Written evidence submitted by Mr Ian Roberts (EVP0043)

Introduction to the author

I am a professional Business Analyst who is well versed in the assessment of options and the production of cost benefit analyses on various forms of change. This has usually been within the private sector and generally within large financial services organisations. However, I also have experience in the electricity industry; both in generation and supply. The whole of my career of almost 40 years I have been required to take basic information and neutrally analyse it in order to reach a best overall conclusion.

My particular interest in this subject is as a motorist who has watched closely as the industry has progressed in the development of emission free vehicles.

Scope

Under the heading of 'Accelerating the shift to zero emission vehicles' this document will address three main barriers to the uptake of pure electric vehicles (EVs), acknowledging that two of these are being addressed by markets and R&D by vehicle manufacturers. The third of these barriers (charging infrastructure) does, however, need some Government attention. This is addressed in some detail with discussion around what is needed in different types of location. There is an analysis of the disparity in the cost of charging, something which must be addressed in order to encourage uptake of EVs from the 40% of UK drivers without off road parking at home.

Under the heading 'Road Pricing' the document acknowledges the challenge as we move away from the current model of raising revenue via specific taxes attached to the sale of petrol and diesel. This continues with suggested models for road pricing with some analysis of how these might work in practice.

Under the heading 'Cost Neutrality' the road pricing is brought together with the analysis of disparity in the cost of charging to highlight some key issues that need to be addressed if any form of road pricing is to be accepted by the UK public.

Terminology

This document focuses almost entirely on Private Cars. For convenience the term EV will be used throughout and this can be taken to mean Electric Cars powered solely by electricity stored in batteries, without the use of any other on-board fuel or any type of Internal Combustion Engine (ICE).

The term ICE vehicle is used to refer to any car powered by an internal combustion engine either alone or in combination with an electric motor in a hybrid arrangement.

Accelerating the shift to zero emission vehicles

Barriers to Adoption of EVs

From my reading on the subject, there are three barriers to the uptake of pure electric cars

1. The price of new pure electric cars

2. The distance which these cars can travel before needing to be re-charged and the accompanying range anxiety
3. The availability and quality of the charging infrastructure.

Barrier 1 is to some degree mitigated by the Plug-in Vehicle Grant. As time progresses, technology continues to improve and the benefits of large scale production with lead to further reductions in the price of new electric cars.

Barrier 2 is more one of education now, as we are seeing an increasing number of mid-price cars coming on to the market with a real-world range in excess of 250 miles on a single charge. The education aspect is around encouraging a change in behaviour – particularly for those with off-road parking where there is access to electricity.

Barrier 3 needs to be considered on three parts.

- Availability of reliable rapid charging points (< 50kW) on major routes
- Availability of a mix of charging points and in town / city centres.
- Availability of reliable, low-cost overnight charging points (around 7kW) in residential areas for those who do not have off road parking.

Motorways and Trunk Roads

The network of rapid chargers is improving daily but there is a great disparity on price and quality. More competition is needed, particularly on the Motorway network. Tesla drivers have access to Tesla's own Supercharger network, which is excellent[1]. But drivers of other electric cars are dependent on whichever charging network(s) have installed chargers at the particular service station. In almost all cases this will be Ecotricity's Electric Highway, which unfortunately has a reputation for being an extremely unreliable network[2]. Added to this whilst all their chargers have a CHAdeMO connection many lack the CCS connection, which is now the primary connection type for new EVs. Where CCS connectors are fitted to these chargers, it is those connectors that are most prone to faults and problems. These facts are well known amongst EV drivers as well as potential converts and is currently a significant deterrent. Increasingly these Electric Highway chargers are being supplemented by Super Rapid chargers from Ionity. These are extremely reliable, which is excellent news, but are 2.5 to 3 times the cost of other networks[3]. This may be justified on grounds of convenience as they can deliver charge must faster than most other networks. Unfortunately, most electric cars on the market today are unable to accept charge at these higher speeds and therefore do not benefit. Where there are charging stations on major routes and motorways there needs to be clear signage on the approach to the station of which charging providers operate chargers at the station and the per kWh price – similar to what is required on the approach to motorway services and almost all filling stations for petrol and diesel. This will be of benefit to drivers of electric cars and will also help highlight to drivers of ICE[4] cars the availability of charging stations as the network grows.

