nationalgrid

Supporting the growth of electric vehicles

January 2019

40,000

There are around 40,000 premature deaths each year in the UK, due to high levels of air pollution. This is equivalent to over 100 preventable deaths every day.

The decarbonisation of transport presents a huge opportunity for the UK to reduce emissions, improve air quality and to be a leader in mobility

Transport became the largest contributor to the UK's carbon emissions (27%) in 2016

Recent research shows that high levels of air pollution, which traditional vehicles significantly contribute to, is harming the respiratory health of the UK's population. This is leading to 40,000 premature deaths, and 6 million sick days each year, costing over £6bn to the NHS and £22bn to the UK economy.

The Government has rightly recognised this in their case for change and commitment to accelerating the shift to low carbon transport through the Industrial Strategy[1], Clean Growth Strategy[2] and Clean Air Strategy[3].

To make the most of the opportunity to improve air quality, reduce emissions and develop one of the best Electric Vehicle (EV) infrastructure networks in the world, the Government needs to speed up its preparations for the uptake of EV's, and provide the right environment to support and encourage the transition.

It is estimated that EV's will reach price equivalency with internal combustion engine vehicles by the mid-2020's. However, consumers will only switch to an EV if they are confident that it will present minimal disruption to their daily lives.

Consumer range anxiety is a key blocker to the uptake of electric vehicles

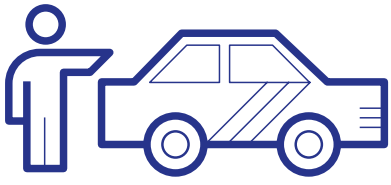
To overcome consumer range anxiety and to remove early barriers to EV uptake, a minimal viable network of ultra-rapid EV charge points along the strategic road network, supported by appropriate electricity network infrastructure in addition to home, destination, local fast and fleet charging, will be vital.

From concept to assets working on the ground, it will take up to four-years to deliver the required infrastructure at sites along the strategic road network. This makes it imperative for Government to make timely decisions on the requirement as well as who would pay for the required infrastructure, to ensure the projections for EV uptake are not hindered by the lack of infrastructure.

The decarbonisation of transport presents a huge opportunity for UK industry in the research, development and production of low carbon vehicles, technologies and infrastructure. The Industrial Strategy sets out an ambition for the UK to be a world leader in mobility, and recognises that EV's support new businesses and jobs in the UK's regions. The strategy identifies the opportunity to build and export new capabilities in automotive, energy, technology and infrastructure sectors globally.

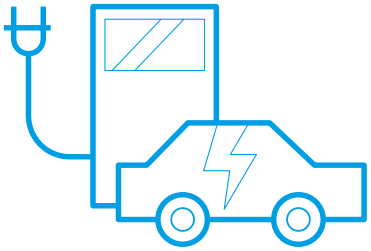
With a targeted investment approach coupled with a proactive strategy to planning network connections, the UK could become a global leader in EV's.

This paper calls for a minimal viable network of ultra-rapid EV charge points to be delivered along the strategic road network and sets out how charging hubs could be delivered quickly and funded efficiently, while stimulating new markets, and minimising costs to consumers.



Consumers will only switch to an EV if there are widespread charging points, which are easily accessible, and can charge at appropriate speed.

Consumers will only switch to an EV if there is a widespread network of charging points, including along the strategic road network



The most convenient and cost-effective way to address 'range anxiety' is to locate ultra-rapid charging infrastructure at existing motorway service areas with the ability to charge a vehicle in the time it takes to buy a cup of coffee.

A key reason for not purchasing an EV is the consumers' perception of 'range anxiety'

This is an anxiety that their battery will run out of charge en route, due to a lack of sufficient charging points, and that it will take to long to appropriately charge their vehicle.

A recent survey, by comparethemarket.com, identified that 66% of motorists do not want to buy an EV or hybrid vehicle as their next car, citing the lack of charging points and upfront cost as the main reasons. A similar number (52%) expressed "range anxiety" and worries that they would not able to travel long distances as serious deterrents to switching[4].

Currently, EV's and hybrids account for just over 2% of current car sales in the UK. Consumers will only switch to an EV if they are confident that it will present minimal disruption to their daily lives. To achieve this, the UK will require widespread charging points, which are easily accessible, and can charge a vehicle at a speed appropriate to the time they spend at a given location. However, existing charging infrastructure is limited in both numbers and location[5].

While charging at home will be a option for some, around 40% of households do not have access to off street parking, leaving millions of vehicles requiring adequate facilities to charge elsewhere.

