LONDON FIRE BRIGADE

LFC–23-072y

London Fire Brigade (LFB) – Carbon Net Zero (CNZ) – Provision of Increased Electrical Power at 55 Fire Stations

Report to:	**Date:**
Investment & Finance Board	29 June 2023
Commissioner's Board	12 July 2023
Deputy Mayor's Fire and Resilience Board	25 July 2023
London Fire Commissioner	

Report by:

Laura Birnbaum, Assistant Director Property and Technical Support Services

Report classification:

For decision

For publication

I agree the recommended decision below.

Andy Roe

London Fire Commissioner

Date This decision was remotely signed on 12 October 2023

PART ONE
Non-confidential facts and advice to the decision-maker
Executive Summary

The Greater London Authority (GLA) and London Mayor have set a target of becoming carbon net zero by 2030. An essential enabler to achieve this is providing sufficient electrical capacity at fire stations and support premises. The London Fire Brigade (LFB) currently operates from 103 fire stations located throughout greater London. This report seeks authority for the London Fire Commissioner (LFC) to commit capital expenditure to commence a project to increase the electrical power provision at London's fire stations by providing individual electrical sub stations at selected fire stations. This project forms Pillar One of LFB's carbon net zero plans and will put in place the building blocks for LFB to become carbon net zero. The report sets out options with the preferred option three being to increase electrical power provision at 30 fire stations in phase 1 and a further 25 fire stations in phase 2. The report also sets out the staffing costs associated with this project. This project will begin during April 2024 and complete in 2028/29.

The increased electrical capacity will also enable the LFC to open fire stations to the other emergency services and Functional Bodies of the GLA to charge their future electric fleets.

For the London Fire Commissioner (LFC)

The LFC has considered the attached report and agrees that:

1. The Carbon Net Zero (CNZ) strategy requires pillar one opening the infrastructure before moving towards low carbon technologies. This includes increasing the electrical capacity provision across the LFC estate and enable the electrification of the LFC fleet by providing additional electric vehicle (EV) chargers. LFB intends to make these available to the functional bodies of the GLA to open the LFB infrastructure for collaboration.

2. Authority is delegated to the Assistant Director of Property and Technical Support Services (TSS) that expenditure can be committed in accordance with Part Two of this report.

In agreeing this decision, the LFC recognises that:

A. This approval is for the first phase of CNZ pillar one only. The phase one selected sites have been chosen during the consultation process, with operations, fleet, and property. The sites are based on 'The priority crewing guide' formerly the degradation list of stations.

B. That key aspects of the project are as follows:

   i. The GLA and London Mayor have set a target for LFC to be carbon net zero by 2030 and the required electrical capacity to achieve this transition is currently not in place. This paper seeks the approval to request and install the additional electrical capacity from the national grid and distribution Network operators (DNO).

   ii. The options being progressed to the next stage include risks and costs as detailed in the Strategic Business Case.

1. Introduction and background

1.1 The London Fire Brigade (LFB) currently operates from 103 fire stations located throughout greater London. The incoming electrical capacity at each station is on average 140 amps and to meet the carbon net zero targets this will need to be increased to an average of 800 amps. This is required primarily to charge electrical vehicles in LFB's operational fleet, but also the increased usage of electricity at fire stations.

1.2 The existing electrical supply is aligned to the current daily requirement and very little further electrical load can be placed on stations until incoming capacity is increased. The level of electrical increase required to decarbonise is significant as the planned future requirements of LFB are based on removing fossil fuels from the entire property and fleet portfolio. The proposed solution to replace the current gas and oil-based fuels is electricity. LFB would be procuring an individual electrical sub-station at each LFB fire station to provide the required electrical load capacity, the sub-station will be solely for LFB fire stations and will increase the electrical capacity by six times. This is required by property to decarbonise and by fleet to charge future electric vehicles. The increased electrical capacity will also enable LFB to provide electric vehicle charging to functional bodies of the GLA, which would open the infrastructure to functional bodies. This is pillar one of LFC's carbon Net Zero strategy and is a fundamental requirement to enable further workstreams to progress.

1.3 The required increase will mean that an electrical sub-station will be required at every fire

station, to provide the necessary electrical power.

1.4 The objective of this paper is to provide the Brigade with an insight into the risks currently posed to the Brigade by the existing electrical capacity and infrastructure. The LFB's intention to become carbon net zero is not possible without increasing the electrical capacity or implementing additional resourcing and is a fundamental step in achieving LFC requirements. This has been outlined in both fleet and property's strategy documents.