Towns and Cities

In town and city centres the need is for a mix of fast and rapid chargers.[5] There are different groups that need to be catered for

- Shoppers – put their EV on charge at around 7kW for a couple of hours while shopping
- Commuters – one or two days per week they will want to charge their EV for the whole day whilst at work. This will be of particular benefit to those without charging facilities at home.
- Commercial Travellers, taxi drivers and others who use EVs as part of their business / job – these will need access to rapid chargers so that they can re-charge their car whilst having lunch or attending a meeting

Residential Areas

In residential areas without private, off-street parking (including apartment blocks, terraced housing, any house without a driveway or garage) there is a need for a significant number of convenient charging points that can be used overnight (or at any time when a car is not in use). People with off-street parking are currently able to benefit from a grant which helps with the cost of installing a 7kW home charger[6]. Those without off-street parking cannot benefit from this grant and currently have no choice but to use public charging points, which will be away from their home and are likely to charge significantly more for electricity than charging at home.

There is a commercial incentive for increasing the infrastructure for vehicle chargers on motorways and major routes, particularly as the number of ICE cars decreases and the demand for the traditional petrol station diminishes. There may also be some commercial incentive for providing the infrastructure in town and city centres, already we see charging points in city centre car parks as well as at out-of-town retail parks and at some supermarkets.

The challenge comes in residential areas without off-street parking. Adoption of electric cars by residents of these areas will require the availability of on-street, cost-effective charging to enable them to keep their cars charged at home or a convenient location.

Cost of Charging

It is difficult to make direct comparisons of fuelling costs (pence per mile) between electric cars and ICE cars as there are so many variables involved but for the purposes of illustration, I have used Kia Niro 4 Self Charging Hybrid as an equivalent to a Kia Niro EV 4+. The self-charging hybrid has a combined MPG or 53.3 WLTP. The electric Niro has a Miles / kWh figure of 3.9.

Assuming a petrol price of £1.12 per litre[7] or £5.08 per gallon, the fuel cost of the Hybrid is 9.61 pence per mile. Based on this the break-even price for electricity to have the same fuel costs as the hybrid would be 37.47pence per kWh (9.61p x 3.9). Annual fuel cost for petrol in this hybrid vehicle driving 10,000 miles per year is £961.

For those able to charge at home the savings from running an EVcan be significant. A driver who is able to charge at home on an average single rate tariff at around 15p per kWh would save £576. However, most EV drivers who charge at home switch to an EV friendly tariff so that they can charge their EV overnight at rates averaging around 5p per kWh[8]. This gives an annual saving on fuel of £832 – cutting fuel costs by around 87% when compared to a reasonably economical petrol hybrid.

For those unable to charge at home, who are totally dependent on the public charging network the savings are nowhere near as good. There are a small number of free to use public chargers but these tend to be at supermarkets and out of town shopping centres and in almost all cases they are rated at 7kW or less. These can be used to top up occasionally but are not viable as the main source of charge due to the relatively short time spent at these locations. Prices at other public charging stations range from 23p[9] per kWh to 69p[10] per kWh. For someone who regularly charges at the 23p rate the fuel saving is a more modest £371 and for an average public charging price of 30p per kWh that reduces to £192.

Whilst it is right that those using the public charging network should contribute something towards the cost of the charging infrastructure, these massive price discrepancies are unsustainable, particularly as the distance an electric car can travel on a single charge continues to increase. This will leave the only people using the public network on a regular basis those who don't have charging facilities at home.

It should be possible to allow cars to be charged anywhere at a price that is linked to the customer's own domestic electricity tariff. There could be a small surcharge per kWh for using a 7kW public charger with a more significant surcharge for those using rapid chargers. EV drivers who are customers for a domestic electricity supply could use a card supplied by their energy supplier. Whilst other EV drivers could pay an all inclusive price to the charging network operator using a contactless credit / debit card.

Summary

In summary, of the three barriers to EV adoption the first two are mitigated by advances in technology which are both increasing the range EVs can travel between charges and also helping to reduce the extra cost of an EV versus and equivalent ICE car. The third barrier, being the public charging infrastructure, is the area that needs to be addressed in three ways

1. The number of public chargers available
2. The reliability of chargers from certain providers. Particularly on the Motorway network where Ecotricity have a near-monopoly for drivers of non-Tesla EVs
3. The huge disparity in cost between charging at home and using the public network, as this presents a huge economic disadvantage to those without off-road parking. No such disadvantage exists when buying fuel for ICE cars.

Road Pricing

Historically the UK has generally kept away from direct road pricing, with the exception of toll bridges / tunnels and a limited number of toll roads. In addition, we have in recent years seen the introduction of congestion charges in major cities. These have effectively been a pollution tax, as EVs have normally been exempt. Beyond these limited examples motorists have contributed to the tax take for their use of the road network by indirect methods

- by way of fuel duty (FD) and VAT on fuel
- by payment of Vehicle Excise Duty (VED).

The contribution for FD and VAT is based on a combination of distance travelled and the efficiency of the car, which in turn means that the contribution is also linked to the CO_2 emissions and other pollution caused by the car. With the current arrangement for VED there

is no real link between this element and the pollution caused by the car (pure EV driver pays no VED and drivers of most other cars pay the standard rate, with a higher rate being triggered based purely on the list price of the car being above a certain threshold).