We need an appropriate network of electric car chargers

A network of car chargers, at appropriate speeds to suit the time spent at each location, will be vital to ensure we are ready for EV uptake. In addition to home, destination, local fast and fleet charging, as seen in Fig. 1., a network of ultra-rapid (120kW to 350kW) charge points is needed along the strategic road network, enabling drivers to charge their vehicles in around 5-10 minutes.

While approximately 90% of Motorway Service Areas (MSA's) have some EV chargers on site, which are often described as 'fast', they are usually 50kw chargers, which can take more than an hour to charge a vehicle.

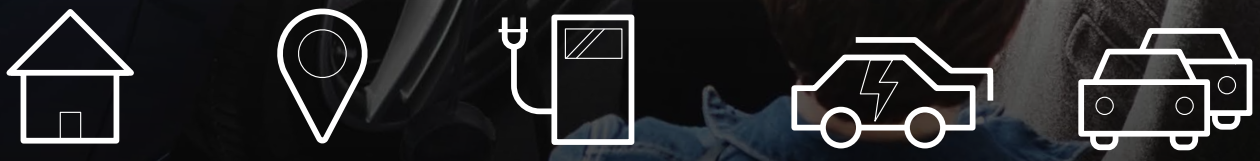
The availability of charging infrastructure can significantly delay the speed of EV adoption in the UK and materially impact the country's ability to achieve clean air and carbon targets. The Government needs to build consumer confidence through the successful delivery of infrastructure.

As set out in the National Infrastructure Assessment, and the BEIS Committee report 'Electric Vehicles: Driving the Transition', National Grid agrees that the most convenient and cost-effective way to address 'consumer range anxiety' is to locate ultra-rapid charging infrastructure at existing MSA's, with the ability to charge a vehicle in the time it takes to buy a cup of coffee.

52%

Lack of infrastructure is the most serious deterrent to over half of UK drivers, 52% of whom say that they are worried about travelling long distances in an electric vehicle.

Fig. 1. There will be 5 key locations required for electric vehicle charging



Home
Or on a residential street typically overnight

Destination
While doing another activity e.g. work

Local Fast
At petrol station equivalent, visited for the recharge

Fleet
At depot hub for fleets

Motorway
At service station, on driver routes enabling long journeys

There is a network solution to overcome consumer range anxiety by 2025, if infrastructure delivery begins in 2019

60%

of the 165 motorway sites in England and Wales are within 5km of the transmission network infrastructure.

54

We have identified 54 locations for strategic ultra rapid charging along the existing motorway network.

99%

With the network of 54 sites, 99% of all electric vehicle drivers could be within 50 miles, in any direction, of an ultra rapid charging station with the ability to charge in the time it takes to buy a cup of coffee.

The electricity networks operators, together, can enable a smooth and efficient consumer transition to EVs

We have examined the links between the strategic road network and the electricity transmission network in England and Wales to understand the minimal viable infrastructure requirement to overcome consumer range anxiety.

Over the last year, we have studied the power capacity of the MSA sites, across the strategic road network, the journeys EV drivers are likely to take, and how close they would need to be to an ultra-rapid charger to overcome consumer range anxiety. We have also assessed the electricity network infrastructure required to support enough ultra-rapid charge points to provide confidence to EV drivers and avoid queues at peak times.

We have considered the use of large scale battery solutions, often in the form of charging hubs, however the commercial models are still in the early stages of development. While solutions are emerging, they are utilising an existing electricity network connection with significant on-site or local renewable energy generation.

It is evident that under any likely scenario of EV uptake, due to existing power constraints, most MSA's will require a reinforced power connection before 2030 to allow for the additional numbers of charge points required to meet consumer charging demand. Given these existing constraints, significant network upgrades will likely be needed to accommodate the use of batteries.

