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BEVs and FCEVs: Infrastructure and Emissions

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With the battery-powered Nissan LEAF named Car of the Year 2011 and sales in the US and Japan already being counted in the thousands, supporters of fuel cell vehicles may be forgiven for feeling that a 2015 commercialisation date is a long way off. Many commentators in both the popular media and in blogs seem to regard the question of battery electric vehicles (BEVs) versus fuel cell electric vehicles (FCEVs) to be all but settled, with BEVs the clear winners, at least for the foreseeable future. Their contention usually rests on two points: the first is that, unlike BEVs, there is no practical refuelling infrastructure for FCEVs and no prospect of establishing one in the near future; secondly, their argument continues, even if a hydrogen infrastructure were to be implemented with great difficulty and at much expense, the hydrogen will be largely derived from fossil fuels and thus would not be zero-carbon anyway – so what would be the point?

It is not often enough acknowledged by these detractors that similar arguments apply to BEVs, and have not yet been satisfactorily countered despite the presence of these vehicles at local dealerships. The difference is, of course, that in the case of BEVs the problems can be deferred while the first few thousand or few hundred thousand vehicles are rolled out. This is not to say that those with interests in BEVs are not working on solutions to these problems, but the point is that BEVs are being offered for sale despite them.

To address the first assertion, BEVs in effect transfer load from an existing liquid (petrol/diesel/alternative fuel) distribution infrastructure to the electrical grid. This may be advantageous from the viewpoint of energy security, but in many nations it will add strain to ageing and already creaking grids. Writing from a UK perspective, I offer as an example a comment from the UK gas and electric market regulator Ofgem which recently made headline news. Ofgem says that a £200 billion investment will be needed before 2020 to upgrade the UK's "outdated energy assets". The pressure arises from ageing power stations and the changing power generation mix, but the situation will not be helped by increasing demand. Typical domestic electricity consumption in the UK is 3,300 kWh annually; if a typical household owned a LEAF and charged it from empty to full once a week, it would add 1,248 kWh to that figure.

While there has been talk of using BEVs to help balance the grid by demand-side management or by providing buffering capacity while charging, there is a practical limit to such measures. Whatever is done in that regard, a significant proportion of BEVs in national fleets will create the need to upgrade electrical grids to meet the new demand – and, hence, will require investment in infrastructure. It is not outside the realms of possibility that by 2020 a motivator for the deployment of FCEVs may be the transfer of load from the grid back to a liquid (or compressed gas) infrastructure. The numbers are not as prohibitive as one might think: a recent study estimates that a hydrogen distribution and retail infrastructure in Europe would cost around €100 billion over forty years.

Second is the issue of carbon emissions. For its two-seater battery electric quadricycle the Twizy, Renault has quoted well-to-wheels carbon dioxide emissions of 62 g per km in a typical European electricity generation mix. Calculations from independent reviewers of the LEAF have put well-to-wheel emissions in the UK at around 80 g carbon dioxide per km. These numbers are low, but BEVs are by no means zero-emission vehicles.

To put it another way, and using the UK as an example again, currently around 43% of electricity production in this country is from natural gas; this proportion is growing and likely to remain significant for decades yet. Natural gas is also the feedstock for steam reforming, the most mature technology for large-scale hydrogen production, offering potential efficiencies of well above 80%. How then do the efficiencies of BEVs and FCEVs running on energy derived from natural gas compare? Analysis by McKinsey of a joint study by the European Commission, the European Council for Automotive R&D and CONCAWE has put the efficiencies at 68% and 56% respectively – a substantial difference, granted, but not by orders of magnitude.

From a climate change perspective the argument is in any case largely moot. To have any chance of decarbonising transportation, both the electricity used to charge BEVs and the hydrogen to fuel FCEVs must be generated renewably. The issues around that are complex and should be kept for a separate discussion, but while we acknowledge the many challenges facing the introduction of fuel cell vehicles, it should be remembered that achieving zero-emission BEVs and the infrastructure to support them will be no easy victory either.

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