At present most 'fuel' for EVs is drawn from the grid at home and is paid for alongside other domestic electricity. This attracts a reduced VAT rate of 5% and no other duty is charged on this fuel.

It will be difficult to distinguish between electricity used to charge vehicle batteries at home from electricity for other domestic uses, therefore a system of taxing based on fuel use is difficult.

It therefore follows that there is a need to raise revenue from a combination of version of the current VED scheme and some form of road pricing. Currently the annual VED for petrol and diesel cars is £150 per year.[11]

Types of Road Pricing

Road pricing schemes can either be a straight cost per mile driven, a variable scheme where different types of road a charged at different rates, a variable scheme where journeys are priced differently based on time of day or a combination of both.

We know that the technology is available to track vehicles, at least sufficiently to know how many miles are travelled on different types of road and at what times. Therefore any of these options can work without the need to install toll booths across the UK road network. Whether this is done by tracking devices installed in vehicles or by Number Plate Recognition systems is beyond the scope of this evidence.

Flat rate per mile

This is the simplest option but takes no account of congestion or the demand for road space versus supply, nor the type of road used. This may penalise those living in rural areas or areas where there is little or no public transport.

Pricing by Time of Use

The concept here is to charge lower per mile rates at times when demand for road space is lower. The concept is similar to existence of off-peak fares on public transport or time of use energy tariffs. For drivers who can flex when they make their journeys there is the possibility to save money whilst helping to even out traffic flow and reduce congestion. Unfortunately, it comes with an economic disadvantage for those who cannot flex the time of their journey. Commuters who must be at work at a set time for example could end up paying a premium for a poorer service – paying extra to make a journey at a time when congestion makes the journey slower.

Pricing by Type of Road

This works by having different prices for different road types. Such types might include:

- Motorways – currently accounting for 19.8% of all miles driven in UK

- Rural A roads – 28.3% of all miles driven
- Urban A roads – 13.8% of all miles driven
- Rural minor roads – 14.8% of all miles driven
- Urban minor roads – 23.3% of all miles driven[12]

This is a generally workable option except that it could result in drivers using alternative roads to avoid higher charges. For example, in West Yorkshire many journeys across the county are made using the Motorway network.[13] At peak times many of these journeys are being made by commuters. If the price per mile on the motorway were significantly higher than on other roads, this could move traffic onto A roads and minor roads causing more congestion, increasing the risk of accidents as a result.

Combination Pricing

Although it would be possible to combine Time of Use with Type of Road to form a pricing matrix, it is essential that the charging structure is understandable to drivers and vehicle owners. Currently drivers believe that they can accurately estimate the cost of a journey based on distance and miles per gallon. Even though such estimates are rarely accurate perception is important. The public will not accept a system which is perceived to make the prediction of journey costs impossible.

Cost Neutrality

It is essential that any form road pricing should be no more expensive per mile on average than what is being paid today by an average motorist driving an ICE vehicle. Ideally the costs should be lower than for ICE vehicles in recognition of the

The average distance that a single car travels in a year is 7,400 miles[14]. Taking our petrol hybrid Niro 4 referenced above with a WLTP combined fuel consumption of 53.3 mpg that would be 138.8 gallons or 630.3 litres. The duty on fuel is 57.95 pence per litre[15]. In addition VAT is charged on the total price including duty. On a retail price of £1.12 per litre the VAT element is 18.67p. Therefore, the total tax take from a litre of petrol is 76.62p. That equates to just under £3.48 per gallon, which for our Niro 4 Hybrid is 6.53 pence per mile. In addition, the VED for a hybrid vehicle is £140 per year from year 2, which is an additional 1.89 pence per mile on average mileage.

Therefore, based on my example, for the total tax take to be neutral the price per mile should be no more than 8.42 pence.

It is important to note however that the choice of car for the example was completely arbitrary and WLTP combined mpg figures range between 28.5 for the Alfa Romeo Giulia Quadrifoglio to 68.9 for the most economical Toyota Yaris Hybrid. Giving tax take per mile figures of 14.24p and 6.94p respectively.

EVs vary in their fuel efficiency in the same way that ICE cars do. Currently one of the most efficient electric cars is the Tesla Model 3 Standard Range Plus at 4.255 miles per kWh and the least efficient the Audi e Tron S55 at 2.326 miles per kWh.[16] Although EVs have no tail pipe emissions there are still some CO2 emissions from the generation of electricity – though significantly less per mile than for ICE cars. Any road pricing scheme fails to take these relative efficiencies into account and the only penalty faced by the driver is the need to use

more electricity. However, given the huge disparities in the price paid for electricity a driver of an Audi e Tron could be paying 2.15 pence per mile on fuel – if charging at home at 5p per kWh. Meanwhile the Tesla model 3 driver could be paying 7.3 pence per mile on fuel – if charging exclusively at Tesla Superchargers due to not having charging facilities at home.