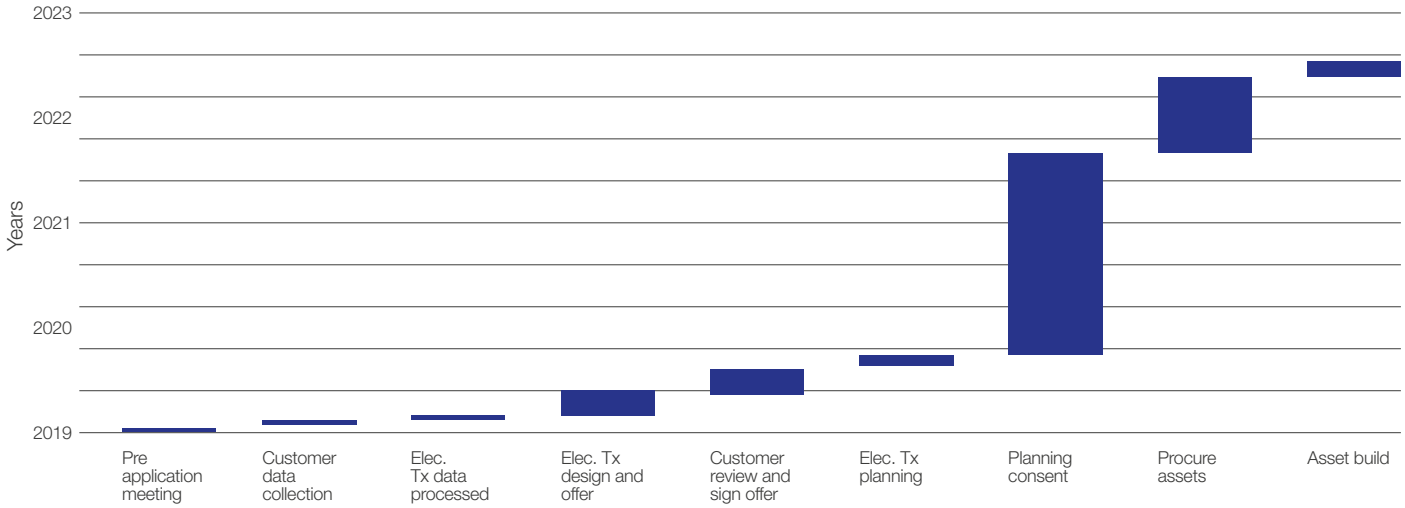
A minimal viable solution is needed to support the uptake of EVs in England and Wales

As shown in Fig. 3. we have identified an initial 54 ultra-rapid EV charging sites along the strategic road network, where an upgraded electricity network connection would allow 99% of EV drivers in England and Wales to be within 50 miles (in any direction) of an ultra-rapid charging station. This would provide drivers with the ability to charge their vehicle in the time it takes to buy a cup of coffee.

We have identified a cost-efficient solution for the identified sites, which could include a combination of utilising the existing distribution networks, where there is enough capacity, and directly connecting to the transmission network.

With 60% of the strategic road network, in England and Wales, being within 5km to National Grid's existing electricity transmission network, it makes us well placed to deliver a cost-efficient infrastructure solution at many of the MSA sites, with the remainder better served by a DNO solution.