1.5 Under the LFB purpose 'representing you' LFC will work with other organisation to provide a safer future for everyone and opening the infrastructure and becoming CNZ meets this challenge. Preventing climate change provides a safer future for everyone.

2. Objectives and Expected outcomes

2.1 A detailed Strategic Business case for the project is attached to this report and includes information on objectives, selection of options, costs, risks and plans for delivery.

2.2 The overall objective is to provide LFC with the electrical capacity to implement the Carbon Net Zero strategy and pillar one of the strategy includes this objective and opening the infrastructure to functional bodies and to provide electric vehicle charging capacity.

2.3 The objectives set out for the project in the business case are as follows:

- **Estate objectives**: The objective of the opening infrastructure project would be to resolve the challenges highlighted by the shortage of available electrical power. Increasing the electrical capacity at stations will enable the Brigade to remove the dependency on greenhouse gas (GHG) burning equipment (boilers and cookers) and will provide additional Electric vehicle charge points (EVCP) this is required to achieve carbon net zero.
- **Fleet Objectives**: Increasing the number of EVCP would provide robust operational readiness to respond to incidents. It would also permit other functional bodies to utilize the LFC electric vehicle charging infrastructure, as the requirement to implement an electric fleet becomes greater. The fleet de-carbonisation strategy requires fleet to become fully electric and this will require LFB to have a suitably sized electrical infrastructure to support the charging requirements of heavy battery powered electric vehicles.
- **GLA objectives:** For London fire Brigade as a functional body to lead by example and adopt carbon net zero by 2030. Opening the infrastructure will also meet the GLA requirement:
    - The need for further electric vehicle charging infrastructure throughout London. As set out in the Mayor's Electric Vehicle Infrastructure Strategy (EVIS), Transport for London (TfL) estimates that London will need between 40,000 and 60,000 public charge points by 2030, with up to 4,000 of these being rapid. TfL estimates that a quarter of these rapids could be located on GLA Group owned land, including land owned by all functional bodies.
    - The additional requirement for Metropolitan Police Service vehicles, London Ambulance Service (LAS) and TfL to access EV charging infrastructure.
    - GLA have a commitment to provide a network of electric vehicle charging points in London. The LFB additional electric vehicle charge points would meet the requirements of 'London's 2030 electric vehicle infrastructure strategy (appendix 3).
    - The Mayor's transport strategy 2022 revision includes the requirement

for additional electric vehicle charging and infrastructure.

- **Delivery objectives**: Being deliverable by end 2030, being affordable for LFB, providing acceptable value for money overall.

2.4 The options for provision of LFC opening the infrastructure and increasing electrical capacity are a key requirement by 2030 to achieve carbon net zero and they are set out in the business case and fall into the following main categories:

Options: further detail of each option is contained in the attached business case.

- Base case - Do nothing and continue reduce carbon emissions using biofuel for the fleet and electrification of station heating only where possible. Does very little to mitigate the risks currently posed to the Brigade and have therefore been discounted as an unacceptable way to continue. Fleet investment currently the underspend from the Zero emissions pumping appliance 1 (ZEPA) project would not be unlocked by this option.

- Option two - Increase the power capacity at fire stations to accommodate the needs to de-carbonise the buildings. This option will meet the needs of property and removes the dependency on burning gas. This option will cost an estimated £4,000,000, however, it will not provide any electrical capacity for electric vehicle charging including the Zero Emission Pumping Appliance (ZEPA) and operational vehicles. Electric response cars and private cars are expected to increase in number and this option does not allow for this. Therefore, the LFC will need to continue with a fossil fuel powered fleet which may not be possible in the long term due to the phasing out of combustion engines. If this is adopted and then in later years option three is required, this would require the road is again excavated with further disruption.

- Option three (preferred option) - Electrical capacity is increased at 30 LFC premises to meet the needs of the zero-emission fleet and property requirements (phase one). Following completion of this project the LFC would increase the electrical capacity at a further 25 stations (phase two). The Carbon Reduction team will then pause for evaluation for the remainder of the LFC estate and re-apply for approval for further expenditure based on the present market and environmental requirements. This preferred and recommended option is costed in part two.

2.5 The project order for option three identifies how stations will be selected based on the following criteria:

- Stations identified as critical from the target resourcing model briefing note and the priority crewing guide (previously degradation list),
- Fleet and Operational Support Centre (OSC) for vehicle re-charging during operational readiness,
- Privacy for all (PFA) completion,
- Strategic sites including satellite HQ locations,
- Availability of electrical power from the Distribution Network Operator (DNO).

