How can society offer freedom of transport in low carbon age?

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In the UK, road and air transport (both overwhelmingly fossil-fuel based) use energy at a rate twice that of the average power transmission of the national grid. In 2015, road transport alone used energy at an average rate slightly more than the peak electricity demand in that year. In simple terms, if we electrify the road transport fleet we are going to need a grid – and electricity generation system – at least twice the capacity we have now. To generate this from nuclear power we would need 16.5 more Hinckley Point C power stations at a total cost of £404 billion.

The success of the IC engine and the failure of alternatives

Personal transportation using the internal combustion (IC) engine has brought great economic development because of its affordability. The IC engine is made from cheap and abundant materials using cost-effective processes while using a cheap energy storage system. Liquid fuels are energy dense, easy to transport and also provide low energy losses both in the vehicle and the energy distribution system. Moving away from this is a significant danger to our economic model that makes transport affordable for all (including manufacturers, fuel companies, governments and consumers). This financial system relies on the consumer being able to afford what is offered and will collapse if this is not the case.

The government provides some stimulus for low-carbon vehicles in the form of rebates for electric vehicle purchases; however, EV sales rarely exceed 1% as a monthly maximum and since the rebate reduction this year they have dropped. I think it unlikely that this will break out into the mainstream any time soon. Unfortunately one can largely discount hydrogen as a solution as well. In addition to the power requirement, we have no hydrogen distribution infrastructure at all and the energetic losses in such a system would be considerable, to say the least.

But we absolutely do need to change from a fossil-fuel based transport economy.

Ensuring the polluter pays

The problem of fossil CO2 emissions from cars (and by extension vehicles in general) is not actually the fault of the manufacturers – the fossil carbon that is emitted comes from the fuel, the sale of which the fuel suppliers alone profit from. Yet, car manufacturers have more significant legislation raised on them to reduce CO2 emissions than the fuel suppliers have to take the fossil carbon out of the fuel. Fuel suppliers have a vast revenue stream which dwarfs that of the car makers, and which could and should pay to develop the means of fully decarbonising their product. They are not made to meaningfully do this, which is not aligned with the maxim 'the polluter should pay'.

It is also somewhat ironic that, after 130 years, most people assume that the IC engine has to use fossil fuel, whereas it was originally fuelled using biofuels and we later made it operate on fossil fuels for cost reasons. In this regard, clearly we are in a circle of hell of our own making.

The pragmatic solution

To this pragmatist at least, the solution appears to be to keep affordable IC engines, but to find a solution in the form of decarbonising the liquid energy carriers. This would keep travel affordable. We could use their high energy density to facilitate access to the huge amounts of renewable and clean energy that falls on the earth (the power of wind energy at turbine heights alone amounts to about 78 TW while the total transportation draw is about 3 TW).

Technologies exist to capture CO2 directly from the atmosphere; this can be combined with hydrogen from water electrolysis to produce methanol at about 50% process efficiency, and this in turn can be onward synthesized to 'drop-in' fuels for existing vehicles with about an 8% point penalty. If all of the energy used is renewable, we have a fully-decarbonised energy vector. We would need 6-7 TW of renewable energy to decarbonise transport – or less than 10% of global wind energy (and this is without accessing solar energy in deserts, for which I estimated that an area half the size of Somerset could gather the same energy as Europe currently uses in its transport fleet).

Transitioning to a decarbonised transport system

With a taxation system based on taxing energy purchased (and not the liquid volume), in combination with a factor penalising any fossil carbon associated with providing that energy, governments could facilitate migration to a decarbonised energy stream while keeping their tax take at a constant level. This is not something provided by the current inducements for EVs. Supply of such fuels – which is being researched by forward-thinking companies and research institutions, including Audi – enables all vehicles to start to be decarbonised immediately. Contrast this with a gradual movement to an electricity or hydrogen-based transport system, where the small number of such vehicles cannot provide an immediate large revenue stream to pay for the change.

If fuel companies do not embrace the requirement to decarbonise their product, but continue to lobby against any change they could find their businesses severely impacted by a move to another energy economy that their resistance has brought about. They have the revenue stream to do the research and to facilitate decarbonisation via industrialisation, as well as the infrastructure to distribute the product – and they also have the ultimate and moral responsibility for CO2 emissions from the fossil fuels they currently supply.

Provided by University of Bath