Fig. 2. Electricity Transmission connection timeline

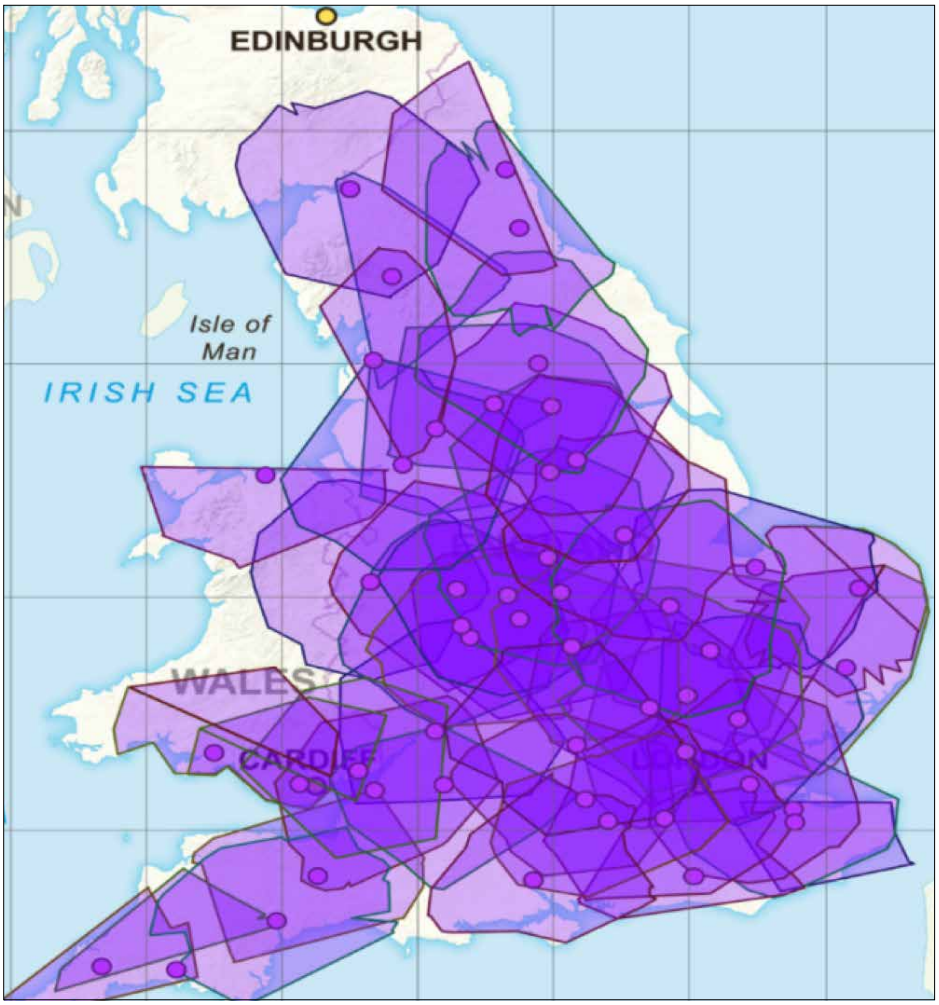


Of the MSA sites which prove most economical for a direct transmission connection, 90% could be supplied from existing National Grid substations, reducing the requirement for wider reinforcement works and therefore minimising the cost of delivering this much needed EV infrastructure. This also aligns with the energy regulators ambitions to ensure networks companies make economic and efficient use of their existing infrastructure.

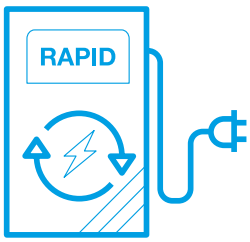
However, as set out in Fig. 2. from concept to assets working on the ground, and dependent on planning constraints, it will take up to four-years to deliver the required infrastructure at each MSA site. This makes it imperative for Government to make timely decisions on the requirement of infrastructure.

Recommendation:
To ensure that consumer uptake of EVs is not hindered, and using powers under the Automated and Electric Vehicle Act, the Government should designate, in 2019, which MSA sites should be part of a minimal viable network of ultra-rapid chargers, to ensure there is adequate time to deliver the required electricity network infrastructure, and achieve EV targets.

Fig. 3. The 54 identified sites will allow 99.6% of drivers to be within 50 miles of an ultra rapid charger.



Building a network of ultra-rapid EV chargepoints along the strategic road network is imperative to the success of the EV industry in the UK



A network of ultra-rapid EV charge points will need to be delivered by the time at which vehicle cost parity is predicted to be reached, to ensure infrastructure is not the remaining barrier to consumer EV uptake.

With the right conditions, the UK has an opportunity to become a global leader in electric vehicles

However, for this to be a reality, a network of ultra-rapid EV charge points will need to be delivered by 2025 - the time at which vehicle cost parity is reached - to ensure infrastructure does not become an unintended barrier to consumer EV uptake.

The infrastructure must allow EV drivers to undertake out of pattern and long distance journeys, delivering charging times similar to those experienced for refueling existing internal combustion engine vehicles.

While initially fewer chargers will be required, until the market develops, the most economic infrastructure solution is to plan for a future where there is no liquid fuel. This would mean ensuring that there is enough electricity capacity to enable more ultra-rapid chargers to be added as and when necessary to meet the future EV demand, without the need for further disruptive and costly construction work to change the network connection.

If there is an inadequate number of EV charge points, queues will form potentially causing the market to stall reinforcing consumers' perception of range anxiety.

While significant investment has been made into UK charging infrastructure, the existing market structures at MSA's are complex. In order to successfully leverage private investment, the market needs certainty in both affordable cost of infrastructure and EV utilisation rates.