2.6 **Benefits:** The delivery of Option three includes the requirement to increase electrical capacity at individual LFC premises by 600%. Providing the electrical infrastructure and staffing resource now allows the LFC to work towards gaining the additional funding that achieving carbon net zero requires. It also creates a stable operating platform for the ZEPA project as it expands and the on-going fleet de-carbonisation programme. LFB may be able to offer EV charging to the LAS and GLA functional bodies. We recommend this is phased into two phases with an environmental, technology and market conditions 'look to the future'. The second part will require further governance as this is not included in this paper. The stations with Diesel engine run vehicles

(DERV) tanks will be held back until part two and the DERV tanks will be filled with HVO fuel. The phasing model will keep the electrification project moving at pace as funding is agreed.

3.0 Resourcing and expenditure

3.1 Resourcing costs and expenditure: The recommended option will need a multi-disciplinary team including location (surveyor) services, electrical engineering, and civil engineering works.

3.2 Delivery of these options will require incur internal staff-related costs of an additional E and G Grade posts, which will be permanent, as well as potential impact to resourcing levels of supporting functions such as Procurement who will be required to support specific carbon net zero projects. Progression through the next stage of the project will involve three main areas of expenditure and cost avoidance:

- Professional fees: the Carbon Reduction team would manage the entire project in house and therefore professional fees would be minimal.
- LFB Project team: This would require the extra resourcing for the LFB Carbon Reduction team and the creation of a carbon reduction team function.
- With additional resource LFB could identify the contestable elements of each Distribution Network Operator (DNO) project installation and identify cost avoidance measures for contestable works (civils and planning requirements) which can be procured independently to realise cost avoidance. This does require additional project management and therefore staffing resource.

3.3 The preferred option three would require the following team:

FRS G role - one officer

FRS F role – one officer (already in the structure)

FRS E role – one officer

FRS D role – one officer (already in the structure)

3.4 A breakdown of the estimated cost for this work is provided in the Part two report.

3.5 The work to upgrade the 55 fire stations is expected to begin in 2024 and be completed by 2028/29. The project is in two parts with part one starting in 2024/25 and part two starting in 2028/29.

4. Equality comments

4.1 The LFC and the Deputy Mayor for Fire and Resilience are required to have due regard to the Public Sector Equality Duty (section 149 of the Equality Act 2010) when taking decisions. This in broad terms involves understanding the potential impact of policy and decisions on different people, taking this into account and then evidencing how decisions were reached.

4.2 It is important to note that consideration of the Public Sector Equality Duty is not a one-off task. The duty must be fulfilled before taking a decision, at the time of taking a decision, and after the decision has been taken.

4.3 The protected characteristics are age, disability, gender reassignment, pregnancy and maternity, marriage, and civil partnership (but only in respect of the requirements to have due regard to the need to eliminate discrimination), race (ethnic or national origins, colour, or nationality), religion or belief (including lack of belief), sex, and sexual orientation.

4.4 The Public Sector Equality Duty requires decision-takers in the exercise of all their functions, to have due regard to the need to:

- Eliminate discrimination, harassment and victimisation and other prohibited conduct.
- Advance equality of opportunity between people who share a relevant protected characteristic and persons who do not share it.
- Foster good relations between people who share a relevant protected characteristic and persons who do not share it.

4.5 Having due regard to the need to advance equality of opportunity between persons who share a relevant protected characteristic and persons who do not share it involves having due regard, in particular, to the need to:

- Remove or minimise disadvantages suffered by persons who share a relevant protected characteristic where those disadvantages are connected to that characteristic.
- Take steps to meet the needs of persons who share a relevant protected characteristic that are different from the needs of persons who do not share it.
- Encourage persons who share a relevant protected characteristic to participate in public life or in any other activity in which participation by such persons is disproportionately low.

4.6 The steps involved in meeting the needs of disabled persons that are different from the needs of persons who are not disabled include, in particular, steps to take account of disabled persons' disabilities.

4.7 Having due regard to the need to foster good relations between persons who share a relevant protected characteristic and persons who do not share it involves having due regard, in particular, to the need to:

- tackle prejudice
- promote understanding.

4.8 An early-stage Equalities Impact Assessment has been undertaken indicating that the project will have a Low impact on equalities because there are no adverse impacts predicted at this stage. The EIA will continue to be developed during the next phase the project which will put staff consultation and equalities at the centre of the design process to ensure alignment with the provisions of the Equality Act 2010.

5. Other considerations

Workforce

5.1 Outside of the Carbon Reduction team resourcing this project will affect station staff whilst the electrical upgrade building works are taking place and some disruption may be experienced as the DNO dig extra trenches for electrical cabling that would be required. The management of this disruption will be under the control of LFB project team and to keep to a minimum with operational resilience being prioritised to ensure readiness. No stations will be required to close temporarily during the project.

