Does the Electric Car have a Future?

David Robinson believes that the long-term prospects are favourable but there are many struggles ahead

This article on the global prospects for the electric vehicle (EV) makes three points. First, the long-term prospects are favourable, if only because we eventually need to de-carbonise the transport sector to meet greenhouse gas emission targets. However, in the next ten to twenty years, the EV will struggle with the same problems that stopped its growth a century ago – namely high cost and limited appeal to most customers. Third, to reach its potential, the EV will need sustained political support, whose justification will depend heavily on the de-carbonisation of the electricity sector. Nowhere is the potential greater than in the large and fast-growing developing countries.

The Case for Electric Vehicles

The first cars were electric. By 1900, 38 percent of US vehicles ran on electricity, 40 percent on steam, and only 22 percent on gasoline. However, the fleet of EVs in the USA peaked in 1912, after which internal combustion engine (ICE) cars running on gasoline became more popular. By 1930, the EVs were no longer important in the USA or Europe.

The EV has recently made a comeback, with hybrid electric vehicles (HEVs) in vogue, and plug-in electric vehicles (PHEVs) about to hit the market. The proponents of EVs see them as game changers, mainly due to the potential to lower greenhouse gas emissions and reliance on oil imports.

Reduced GHG emissions. First, EVs emit significantly less greenhouse gas (GHG) than a car with a conventional ICE running on gasoline. The latter has an energy efficiency of about 20 percent. The electric motor is much more efficient and battery EVs using renewable electricity can lower life-time GHG emissions by 80 percent. But, in practice, GHG emissions will depend on the local conditions, in particular the electricity generation mix and the driving patterns. Assuming EU conditions, for instance, the life-time GHG emissions for battery EV light vehicles are about 40 percent lower than for conventional vehicles.

Second, by replacing conventional vehicles, EVs shift the burden of controlling CO_2 emissions to the electric sector and thereby facilitate the control of CO_2 emissions. There are fewer than 5000 large fossil-fuel power stations in the world responsible for the bulk of CO_2 emissions from electricity. Cutting or simply monitoring the emissions from a relatively small number of stations is significantly easier than cutting or monitoring the emissions from hundreds of millions of cars running on fossil fuels.

Third, in order to meet GHG targets from 2030 and beyond, it seems likely that we will need to de-carbonise transportation. EVs will become increasingly attractive, unless some other better zero-carbon alternatives emerge for the transport sector.

Security of supply and reducing oil import dependence. Concerns over energy supply security refer primarily to reliance on the imports of oil products from potentially hostile countries. In particular, political enthusiasm in the USA for EVs reflects a perception that they would reduce the cost of oil imports and reliance on potentially unfriendly nations. This argument has more or less influence depending on the international and domestic political context, as well as perceptions about the future price of oil.

Rising gasoline and CO_2 prices. The prospect of rising gasoline prices (due to rising CO_2 prices and tighter hydrocarbon markets) may lead consumers to change their buying

and driving habits, moving towards more efficient and smaller cars and, possibly, EVs. If oil prices stay high enough for long enough, this may encourage customers to overcome their reluctance to pay the higher initial cost of the EV.

The Challenges

The future of EVs will depend on four key factors: the importance of the fixed cost of the EV relative to the potential fuel savings, the turnover of car fleets, the attraction of EVs to customers, and the sustainability of political support for them. The first three factors do not currently augur well for the EV, at least in the short run.

*Fixed cost of electric vehicles in relation to potential fuel savings***.** When consumers buy new vehicles, the initial fixed cost is a key choice determinant. According to the International Energy Agency (IEA), the extra cost of an HEV is about $5000, of which $3000 is for the battery. The additional costs are higher for a PHEV and they rise with the distance the car can travel between recharging. A recent US National Research Council (NRC) report estimated that the additional costs for a PHEV-10 (10-mile limit) would be $6300 in 2011.

Will the saved fuel costs compensate for the higher fixed costs? The studies I have seen suggest that for this to happen very high oil prices would be required, very low electricity prices and very low discount rates (for customers). Apparently, most customers are not willing to pay much, if any, additional fixed cost when they buy a new car.