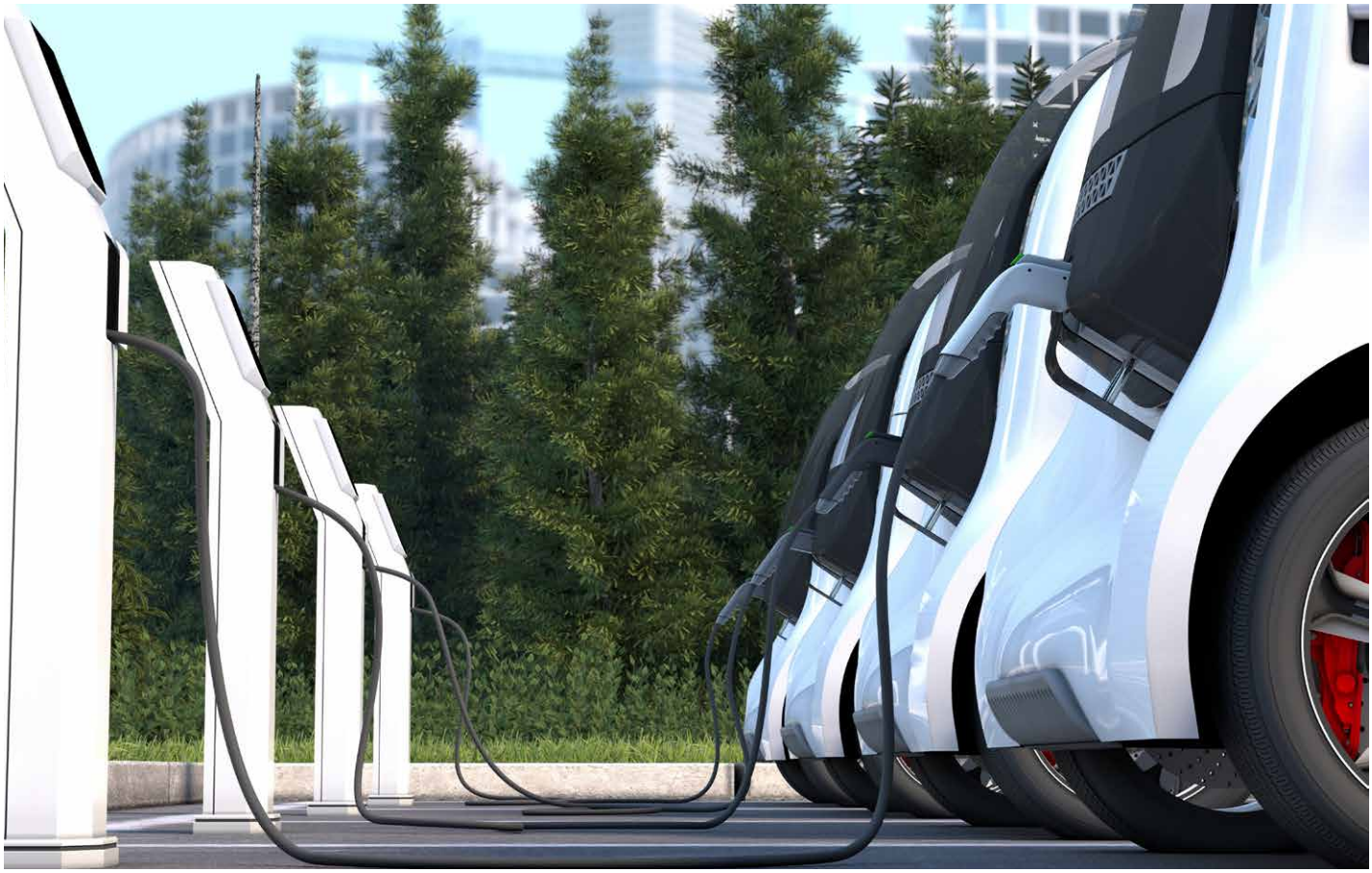
We know from talking to prospective market participants that they do not currently have certainty on either, with many struggling to make the case for the costs of the electricity network infrastructure, especially ahead of full utilisation. This is a market failure.

A truly national solution is needed to avoid air inequality

If Government want to realise the ambitious commitments to improving conditions for all UK citizens, irrespective of location, there is a need for intervention to enable the market to mature quicker than it otherwise would. If the market matures, the utilisation risk will reduce and make it more commercially viable for private investment to deliver ultra-rapid charging infrastructure across the UK.

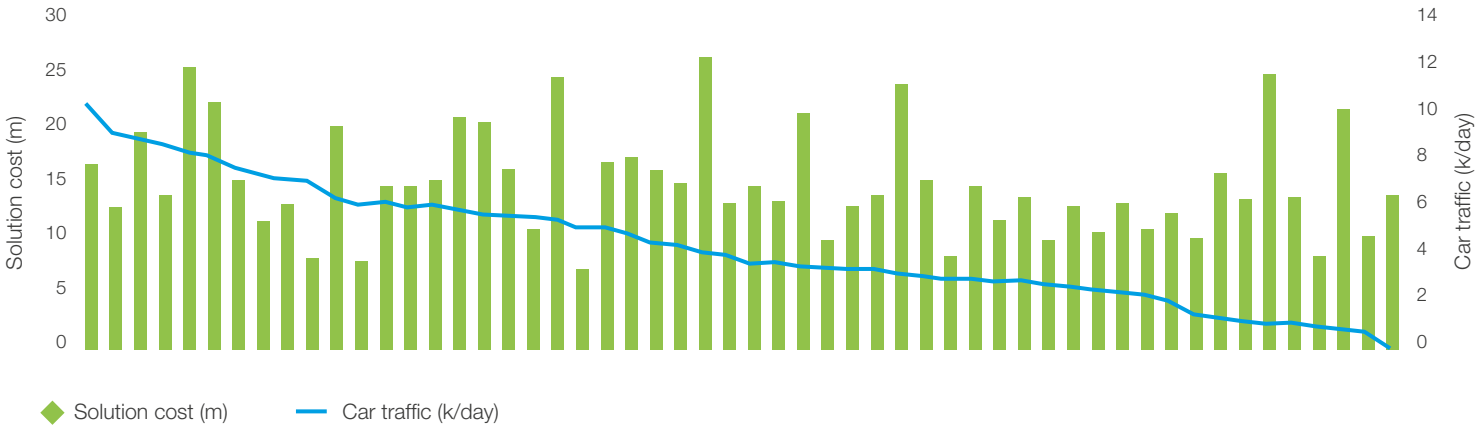
A market-led approach, without the appropriate government intervention, will result in a postcode lottery with many low wealth and rural areas left with an insufficient network of rapid charging infrastructure. This will be a serious deterrent for potential EV drivers. We need to ensure that all families across the UK have an equal opportunity to reap the technology and air quality benefits that EV's will bring. If left to the market alone, sufficient charging capacity will likely only be delivered at the high utilisation / low costs sites highlighted in Fig.4. with a maximum of only 16 sites having potential for the market to deliver.