Sustainability

5.2 One of the project's objectives is to deliver environmental sustainability – capital build options will be aiming for at least a Building Research Establishment Environmental Assessment Method (BREEAM) Excellent rating and sustainability will be built into consideration during the process of design and / or selection of buildings. The project team are working with LFB Sustainable Development team and will carry out the necessary Sustainability Impact Assessment during the next stage of the project.

Procurement

5.3 The current project team are working with Procurement and Commercial Department (Assets and Estates) on the development of a procurement strategy which is fully compliant with LFB Scheme of Governance and Standing Orders relating to procurement to ensure timely procurement of necessary services whilst providing sustainable and value for money solution.

Communications

5.4 The next phase of the project will involve the production of a developed design (RIBA Stage 3) and planning application.

5.5 The main focus of communications for this stage of the project will be with the future users and defining LFB corporate and individual department requirements of a new HQ. It is intended that a comprehensive workplace survey will be undertaken allowing all staff to contribute. In addition, focus groups will be formed to seek further information on user requirements. Equalities Support Groups will be engaged with.

5.6 Feedback from the staff engagement process will be used to directly inform the design process which will support new ways of working.

5.7 In the run-up to a planning application the correct levels of engagement with the local community will be considered very carefully based on advice from architects and planning consultants and engagement with the local planning authority.

6. Financial comments

5.1 Under part two of this report, commercially sensitive information is disclosed. This report recommends that capital expenditure for providing increased electrical power provision at 55 fire stations, as well as associated revenue expenditure, are agreed for the amounts set out in Part Two of this report.

6.1 As part of this the requirement for both feasibility funding and potential capital funding is set out in respect of option 3, the funding of increased electrical provision at 55 fire stations.

6.2 The budget as part of the feasibility will be contained as part of existing capital budgets.

6.3 In terms of longer-term capital costs, these will need to be incorporated into the future capital plan along with the associated financing of any such project once given approval and this will be developed throughout the budget setting process.

6.4 DNO organisations make a standing charge based on agreed supply capacity per KVA (kilovolt amp) and therefore upgrading from 69 KVA to 430 KVA will carry an extra cost per month. It is the intention however to hold the agreed supply capacity at current levels until it is required for use. The decision requested at this time refers to capital investment in the infrastructure. Further business case(s) will require to be submitted through appropriate governance for schemes that will ultimately use that infrastructure. Increased costs associated with higher electricity usage will need to be considered, along with any potential savings, as part of that process.

6.5 This will also have a significant impact on the revenue budget. Again, this will need to be incorporated into the budget setting process in terms of potential savings and investments required in order to deliver the preferred option. This is identified in table 5.2.4 of appendix two.

6.6 An application will be made to GLA green finance initiatives borrowing for the following. These schemes are designed to allow functional bodies to borrow funding at a lower rate than PWLB by at least 1%.

- The Green Finance Fund will initially be up to £500m and is loan finance provided by the GLA to the GLA Group and London boroughs at an interest rate that is cheaper

than PWLB. The £90m of GLA grant funding has been split: £75m to subsidise the costs of finance offered by the Green Finance Fund and the £15m will be used to provide funding to develop the pipeline of projects, mainly through the Accelerators. So, the £75m will be used, internally by the GLA, to reduce the cost of finance from the GFF so that it is more competitive than PWLB, in a similar way to how the UKIB is setting up the cost of its finance.

- The GLA has established a **Green Finance Fund** to support the GLA Group, London boroughs and the NHS Trusts by providing competitive, flexible finance to help accelerate the delivery of a range of environmental projects that re being delivered in pursuit of getting to net zero. This Green Finance Fund can provide a loan to the LFB to support the delivery of a project or a portfolio of projects that have been developed to support the LFB in getting to net zero. This finance, at below Public Works Loan Board (PWLB) rates, is available to the LFB as an organisation and will need to be paid back by the LFB. Therefore, it will be for the LFB to decide from which of their budget streams it will be paid back from; for example, from the savings/revenues generated by the projects and/or another existing or new budget stream within the LFB and/or (least preferred) by the GLA top-slicing future budget that is being provided to the LFB. The finance being provided by the green finance Fund will be cheaper than borrowing from the PWLB.

7. Legal comments

7.1 Under section 9 of the Policing and Crime Act 2017, the London Fire Commissioner (the "Commissioner") is established as a corporation sole with the Mayor appointing the occupant of that office. Under section 327D of the GLA Act 1999, as amended by the Policing and Crime Act 2017, the Mayor may issue to the Commissioner specific or general directions as to the manner in which the holder of that office is to exercise his or her functions.