Might the economics change? One possibility is that the cost of batteries will fall enough to make a difference. However, battery technology is quite mature. The US NRC study has a 'probable' scenario in which the additional cost of a PHEV-10 would only fall from $6300 in 2011 to $4100 by 2030; most of that additional cost is for the battery.

One proposed development that would favour PHEVs is to enable owners to sell ancillary services (e.g. electricity reserves that can be tapped at short notice) from their batteries back to the electric system. This will require the development of smart grids that allow for two-way communication between the customer and the electricity networks (the so-called Vehicle-to-Grid technology, or V2G). However, it is important also to recognise that a massive increase in PHEVs will require new generation capacity. The current costs of V2G technology do not seem to justify its deployment today, and some trusted experts are convinced this is really a dead end.

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Are there ways to overcome the problem of the high initial fixed cost of EVs, short of subsidies? Certainly, there will be commercial strategies that aim to overcome a customer's reluctance to make the initial investment. For instance, the company Better Place proposes to lease car batteries to EV buyers (lowering the customer's initial outlay) and to provide replacements through a network of 'fast charging' stations. Better Place is also offering a second alternative in which they charge subscribers a fee per-kilometer driven, just like a mobile phone operator charges its subscribers for minutes used.

*Turnover of fleets***.** In wealthy countries, two other factors militate against an early, rapid growth of EVs. First, car penetration is already high; in the USA, for instance, the average household has more than two cars. Second, vehicles are kept on the road for many years, even though they may be resold. The 'cash for clunkers' policies have probably postponed the period when EVs might have expected to grow, since many consumers have locked themselves into a new conventional vehicle for a number of years.

There is, however, a greater potential for rapid EV growth in large and rapidly developing countries in the next few decades. There, car penetration is very low and the prospects are good for dramatic growth. It is also possible to imagine that mass production of EVs in India and China would drive down the costs. Already, the largest producer of EVs is a company based in Bangalore, India. If the Indians can produce a conventional car for $2000, what is stopping them from producing a relatively low cost EV for their domestic market and for export?

Customer preferences. When it is time to choose a new car, will the consumer choose an EV? There is some research that indicates that, even if the price was the same as a conventional vehicle, customers still see pure EVs as being insufficiently versatile. The limited autonomy of EVs will restrict the market for non-hybrid vehicles.

On the other hand, an even more important question is whether customers actually like EVs. Do the styling, image and performance appeal? If not, then it is very unlikely that the EV will ever take off. This is a major challenge for the industry.

The challenges summarised above are all largely short-term problems. There is no reason for them to stop the EV from becoming an important transport mode in the longer term.

Political Support

Significant growth in EV fleets is likely to depend on sustained political support. In the OECD countries, this will involve subsidies, tax and other benefits to buy and run electric vehicles; additional taxes on fossil fuels, ICE cars, road use, and CO_2 emissions; and regulatory and fiscal support for the development of smart grids, PHEV plug-in networks and battery RD&D.

But will the political support be sustainable and sufficient enough to make the EV a game changer? Many countries are now promoting EVs as a way of reducing their reliance on

imported oil, meeting CO_2 emission reduction targets, supporting local car manufacturing industries and even as a way of soaking up excess supply of electricity and integrating renewable energy. However, the costs of supporting these policies will come under increasing pressure due to the cost of overcoming customer reluctance to pay more for EVs, and of developing an electricity infrastructure to support them. The IEA has estimated a huge deployment cost between 2005 and 2050 to achieve a 15–25 percent share of new car sales by the end of that period in the main markets. It is certainly questionable whether political support will be adequate.

