ELECTRIC CARS: THE BETAMAX OF GREEN TRANSPORT

Claims made for the 'green' credentials of electric cars are not as clear as they first appear. It is easy to be taken in by assertions supported by unreliable advertising and by a naïve establishment. Even the European Vehicle Market Statistics state that electric cars have zero emissions[1].

So much faith has gone in to their green credentials that the government has been persuaded to pay up to £5,000 to purchasers of new electric vehicles. Although the cost of any commodity is dictated by the labour cost, R&D, advertising and production, its price, in a free market, is decided by what someone is prepared to pay for it. A customer may be reluctant to pay £20,000 for a car but will be happy to pay for a more expensive one at £24,000 if someone else puts £5k towards it. Marketing people know this. Presented with a 'bargain' and a commendable wish to be green, you can see how a potential purchaser could feel great about buying an electric car.

SO HOW GREEN IS ELECTRIC?

So why are electric cars not zero emission. The shock is that electricity is the dirtiest of all forms of energy and will remain so for some considerable time. There are two reasons for this. Apart from photovoltaic (PV) generation, which we will return to, electrical power is generated by rotating generators and no machine is 100% efficient. Most of these generators, in fact all of the controllable ones, are driven by fossil fuels.

The second reason is that electricity uses energy to get from its point of generation to its point of use. The resistance of thousands of miles of overhead and underground cables consume energy – a lot of energy. The result is that each unit (kilowatt hour, kWh) of electrical energy sends 462 grams of carbon dioxide (CO_2) to atmosphere[2].

Found energy, such as coal, oil and gas, is refined, stored and transmitted with the same calorific value, or energy, at both ends of the pipeline. This is one reason why the CO_2 output per kWh of energy is 253 grams for petrol or 260 grams for diesel; much lower than the CO_2 from electricity.

This is not to suggest that the petrol car is cleaner than the electric because the electric motor is far more efficient than the internal combustion engine. The difference, however, is not overwhelming. The Nissan Leaf electric car produces 55 grams of CO_2 per kilometre travelled[3] whereas the petrol driven Micra 1.2 DIG-S, a similar sized vehicle from the Nissan stable, emits 95 grams per kilometre[4]. Nissan continue to claim that the Leaf has an output of zero CO_2 per km. Nissan have been chosen for no other reason than their familiarity and predominance in this field.

Nothing, of course, is that straight forward. Unlike all other forms of energy, electricity is used in the same instant that it is generated. The energy content of liquid and gaseous fuel does not change as it sits in the tank waiting to be used. Neither does the energy stored in a car's battery – at least in the short term. The government's conversion table for carbon dioxide equivalent relate to energy and not power. As electrical power drawn from the national grid is provided from various sources it changes all the time. The CO_2 emissions should

actually relate to the power generation at the time of charging the vehicle. The government figures are an average over the whole year.

The national grid has to provide power to the whole country at varying rates of demand. The generating fleet needs to be able to provide for the maximum demand that occurs between 4pm and 7pm Monday to Thursday from December to February. A time when, it should be noted, there is no contribution from the roof mounted and ground mounted solar farms after sunset. The PV investors receive generous payments from the remaining customers through their electricity bills to generate power in the middle of the day in summer: precisely when it is not needed. Coupled with the possibility that the wind is not blowing, the time that all the new electric cars are being plugged in on arriving home coincides with the time that the national grid is largely fossil fuel driven. The 55 grams of CO_2 per kilometre quoted earlier for the electric car will be much higher if it is charged at the 'wrong' time. Even though there is talk of Internet controlled demand management (your tumble dryer will only work on a sunny, windy day), adding your car's electrical load to the system at busy times makes no sense.

LIFECYCLE EMISSIONS

In addition to the revelation that electric cars are far from zero emission and rather closer to their petrol equivalents, there is also the carbon produced in their manufacture to be considered. A report compiled for the Low Carbon Vehicle Partnership by Ricardo[5] shows that for a medium sized internal combustion engine car the embedded carbon in production will be 5.6 tons of CO_2 (tCO_2e) a similar electric car has embedded production emissions of $8.8tCO_2e$. The higher emissions are mainly due to the battery.

Based on a vehicle life of 150 thousand kilometres, the study concludes that the whole life tCO_2e emissions are 24 for the petrol car and 19 for the electric. Still in favour of electric but hardly justifying the zero emission claims. They also use the average carbon conversion figure referred to earlier without account of charging times corresponding to maximum demand periods.

If this all seems exaggerated, consider the concerns now being raised in China over the increasing use of electric cars. 200,000 new electric and plug-in hybrids were registered there during last year alone. Using the same naïve logic of European countries, the Chinese government has put in place incentives to increase the sale of electric vehicles. Volkswagen expects to increase its sales of electric and hybrid vehicles to China over the next five years to annual sales of two million.

However, due to the high coal usage in electricity generation, researchers at Tsinghua University have concluded that electric cars produce between two and five times more polluting particles than petrol engine cars. Electric cars are actually increasing their pollution problem. At best, according to Tsinghua University environmental science professor Huo Hong, electric cars will push the pollution out from the cities to the countryside.

IS THERE A FUTURE FOR ELECTRIC CARS?

Whilst engineers have always accepted that ten per cent is the maximum capacity of solar and wind power that can be incorporated in to the grid, it continues to increase due to the feed in tariffs paid to PV operators and constraint payments made to wind farms to not generate during low demand periods. That is why investment in wind power is so popular – the more they build: the more often the constraint payments are made. The more this expands, the more money goes to the operators to switch off unless we can make use of the power generated that is excess to requirements.

A POSSIBLE SOLUTION

We can use all of the excess power to produce hydrogen: a fairly simple process using water and electrical power. This is one of the practical forms of energy storage and makes use of energy generated at the wrong time.

Hydrogen may be stored and used when required. It may be distributed by tanker or pipework and used for heating, power generation or, and this is the point, vehicle fuel. This can be used either as an engine fuel or as hydrogen cell providing an electric drive for the car. Hydrogen cell cars already exist and are queuing up to write the obituary of the electric car.

Hydrogen powered cars could genuinely claim zero emissions if exploiting the excess power generation of an expanding intermittent renewable sector. Electric cars cannot make that claim when charging from an instantaneously operated grid.[6]

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[1] Figure 3-17, *European Vehicle Market Statistics Pocket Book 2015/16*,

[2] DEFRA / DECC Conversion factors 2015 version 2.

[3] Nissan Leaf specification
http://media.nissan.eu/content/dam/services/gb/brochure/Nissan_Leaf.pdf
199km autonomy on New European Driving Cycle for 24kW battery.
24/199 = 0.12kWh/km.
1 kWh of electricity = 0.462 kg CO_2e.
0.12 x 462 = 55.4g CO_2e per kilometre.

[4] Nissan Micra Specification 2016
http://media.nissan.eu/content/dam/services/gb/brochure/Nissan_Micra.pdf

[5] LowCVP, http://www.lowcvp.org.uk/news,lowcvp-study-highlights-importance-of-measuring-whole-life-carbon-emissions_1644.htm

[6] The author has no interests in hydrogen technology.