7.2 By direction dated 1 April 2018, the Mayor set out those matters, for which the Commissioner would require the prior approval of either the Mayor or the Deputy Mayor for Fire and Resilience (the "Deputy Mayor").

7.3 Paragraph (b) of Part 2 of the said direction requires the Commissioner to seek the prior approval of the Deputy Mayor before "[a] commitment to expenditure (capital or revenue) of £150,000 or above as identified in accordance with normal accounting practices…".

7.4 The statutory basis for the actions proposed in this report is provided by sections 7 and 5A of the Fire and Rescue Services Act 2004 ("FRSA 2004"). Section 7 (2)(a) FRSA 20014 the Commissioner has the power to secure the provision of personnel, services and equipment necessary to efficiently meet all normal requirements for firefighting and section 5A allows the Commissioner to procure personnel, services and equipment they consider appropriate for purposes incidental or indirectly incidental to their functional purposes.

List of appendices

Appendix	Title	Open or confidential*
1	**EIA**	**Open**
2	**London 2030 electric vehicle (EV) infrastructure strategy**	**Open**
3	**SIA**	**Open**
4	**List of 30 Fire Stations**	**Open**

Part two confidentiality

Only the facts or advice considered to be exempt from disclosure under the FOI Act should be in the separate Part Two form, together with the legal rationale for non-publication.

Is there a Part Two form: YES

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Equality Impact Assessment (EIA) Form

The **purpose** of an EIA is to give **as much information as possible** about potential equality impacts, to demonstrate we meet our **legal duties** under the Equality Act 2010.

Please read the EIA Guidance on Hotwire before completing this form.

Once you open the template please save it on your OneDrive or SharePoint site. Do not open the template, fill it in and then click Save as this will override the template on Hotwire.

NOTE – All boxes MUST be completed before the document will be reviewed.

1. What is the name of the policy, project, decision or activity?
Carbon net zero strategy- opening the infrastructure

*Overall Equality Impact of this policy, project, decision or activity (**see instructions at end of EIA to complete**):*

High		**Medium**		**Low**	

2. Administration			
Name of EIA author	Milly Osborne		
Have you attended an EIA Workshop	Yes ☐ No ☒		
Department and Team	Carbon Reduction, Property		
Date EIA created by author	09/06/2023		
Date EIA signed off by Inclusion Team			
Date Actions completed			
External publication	Are you happy for this EIA to be published externally?	Yes ☒	No ☐ If No state why:

3. Aim and Purpose	
What is the aim and purpose of the policy, project, decision or activity?	The GLA/Mayor have set a target of becoming carbon net zero by 2030 and an essential enabler to achieve this is providing sufficient electrical capacity at fire stations and support premises. The London Fire Brigade currently operates from 103 fire stations located throughout greater London. The incoming electrical capacity is on average 140 amps and to meet the carbon net targets this will need to be increased to an average of 800 amps. The existing electrical supply is aligned to the current daily requirement and very little further electrical load can be placed on stations until incoming capacity is increased. The level of increase required to decarbonize is significant as the planned future requirements of LFB are based on removing fossil fuels from the entire property and fleet portfolio. The required increase will mean that an electrical sub-station will be required at every fire station, to provide the necessary electrical power. The LFB's intention to become carbon net zero are not possible without increasing the electrical capacity or implementing additional resourcing and is a fundamental step in achieving LFC requirements. This has been outlined in both fleet and properties strategy documents. The aim of this project is to increase the electricity supply Across the estate, allowing the Brigade to use Low Carbon Technologies (LTCs).
Who is affected by this work (all staff, specific department, wider communities?)	Station Staff will be affected due to works such as the yard, this will include the yard being dug up. The upgrade works will not have an operational impact as stations will not need to be taken off the run. The works will enable the Brigade to significantly increase the use of LTCs, reducing environmental impact- this will positively impact station staff, FRS staff and the wider community.
What other policies/documents are relevant to this EIA?	Carbon Net Zero Strategy

4. Equality considerations: the EIA must be based on evidence and information.	
What consultation and engagement has taken place to support you to predict the equality impacts of this work? Consultation must take place with ESGs (including RB ESGs), Learning Support and affected groups.	*Please attach evidence of consultation and challenge/advice given* *Email Gareth Dawes- send the business case and ask for feedback for the FBU ect - contacted* *Discussions with the Sustainable Development team have taken place and an SDIA has been completed and signed off. Opening the infrastructure will have a positive impact on sustainability as it will allow the Brigade to stop using fossil fuels and reduce carbon emissions.*