Recommendation:
As set out in the National Infrastructure Assessment[6] and the BEIS Committee Report "Electric Vehicles: Driving the Transition"[5], we believe the Government should prioritise the rollout of a "national network of ultra-rapid EV chargers".



A market-led approach, without the appropriate government intervention, will result in an infrastructure postcode lottery, and an unequal distribution of chargers across the UK, specifically in rural areas.

Fig. 4. National Grid analysis highlighting cost of delivering electricity network capacity at strategic MSA sites vs. traffic flow.



We are developing funding options which minimise the cost to consumers, while enabling the future market to mature

For most energy transmission network infrastructure projects, National Grid will fund the initial upfront capital investment for the required infrastructure, recovering the costs over the lifetime of the asset, typically 40 years, through an annual connection charge.

We recognise that, in addition to the market funding challenges, there are also concerns with energy bill payers funding EV transport infrastructure, especially in the early adoption years.

A strategic approach is required to fund a network of ultra-rapid chargers

While there are likely several options for how to fund a strategic network of ultra-rapid chargers, we believe one of the swiftest and simplest methods is using the existing network charging regime, which requires minimal legislative intervention from Government.

To remove the initial market entry barriers and ensure the timely delivery of future-proofed network infrastructure, Government would be required to underwrite the overall construction cost (c. £0.8-1bn), and pay the early years' annual connection charges.

With the creation of a funding pool, which would see market participants coming forward to pay for capacity access to each site, the market would begin to contribute towards the annual costs, reducing the overall amount Government pays in the long-term.

As an example of how the market could participate in practice, the capacity price could be cost reflective, with payment proportionate to the capacity required i.e. a participant requesting a fifth of the site capacity, where a site has annual connection charge of £300k, would pay £60k/yr. into the funding pool.

As the market matures, and the utilisation rates increase, market participants will erode the Government payments, as depicted in Fig. 5. While this will likely happen faster in some areas than others, especially in areas of high utilisation, this model will ensure that the country is served as a whole. Those areas that are not as commercially viable to the market, such as the low wealth and rural areas, will also have access to sufficient infrastructure to overcome consumer range anxiety.

As set out in Fig. 6, if we assume that the actual construction start date is phased over five years from 2022, to deliver the 54 MSA sites, the maximum annual payment will be £50m, in year five, with the average annual connection fee across the project being c.£20m. While we appreciate the challenges to justify any Government spend, it serves to highlight the need for interdepartmental, long term thinking.

We recognise the current charging method for DNO's does not enable them to recover costs over the lifetime of their assets. We understand however that there is work ongoing to align the distribution and transmission charging regimes. This change would ensure that the suggested funding mechanism would work for both transmission and distribution networks.

Recommendation:
To ensure the infrastructure can be delivered in a timely manner, as a priority, the Government and Regulator should agree in 2019 who should pay for MSA reinforcement and other critical EV infrastructure, and agree an appropriate funding mechanism.