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It would be easier to provide sustained, global, political support for the EV if its growth would lead to a substantial reduction in CO_2 emissions. An IEA scenario estimated that EVs could save 2 $GtCO_2$ in 2050 (energy-related emissions in 2008 were about 28 $GtCO_2$). However, EV technologies are among the most expensive forms of CO_2 abatement. In that IEA scenario, EVs constitute only 17 percent of the potential abatement in the transport sector, with improved fuel efficiency from conventional cars accounting for over 50 percent. In a more conservative scenario, the IEA forecasts savings of only 0.5 $GtCO_2$ in 2050 from EVs, which is less than 1 percent of the projected (business as usual) energy related CO_2 emissions in that year. Hardly a game changer.

If there is a public policy case to be made to support EVs, it will be in the largest developing countries that currently depend on coal-based electricity. In China and India, the GHG savings from EVs would be relatively minor while electricity is fuelled mainly by fossil fuels. If, on the other hand, these countries substantially de-carbonised their electricity systems and simultaneously promoted EV penetration, this would have a double effect: lowering emissions in the power and transport sectors. The IEA estimates that China's CO_2 emissions from coal-fired generation and transport will account for about 19 percent of global energy-related emissions in 2030. India's electricity and transport sectors will account for at least an additional 5–10 percent of global energy related CO_2 emissions in 2030. Therefore, de-carbonisation of electricity and aggressive expansion of the EV fleet in these countries would make a big contribution to global efforts to reduce greenhouse gas emissions. But, this comes with an important incremental cost.

Is this an opportunity to forge a deal with China, India and other fast growing developing countries that rely on fossil fuels? They would agree to facilitate investment to shift to low carbon electricity and a rapid growth of EVs, and the rest of the world would agree to share with them the incremental costs of this transformation. We would all be winners to the extent that this significantly lowered CO_2 emissions. The main developing countries would gain to the extent that they enjoyed low-carbon electricity and transport, partly financed by the rest of the world. Investors from around the world would benefit to the extent that they participated in the transformation. Developing countries would become major exporters of low cost EVs, making it easier for the rest of the world to adopt them. If this also lowered oil prices, it would benefit oil-importing countries. Who would be the losers? Mainly the manufacturers of conventional automobiles, oil-exporting countries, the oil and gas companies that had not moved into electrification and, of course, everyone who helped to pay for the transformation! As always, agreement on the sharing of the burden would be difficult, and it would be necessary first to demonstrate that the benefits outweighed the cost.

Who Will Lead this Charge?

Is there global political will to make this sort of vision come true, or at least to get the EV off to a good start in developing countries? I doubt it. In the aftermath of the Copenhagen Climate Change Conference, geopolitics seem to be moving more in the direction of multiple 'bottom up' deals, including sector-wide agreements and national or regional commitments to lower CO_2 emissions, with a clear eye on commercial advantage to be gained. The way forward for the EV probably lies in defining more clearly the strategic commercial proposition for a group of countries or sectors.

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If we were looking for white knights with a commercial interest in realising this vision, one would be the electricity sector itself (with a second being the automobile sector). The OECD electricity sector organisations recognise climate change legislation as a threat and an opportunity. They expect increasing demands for investment in zero carbon electricity generation and in massive new transmission networks to connect renewable sources of power that are often far from the market. At the same time, the sector faces a declining demand for their product from traditional customers, as prices rise to reflect CO_2 costs and scarce fossil fuels, and as governments introduce measures aimed at encouraging energy efficiency and savings. On a business as usual basis, electricity demand forecasts in the OECD countries are flat or growing at less than 1 percent per annum. With climate legislation, demand for conventional electricity uses could well begin to fall.

The response by the OECD electricity sector organisations to this threat has been to accept, in principle, the

need to de-carbonise the generation of electricity by 2050 and to promote (and here is the opportunity) a switch from fossil fuels to electricity, especially in transport and heating. EVs provide a new source of demand and might also help the electricity network operators to better manage the electricity systems, especially if the vehicles are charged during periods of off-peak demand.

It is ironic that the OECD electricity sector organisations have adopted this strategic vision, whereas the electricity sectors that really matter in this debate are in the large non-OECD countries. I think it is time they talked to one another, if they are not already doing so. If they did, they might well find that their collective futures were tied to the de-carbonisation of the sector, the development of smart grids and the growth of the EV.