5. Cultural consideration: the EIA must consider how the work improves the culture of the organisation	
How does this piece of work contribute to improving the culture of the organisation? How does this piece of work improves staff divides? Can you provide evidence?	*Working toward being carbon net zero has a positive impact on the environment. The work will positively impact the culture at LFB because it indicates we are working toward creating a better environment, not just for LFB staff, but for the wider community too.*

4. Wellbeing considerations	
How will this piece of work impact the physical and mental wellbeing of staff and communities in London?	*This work will positively impact the wellbeing of staff and communities. This is through aspects such as reduced carbon emissions leading to improved air quality and helping to reduce the impacts of climate change.*

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5. Assessing Equality Impacts			
Use this section to record the impact this policy, project, decision or activity might have on people who have characteristics which are protected by the Equality Act.			
Protected Characteristic	**Impact: positive, neutral or adverse**	**Reason for the impact**	**What information have you used to come to this conclusion?**
Example: Age	***Adverse***	***Moving this service online will adversely affect older people, who are least likely to have access to a computer or smart phone and may not be able to use the new service.***	***GLA Datastore: X% of the London community are aged 70 or over. GLA data shows that only 10% of those over the age of 70 have regular access to a computer or smart phone.***
Age (younger, older or particular age group)		*A review commissioned by the GLA provides the most up-to-date summary of the significant body of scientific evidence showing that air pollution poses a serious risk to people's health at every stage of life, including prior to birth. The latest evidence shows that adverse health effects are seen even in relatively low air pollution environments, below those experienced in London Find. The review also confirms that air pollution caused by traffic is a major issue in London, and that schoolchildren are especially vulnerable to developing health complications as a result. The work proposed in the opening the infrastructure workstream will positively impact staff regardless of their protected characteristics. The works will increase electrical supply at all stations, meaning that we can increase the number of low carbon technologies. This includes electric cookers, air source heat pumps and electric vehicle chargers. Using low carbon technologies will reduce the Brigade's carbon*	***Staff:*** *You may need to gather data on staff. Basic equalities data is available here (select the most recent data document)* *If you need specific data on a department, contact the* ***HR People Management Information Team*** *- pshrpmi@london-fire.gov.uk – no less than* ***five working days*** *notice must be given for all data requests.* ***Community/Public:*** *you may need data from the GLA Datastore.*

		emissions, helping to limit climate change and improve air quality. Older and younger people can be more susceptible to heat and poor air quality, so the work to reduce the Brigade's emissions may impact the very young and old in a more positive way.	
Disability (physical, sensory, mental health, learning disability, long term illness, hidden)		*The works to be carried out on station could potentially cause access issues (due to concrete being dug up and contractors keeping equipment untidily). At the start of each project contractors are sent information on maintaining clear walkways/ access areas. This is also reiterated to them during the kick off meeting.* *The opening the infrastructure works will enable the Brigade to move to using low carbon technologies, reducing the Brigade's impact on climate change. Climate change can cause extreme heat during the summer months which exacerbates some health conditions and can be dangerous to the very young and the very old.*	***Staff:*** *You may need to gather data on staff. Basic equalities data is available here (select the most recent data document)* *If you need specific data on a department, contact the **HR PMI Team**- pshrpmi@london-fire.gov.uk – no less than **five working days** notice must be given for all data requests.* *You may need to contact the **Learning Support Team,** Disability Working Group or Neurodiversity Support Group for advice and data on accessibility.* ***Community/Public:*** *you may need data from the GLA Datastore.*
Gender reassignment (someone proposing to/undergoing/ undergone a transition from one gender to another)		*This business case does not use any gendered language.* *HR don't have data on the number of staff undergoing gender affirming surgery.*	***Staff:*** *You may need to gather data on staff. Basic equalities data is available here (select the most recent data document)* *If you need specific data on a department, contact the **HR PMI Team**- pshrpmi@london-fire.gov.uk – no less than **five working days** notice must be given for all data requests.* *You may need to contact the LGBT+ Staff Network or Stonewall for advice.* ***Community/Public:*** *you may need data from the GLA Datastore.*