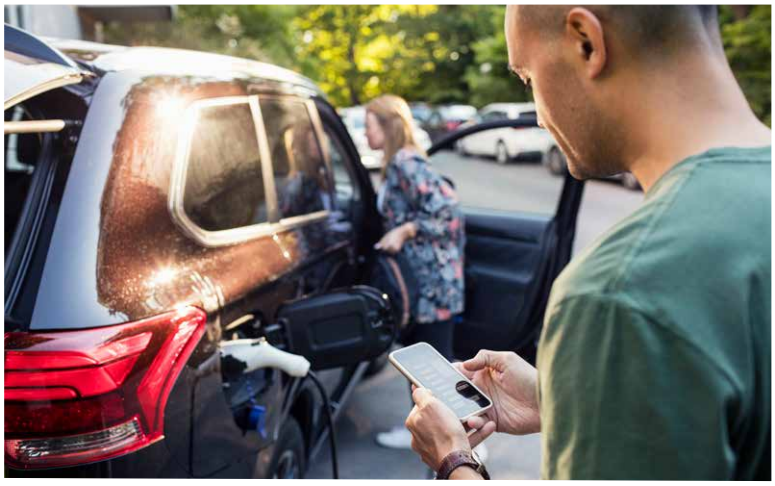


Fig. 5. Indicative market share

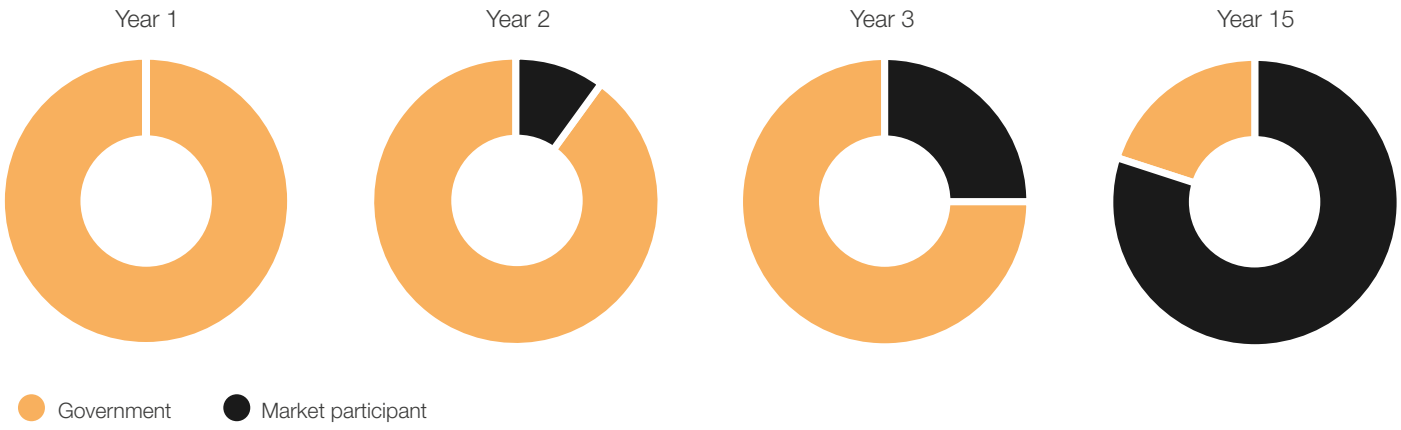
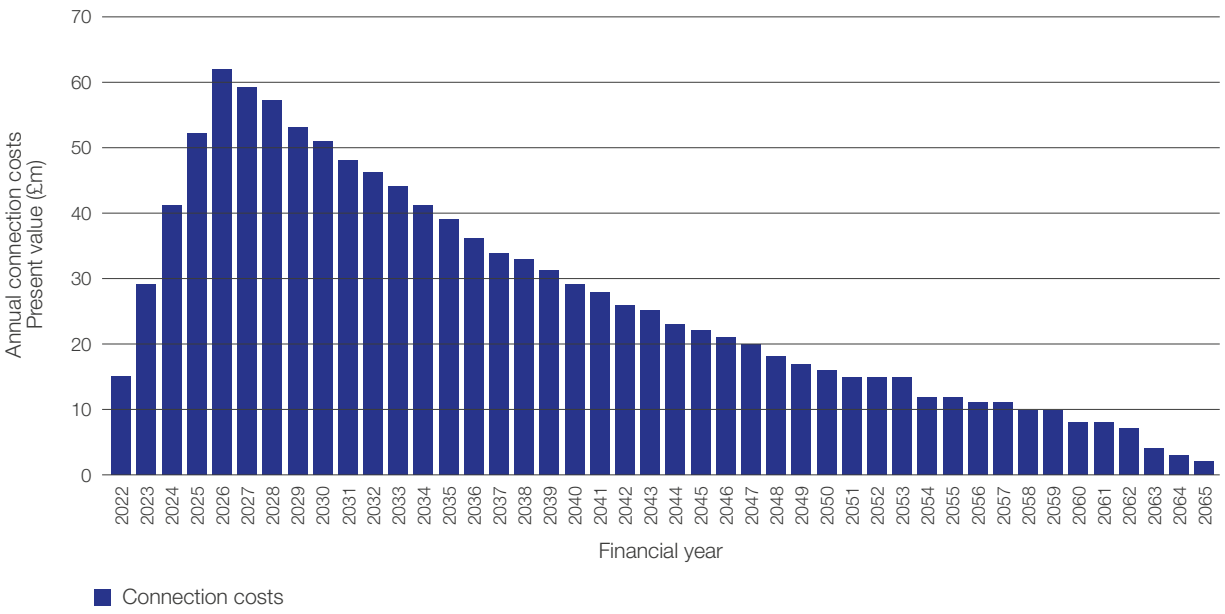


Fig. 6. Annual electricity connection costs for 54 MSA sites



Recommendations

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As set out in the National Infrastructure Assessment and the BEIS Committee report 'Electric Vehicles: Driving the Transition', we believe the Government should prioritise the rollout of a 'national network of ultra-rapid EV chargers'.

