783 public charging stations in Australia, the great majority being slow charging. There are more than ten times this number of hydrocarbon fuel stations.
6. *A CO2 emissions rule should be introduced for non-electric vehicles*. Despite coal- and gas-fired electricity generation producing CO2, EVs produce a net reduction.
9. *The federal government should implement a 10-year EV manufacturing roadmap covering research and development, vehicle and system design, battery manufacture, telematics, supply chain and component manufacture*. In the light and medium duty truck segment, there is an opportunity for OEM suppliers to import 'glider' trucks which are fitted out locally.

There is also potential for EV technology to be installed on trailers, in which case the tractive effort could be spread throughout the combination vehicle. This would provide regenerative retardation where more is needed on the trailer and allow the size of the truck diesel engine to be reduced. Australia could lead in the trailer segment.

12. *Apprentice and trainee programs need to be established*. EV technology will require greater electrical knowledge in workshops. We need to be training more auto electricians!

*https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Electric_Vehicles

13. *Electricity network infra-system development will be needed to cope with widespread adoption of EVs*. Widespread uptake of EVs will alter the electricity load profile and this will require electricity grid development.
17. *Standards Australia should develop a series of national standards relevant to EVs*. Sound technical standards will be needed to lessen fire risk and promote co-ordination of multiple traction centres on a (multi-) combination vehicle. The basis for Australian standards exists as the AS/ISO 6469 series – Electrically propelled road vehicles.

EVs are a significant threat to road funding resulting from fuel excise, as there is no excise charge for electricity. Eventually government is likely to introduce a road-user charge that is independent of the fuel used. The federal government is currently funding an investigation into road-user charging models. It will be difficult for the heavy logistics sector to argue for special treatment (such as a fuel excise rebate) under a new charging model. Diesel trucks are likely to be penalised by losing the fuel excise rebate.

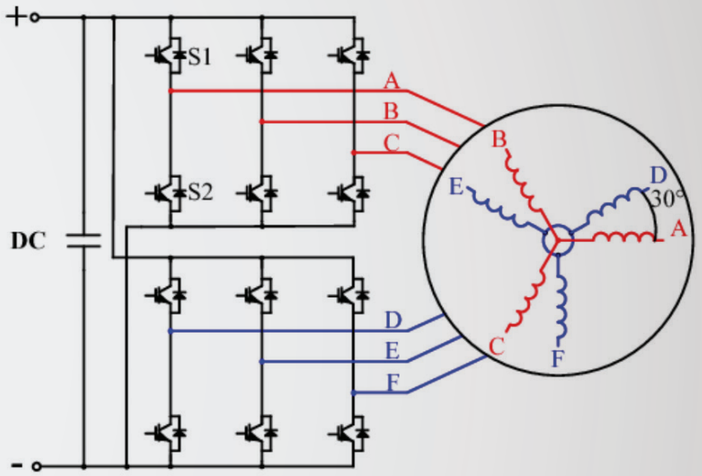
The range that a vehicle can achieve depends upon three factors: the energy stored, the efficiency of energy conversion and the level of 'regeneration' energy capture. Lithium ion battery energy density is currently about 1.45 MJ/L. For comparison, the energy density of diesel fuel is about 38.6 MJ/L, nearly twenty-five times greater based upon volume. The efficiency of energy conversion with diesel fuel is probably about 30 per cent whereas for an EV battery it is probably 90 per cent. Therefore, taking account of efficiency, but ignoring regeneration, the expected range of a diesel truck will be about nine times more for the same volume of energy storage.

What about the relative costs? One litre of diesel fuel costs ~ $A1.30. The same amount of electrical energy, assuming 1kWh of electricity costs $A0.20, costs ~ $A2.00. However, allowing the better efficiency of the electrical drive, the electrical cost is about half that of diesel fuel. So, the viability of electric traction for long distance heavy vehicles is limited by range and not fuel cost. Viability depends mainly on achieving a higher energy density that the 1.45 MJ/L that is possible from current generation battery technology.

So, what about technical aspects? We don't seem to have come to grips with the new safety considerations that will arise with EV technology. EVs probably have DC battery voltage of 200 Vdc. The inverter then produces a three- or six- phase AC voltage of say 450 Vac. These voltages are well above the unregulated voltage domain (Extra Low Voltage < 50 Vac and < 120 Vdc). Therefore, workshops who work on EVs probably need licenced electrical workers.

Electromagnetic compatibility (EMC) rules are applicable to EVs. EMC risk is that the control system on the vehicle will be adversely affected by 'noise' coming from the EV traction system. EVs in Australia should have been proven to comply with AS/NZS CISPR 12 or as an alternative, ECE Regulation 10. Both standards require immunity and emissions testing of a typical vehicle under laboratory conditions.

I worry about the safety risks of batteries with high energy density. Internal insulation failures within batteries do occur with consumer-level LiPo batteries. There will occasionally be internal battery failures. The main electrical cables on EVs should be run in cable trays. This will separate them from other systems and help define which cables have dangerous voltages on them. If the hotchpotch of electrical cable installations used on some diesel-powered trucks were applied to EVs, serious fire risks and safety risks would arise.



Vehicle range is dependent on energy stored, the efficiency of the energy conversion and regeneration of energy capture.

It should be noted that EVs have the potential advantage of regeneration but the disadvantage of needing electric motors to drive the air conditioner, power steering and air compressor. Because the usable energy density of diesel is about nine times more than for LiPo battery, fuel cell technology is being actively considered. For example, the 'Nikola' electric truck that is under development in the USA has a fuel cell that is supplied by hydrogen. A fuel cell is like a battery that consumes its electrolyte. A hydrogen storage tank is needed. However, hydrogen is difficult to store because it has a low volumetric energy density and it leaks out of most metals. Therefore, the fuel cell technology with on-board hydrogen storage seems to be a long way off. It is unlikely that fully electric traction on long distance trucks will be viable within the next two decades. However, electric traction on trailers might be viable beforehand.

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*Note: With Martin Toomey recently named the new Chairman of ARTSA, Peter Hart will continue in his role writing a monthly technical column in *Prime Mover*.