Marriage / Civil Partnership (married as well as same-sex couples)		*This business case does not require information about people's marriage or civil partnership status.* *HR don't have data on marriage or civil partnerships status.*	
Pregnancy and Maternity		*This business case does not exclude pregnant people, the benefits from moving to low carbon technologies will be for everyone. HR data team don't capture data on numbers of pregnancies.* *A review commissioned by the GLA provides the most up-to-date summary of the significant body of scientific evidence showing that air pollution poses a serious risk to people's health at every stage of life, including prior to birth. Poor air quality can also increase the risk of premature birth and low birth weight. The work proposed in the opening the infrastructure workstream will positively impact staff regardless of their protected characteristics. The works will increase electrical supply at all stations, meaning that we can increase the number of low carbon technologies. This includes electric cookers, air source heat pumps and electric vehicle chargers. Using low carbon technologies will reduce the Brigade's carbon emissions, helping to limit climate change and improve air quality. Older and younger people can be more susceptible to heat and poor air quality, so the work to reduce the Brigade's emissions may impact the very young and old in a more positive way.*	*You may need advice from the **HR Helpdesk**: IT.HR@london-fire.gov.uk* *You may need data from the GLA Datastore.*
Race (including nationality, colour, national and/or ethnic origins)		*Research shows that those exposed to the worst air pollution are more likely to be deprived Londoners and from Black, Asian and Minority Ethnic communities. The works carried out to open the infrastructure will allow the Brigade to reduce carbon (and therefore air emissions).*	***Staff:** You may need to gather data on staff. Basic equalities data is available here (select the most recent data document)*

		This should have a positive impact on all communities in London.	*If you need specific data on a department, contact the **HR PMI Team**- pshrpmi@london-fire.gov.uk – no less than **five working days** notice must be given for all data requests.* ***Community/Public:** You may need data from the GLA Datastore.*
Religion or Belief (people of any religion, or no religion, or people who follow a particular belief (not political)		*Works will be carried out outside of the station buildings so will not impact prayer facilities.*	*You may need data from the GLA Datastore.*
Sex (men and women)		*Improving the electrical infrastructure works themselves will not negatively or positively impact more on men, women or* non- binary people. However, the United Nations report that the climate crisis is not "gender neutral". Women and girls experience *the greatest impacts of climate change, which amplifies existing gender inequalities and poses unique threats to their livelihoods, health, and safety. Reducing the Brigade's impact on climate change will support lessening of the impacts of climate change on Women and Girls across the world.*	***Staff:** You may need to gather data on staff. Basic equalities data is available here (select the most recent data document)* *If you need specific data on a department, contact the **HR PMI Team**- pshrpmi@london-fire.gov.uk – no less than **five working days** notice must be given for all data requests.* ***Community/Public:** You may need data from the GLA Datastore.*
Sexual Orientation (straight, bi, gay and lesbian people)		*Gender neutral language has been used in the business case, the works to improve electrical capacity at stations will not have an impact on the LGBTQ+ community.*	***Staff:** You may need to gather data on staff. Basic equalities data is available here (select the most recent data document)* *If you need specific data on a department, contact the **HR PMI Team**- pshrpmi@london-fire.gov.uk – no less than **five working days** notice must be given for all data requests.* *You may need to contact the LGBT+ Staff Network or Stonewall for advice.* ***Community/Public:** you may need data from the GLA Datastore.*

6. Impacts outside the Equality Act 2010
What other groups might be affected by this policy, project, decision or activity?
Consider the impact on: carers, parents, non-binary people, people with learning difficulties, neurodiverse people, people with dyslexia, autism, care leavers, ex-offenders, people living in areas of disadvantage, homeless people, people on low income / in poverty.
Black text has been used on a white background, diagrams and tables have been included to improve accessibility to neuro diverse people. *Socioeconomic status- communities which have higher levels of deprivation, or a higher proportion of people from a non-white ethnic background, are still more likely to be exposed to higher levels of air pollution. The analysis, commissioned by City Hall, shows that significant inequalities remain, and more work is needed to further reduce pollution levels and the health inequalities that result from unequal exposure to air pollution.*

7. Legal duties under the Public Sector Equality Duty (s149 Equality Act 2010)	
How does this work help LFB to:	
Eliminate discrimination?	
Advance equality of opportunity between different groups?	
Foster good relations between different groups?	*Working with the sustainable development team- we have engaged with the SD team right from the start of the carbon reduction strategy (of which opening the infrastructure is part of). The opening the infrastructure work will reduce the Brigade's carbon emissions, this aligns fully with the sustainable development strategy.*

8. Mitigating and justifying impacts

Where an **adverse** impact has been identified, what steps are being taken to **mitigate** it? If you're unable to mitigate it, is it **justified**?		
Characteristic with potential adverse impact (e.g. age, disability)	**Action being taken to mitigate or justify**	**Lead person responsible for action**

9. Follow up, actions and evaluation		
Where the Inclusion Team or other stakeholders have recommended **actions** in order to demonstrate due regard, these must be recorded here and delivered in accordance with time scales. Additionally, what is the organisational learning in relation to this piece of work in regards to the Equality Act 2010.		
Action recommended and person responsible for delivery	**Target date Action to be completed by**	**Date action completed**
Lessons learnt and evaluation		
Free text		

Now complete the RAG rating at the top of page 1:

High: as a result of this EIA there is evidence of significant adverse impact. This activity should be stopped until further work is done to mitigate the impact.