Recommendation 2

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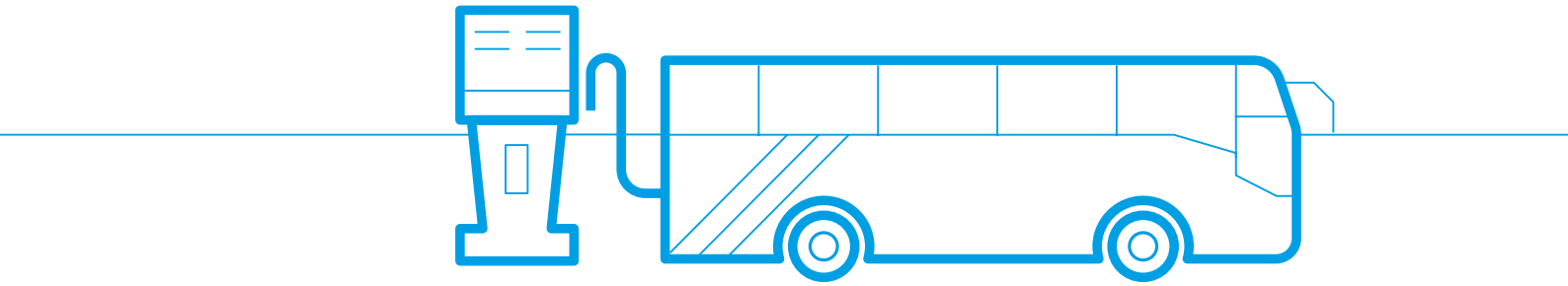
Recommendation 3

To ensure the infrastructure can be delivered in a timely manner, as a priority, the Government and Regulator should agree in 2019 who should pay for MSA reinforcement and other critical EV infrastructure, and agree an appropriate funding mechanism to deliver the necessary investment, in areas where the market won't deliver.

References

1. HM Government (BEIS), Industrial Strategy: Building a Britain fit for the Future, (2017)
2. HM Government (BEIS), The Clean Growth Strategy: Leading the way to a low carbon future, (2017)
3. DEFRA, Clean Air Strategy 2018, (2018)
4. Comparethemarket.com, “16 million motorists say they can’t afford to drive electric cars”, (2018)
5. BEIS, Electric Vehicles: Driving the Transition, (2018)
6. National Infrastructure Commission, National Infrastructure Assessment, (2018)
7. HM Government, AEV Act, (2018)



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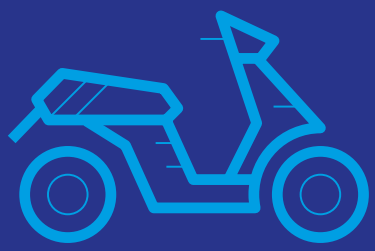

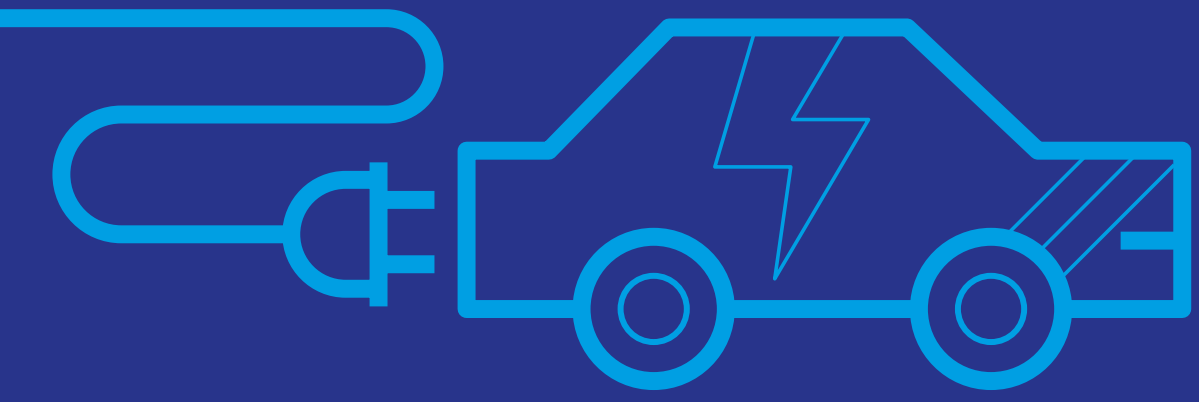

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