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SAVING CARBON EMISSIONS FROM ELECTRIC VEHICLES COULD BE ILLUSORY

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THE DROUGHT this summer has kept the issue of global warming and carbon emissions in the public eye. Road transport is the principal sector where emissions continue to rise and the government has proposed to reduce carbon dioxide by progressively replacing conventional light vehicles by electric vehicles (EVs) over the next 30 years. This may seem to offer an attractive solution, but it is crucially dependent upon the fuels used to generate the electricity for the batteries. There may be no benefit at all for the UK.

There are some thirty million light vehicles on UK roads and replacing the vehicle population will take decades so a degree of crystal ball gazing is necessary to examine this issue. Motor vehicles currently on sale have average emissions of about 125g CO_2/km. This equates to 52 miles per gallon to use pre-SI units. The combustion of one litre of petrol produces 2.35 kg of CO_2 and 125g CO_2/km is 8 km/kg. Therefore 2.35 kg of CO_2 is released travelling 18.8 km. Average annual car mileage is about 8,000 miles or 12,800 km. This gives an annual fuel consumption of 680 litres and average CO_2 emissions of 1600kg.

Annual energy consumption from 680 litres is 6250 kWh of which about 1560 kWh turns the wheels.

With electric vehicles, a similar 1560 kWh is needed at the wheels, but the power stations would have to supply more because of losses through the network and the battery's charge/discharge. Performance will deteriorate with charging cycles and an average efficiency of 65 per cent is taken for the whole life. The battery car will therefore require annual electricity generation of 2400 kWh. The CO_2 emissions can be calculated for comparison with the petrol/diesel but in addition to the emissions from driving the car there are three other sources:

a. The carbon released in the manufacture of the battery, which is much greater than the internal combustion engine;

b. The effect of replacement batteries; and,

c. The contribution from the infrastructure to support EV use.

In 2016, average emissions from UK electricity generation were 283g/kWh. The average car would cause 2400 x 0.283 = 680 kg per annum to be produced at the power station – compared with 1600 kg from the conventional car. The carbon dioxide reduction brought by the replacement of the internal combustion engine by the EV is therefore about 60 per cent.

This is a modest starting point, when the objective is to reduce our total emissions by 80 or 90 per cent – and the 60 per cent is the optimum that will not be achieved because of practical limitations.

The carbon emissions of electricity generation is likely to increase. Low carbon UK nuclear plant generation and imports from France comprise almost 30 per cent of demand in 2016. Almost all the nuclear stations will have been retired before 2030 and imports from France and Holland may be less secure after the exit from the EU. These low-carbon sources would be replaced by intermittent renewable sources requiring long periods of secure back up, inevitably natural gas (with possibly some coal) having emissions/kWh greater than nuclear stations. Even with all the current nuclear plants, emissions reach 400g/kWh over the winter when wind and solar outputs are negligible. That would increase the annual output for the EV from 680 kg to 970kg. If the annual 80 TWh of the main zero carbon generators were lost, the gas /wind /solar mix would have to increase output by about two thirds. That would increase the 680g to at least 1140g/kWh – meaning a reduction in emissions of only 28 per cent and there are still other factors to take into account.

Even for the Nissan Leaf, manufacturing the 30 kWh battery releases 5.3

Te CO_2, much more than the conventional engine. It would take about three years for the lower emissions of the EV to compensate for that battery under perfect conditions. With allowances for real conditions it could be five or six. For the 100 kWh battery as in a Tesla – US studies have shown that it will take three to six years before the lower emissions from the electric vehicle match that of the fossil-fuel equivalent. In the UK, with lower average vehicle mileage, it would take longer. The Jaguar I-pace is comparable, having a 90 kWh battery.

Those times relate to the original battery. Rechargeable batteries have a life measured in years rather than the decades of the internal combustion engine. Each new battery will take several years of lower emissions from the EV to compensate for its construction.

Lastly there is the generation of the extra electricity. Energy for 30 million cars will increase UK annual electricity by almost 25 per cent. The construction of the extra power stations plus the complete new infrastructure, cabling with tens of thousands of charging points, adds to the carbon footprint of the EV option. With a combination of all the factors in the chain, the reduction in CO_2 emissions from the switch to electric vehicles may be minuscule and could go into reverse if battery life is short.

Conventional cars have the capacity to be refuelled at any time of the day in only a few minutes, spreading out the energy uptake. This convenience will be lost with the growth of electric vehicles. Batteries take many hours to recharge, which will encourage most drivers to plug in as soon as they arrive home at the end of the day. Standard chargers start at about 3.5 kW and fast chargers for electric vehicles are rated at between 7 kW and 22kW. There are others rated at 50 kW that can reduce the charging time to less than an hour and will be a very tempting choice for larger vehicles. If there are only five million electric cars in a few years and 50 per cent are connected to charge together in the early evening using the 22 kW units, their power demand will be 55 GW – which alone is greater than the winter peak load in 2017. Significant strengthening of the grid and distribution networks will be required to cope with such loads. National Grid has examined this in its future energy scenarios. FES2017 Chapter 5 forecasts an increase of 30GW in peak demand by 2045.

'Smart grids' it is claimed will help to smooth out the peaks, but that is really jargon for a technology that overrides the consumer's choice and charges the battery to suit the energy company. Such loss of flexibility may prove very inconvenient for EV owners who need to recharge their batteries very quickly.

If all the relevant factors come to fruition perfectly, electric vehicles may reduce carbon emissions by a measurable amount. However if the low-carbon nuclear plants are not replaced, the reduction envisaged by their proponents may not be achieved at all.

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