ELECTIC AND CONVENTIONAL DRIVE VEHICLES – SUMMARY NOTE.

Transport-Watch 26th April 2011 Wp Ref Electric for Disk point April 2011

The UK Government's belief, that electric vehicles will emit less carbon (e.g. 40% less) than internal combustion engine vehicles depends largely on a produced by paper by Arup and Cenex[1] for the BERR and DfT. However, that paper relies on the claims of manufactures rather than upon tests or fundamental data. Furthermore, although the paper claims to compare lifetime emissions, the emission associated with battery manufacture is omitted. To illustrate the paucity of the whole here are the responses to freedom of information requests.

"We [Arup] did not look at individual element losses within the vehicle, only the overall efficiency figures as supplied by manufacturers."

"We [Arup] *could find no quantitative data on the energy required to manufacture a lithium ion battery. Neither was there any data available on the energy required for recycling the battery"*.

We are astonished. After all, (a) without knowledge of the energy used to manufacture batteries how can anyone calculate the whole of life carbon emissions and (b) manufacturers' claims are notoriously optimistic, as illustrated by the following anecdotes.

(1) An electric car provided to a journalist for tests was alleged to have a 70 mile range. The journalist decided to be safe and planned a 50 mile trip, only to find the specially prepared car failed at 37 miles.
(2) A user of a G-Wiz found that the battery expired after 2 years and 3 months instead of after the hoped for 5 years.
(3) Jeremy Clarkson of Top Gear found that the Tesla ran out of power after 55 miles on his test track rather than after the 220 miles claimed by the manufacture.
(4) An electric Ford Transit sized van provided to a manufacturer, who wants to remain anonymous, was alleged to have a range of 100 miles. The manufacturer found that on the level, and with no load, the vehicle managed 60 miles, but that on hills in Wales in managed six (yes six).
(5) Adverse weather conditions are said to reduce battery performance by 40% to 50%.

Not only that, the Arup paper did not deal with differences in performance and compared running costs without removing the (overwhelming) effect of taxation on petrol or diesel. Hence we regard the basis for Government policy as inadequate, if not entirely wrong.

In contrast we made estimates of the efficiencies of each link in the chain between primary burn and the residual needed to overcome wind resistance. E.g. power station efficiency, transmission efficiency, battery charging efficiency, battery discharging efficiency, electric motor efficiency, mechanical transmission efficiency, rolling efficiency and inertia/breaking efficiency. The product of those individual elements provided the overall vehicle efficiencies and, provided the vehicle weights are the same, those overall efficiencies compare the energy consumptions of vehicles with identical performances.

In fact, because of the battery, the electric vehicle is substantially heavier, perhaps 25% heavier, than one powered by an internal combustion engine. Hence we adjusted the base efficiencies by dividing the relevant links in the energy transfer chain by a factor which captures the effect. We also adjusted the data to take account of the energy burnt in battery manufacture, see below.

Emissions were compared by dividing the emissions per kWh of primary burn (i.e. as at the power station or by the engine of an internal combustion engine) by the overall efficiencies.

That procedure avoided the problems inherent in comparing the often wild of claims of manufactures, and the problem that those claims may relate to vehicles with different performances. However, the disadvantage is that the various efficiencies and relative weights are themselves contentious. Worse still, there appears to be no reliable data which compares

the energy required to manufacture an electric car's battery with the energy that it will transmit during its life.

A paper by Samaras and Meisterling[2] says that 470 kWh are required to manufacture one kWh of battery capacity and that that amounts to about one eighth of energy transmitted during the battery's life. However, Samaras and Meisterling assumed that the batteries last the lifetime of the vehicles, i.e. 10-15 years. In contrast to that the anecdotes above suggest a battery life of perhaps 3 years and that charging may be needed at half discharge. If so the battery may withstand the equivalent of between only 500 to 1,000 full charging cycles. On that basis the manufacturing energy lies in the range 50% to 100% of that transmitted and it is that range that we have used in our calculations.

Our detailed analysis provides data for a range of operating conditions. The associated spread sheets enable the reader to carry out sensitivity tests, see

spreadsheet **A (http://www.transport-watch.co.uk/transport-files/web-electric-cars-50.xls)**

spreadsheet **B (http://www.transport-watch.co.uk/transport-files/web-electric-cars-100.xls)**

In summary, we found that Arup's claim could be substantiated only if battery manufacture were ignored and if the comparison was with existing diesel vehicles. However, when battery manufacture was included the electric vehicle emitted between 22% and 63% more than an improved diesel and between 50% and 100% more than the experimental MUSIC, an engine under development by MUSI Engineering. Additionally we found that void of taxes and at current prices the difference in fuel costs would be very much in favour of the ICV.

Separately from that, subject to carbon capture, coal fired generation emits double the carbon of the UK generating industry average. Since large scale electrification would extend the life of the coal-fired, there is a case for assigning coal fired emissions to the electric vehicle. If that were accepted as the correct approach then these vehicles would be seen as an environmental disaster.

Additionally, the government has not addressed the problems of disposing of e.g. 30 million lithium-ion batteries or the problem of sourcing the lithium should there be a surge in global demand.

Against that background we believe investment in electric vehicles should be discontinued until tests have been carried that establish their in-use fuel consumption and battery life along with an assessment of the time line for decarbonising coal-fired electricity and of the potential improvements to conventional vehicles.

In support of that we note that Professors David Cebon and Nick Collings of Cambridge have concluded for similar and other reasons that it would be far better to improved conventional vehicles than to pursue the electric route, see http://www-cvdc.eng.cam.ac.uk/Ingenia-letter.

---

[1] Investigation into the Scope for the Transport Sector to Switch to EVs and Plug in Hybrid Vehicles, dated October 2008 for the BERR/DfT available at http://www.berr.gov.uk/files/file48653.pdf

[2] Samaras, C. and Meisterling, K., Life Cycle Assessment of Greenhouse Gas Emissions from Plug-in Hybrid Vehicles: Implications for Policy, Environmental Science & Technology, Vol. 42, No. 9, 2008, p. 3171 http://pubs.acs.org/doi/full/10.1021/es702178s .