So, we have seen the range of where the price per mile for road pricing needs to be to give a neutral tax take from the average motorist. Whilst this is extremely important for The Treasury the individual driver is more concerned with his overall cost per mile.

For our Niro Hybrid driver, the fuel cost per mile is 9.61p

For our Niro EV driver, the fuel cost per mile if charging at home overnight at 5p per kWh is 1.28p. Of this around 0.06p is VAT[17]

For our Niro EV driver, the fuel cost per mile if charging on a public network at 30p per kWh is 7.69p. Of this around 1.28p is VAT[18]

Fair Pricing for Fuel

In order to be able to introduce per mile charging in the region of 8.42 pence (neutral tax figure above) without disadvantaging those without home charging capability, it is essential to address this disparity, both in terms of the cost and the amount of VAT paid. The electricity is being used for the same purpose whether bought at home of form a public charger. Therefore, all electricity bought by individuals for either transport or domestic use must attract the same rate of VAT. With the gap being made up from an element in the road pricing model. A higher VAT rate (standard rate) could be justified where the charging source is rated higher than 7kw, as that would provide extra convenience beyond what is comparable to ‘at home’ charging.

Battery capacity will increase in the years to come as will the maximum kW rate at which cars can accept charge from DC chargers on the public network. However, 7kW is a practical limit for charging at home and should also be the limit for the on-street chargers that are designed to be in lieu of charging at home, leaving the rapid charging infrastructure for those in a hurry or those needing to recharge during a long journey.

Conclusion

I have shown that the main barrier to the uptake of EVs going forwards will be ready access to a reliable charging infrastructure. This will be a combination of at home AC chargers, 7kw AC on-street chargers (in lieu of at home charge for those who do not have off road parking) and rapid DC chargers at strategic points on motorways and trunk roads. I have mentioned in this context the current poor provision and low reliability of chargers with CCS connectors on motorways. Encouraging the provision of motorway charging hubs by companies other than Ecotricity and Tesla would resolve this issue[19]

I have also shown that it is essential to make the cost of charging EVs more consistent between those who can charge at home and those who can’t. The high price of topping up at rapid chargers can be justified on the grounds of convenience but is unfair when 40% of the population have no effective alternative and lack access to alternatives which are available to others at one tenth the price.

Parity in the cost of electricity for day to day topping up is essential to gaining public acceptance of a road pricing scheme as the alternative to the current system of taxing fuel for ICE cars. I have shown analysis to indicate where a cost-neutral flat rate pence per mile might sit in terms of price as well as referencing alternative, more nuanced, approaches. However, I have not suggested any detail around pricing structures for these alternative options. That would be the subject of detailed reviews once basic principles have been established.

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Endnotes

[1] https://www.autoexpress.co.uk/news/352089/best-chargepoint-providers-2020
[2] https://www.autoexpress.co.uk/news/352089/best-chargepoint-providers-2020
[3] 69p/kWh compared to 30p/kWh for Ecotricity or 25p/kWh for BP Pulse
[4] Internal Combustion Engined
[5] Fast chargers operate between 7kW and 43kW and deliver charge in AC. Radid chargers operate at > 50kW and deliver charge in DC. Subject to the limitations of the vehicle, weather and the charge status of the battery being charged
[6] OLEV grant of £350 in England and Wales via the Home Vehicle Charging Scheme. An additional £300 is available in Scotland from the Energy Saving Trust for Scotland.
[7] Average Supermarket Price Jan 2021 https://www.arval.co.uk/about-arval/insights/average-uk-fuel-prices
[8] Price per kWh on Octopus Energy's 'Go' tariff between 00:30 and 04:30 each day.
[9] PodPoint
[10] Ionity
[11] From year 2 onwards. Initial VED ranges from £10 to £2,175 depending on CO_2 emissions.
[12] https://www.racfoundation.org/motoring-faqs/mobility#a33
[13] M1, M62, M606, M621
[14] Vehicle mileage and occupancy data - https://www.gov.uk/government/statistical-data-sets/nts09-vehicle-mileage-and-occupancy#table-nts0901
[15] Tax on Shopping and Services https://www.gov.uk/tax-on-shopping/fuel-duty
[16] EV Database UK https://ev-database.uk
[17] 5% VAT for domestic electricity
[18] Electricity from the public charging network is rated for 20% VAT
[19] Ecotricity currently have an effective monopoly at motorway service stations for EVs other than Tesla. Tesla's SuperCharger network is excellent but only available for use with Tesla manufactured vehicles.