Medium: as a result of this EIA there is potential adverse impact against one or more groups. The risk of impact may be removed or reduced by implementing the actions identified in box 8 above.

Low: as a result of this EIA there are no adverse impacts predicted. No further actions are recommended at this stage.

Document Control

Signed (lead for EIA / action plan)		Date	
Sign off by Inclusion Team		Date	
Stored by			
Links			
External publication	Are you happy for this EIA to be published externally?	Yes ☐	No ☐ If No state why:

Sustainable Development Impact Assessment Checklist

Project Name/ Policy Name & No: Opening the Infrastructure- this is pillar 1 of the CNZ strategy. A full SDIA has been carried out for the CNZ strategy, it has been agreed with the Sustainability team that a SDIA checklist will be completed for each pillar of the strategy.

Contact Person: Milly Osborne

Date completed: 30/05/2023

Please send through the completed checklist with a copy of the project PID or the draft policy to environment@london-fire.gov.uk. For existing policies undergoing minor amendments, please send through a marked up copy of the policy, with the original SDIA.

	Other impact assessments completed	Yes	No
1.	Has an Equalities Impact Assessment been completed?	☒	☐
2.	Has a Health, Safety and Wellbeing assessment been completed?	☐	☒

Environmental Impacts

3. Will this consume any of the following (please tick those that apply and state how and if this would increase or decrease our consumption):

Gas	☐	Electricity	☐	Water	☐
Petrol or diesel	☒	Hazardous chemicals	☐	Other natural resources e.g. timber	☐

Comments:
Works will be carried out by the Distribution Network Operator (DNO) to increase electrical capacity at fire stations. This will involve digging up the yard and road in front of the stations. This will use equipment that consumes diesel.

4. Will this produce or reduce our production of (please tick those that apply and describe what and how):

Non-hazardous waste	☐	Hazardous waste (see PN 862)	☐	pollutants to air, land or water?	☒

Comments:
Increasing the electrical capacity at stations will allow the Brigade to move towards using Low Carbon Technologies, such as Air Source Heat Pumps, electric boilers, and electric cookers, and will allow charging infrastructure for an electric fleet. This will enable the Brigade to become carbon net zero, significantly reducing the Brigade's environmental impact.

	5. Will this impact (positively or negatively):	Yes	No
a.	Operational/business travel by staff	☐	☒
b.	Travel/deliveries by our suppliers	☐	☒
c.	Environmental protection at incidents	☐	☒
d.	a Site of Special Scientific Interest	☐	☒

e. Gardens or other wildlife at stations/brigade sites (e.g. nesting birds or bats)	☐	☒
Comments: Click here to enter text.		
Procurement	**Yes**	**No**
6. Will this result in the purchase of goods, services or works or influence how they are procured?	☒	☐
f. Is this for a purchase of greater than £1m?	☒	☐
g. Will this use/result in a tender for manufactured goods such as electronics, textiles, and building materials?	☒	☐
h. Will this service require low skilled/low paid employees?	☐	☒
i. Will the goods consume utilities or consumables?	☒	☐
j. Does this involve major works taking place? k. If so are BREEAM and Ecological surveys required?	☐ ☐	☒ ☐
l. Will this support future cost avoidance?	☐	☒
m. Could all or part of the purchase be provided by small or local businesses?	☐	☒
n. Could this be delivered by a voluntary/community sector organisation?	☐	☒
o. Has a Request For Tender been submitted to Procurement through hotwire?	☒	☐
Comments: A periodic assessment is recommended to ensure the sustainability of the project, ensuring, in particular, that the socio-environment aspects of the goods and services are procured in accordance with the PN 696 - the GLA group responsible procurement policy.		

For the SD Team to complete:

Policy sustainability risk rating: High

Inputs/outputs/ impacts to address in Full SDIA: A full SDIA is not required since this SDIA is 1/6 pillar of the Carbon Net-Zero Strategy. Daniel Bellucci

Date completed: 09/06/2023

London's 2030 electric vehicle infrastructure strategy

December 2021

MAYOR OF LONDON

TRANSPORT FOR LONDON

EVERY JOURNEY MATTERS

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Executive Summary

Overview

This strategy sets out our vision, addresses recent trends and policy changes, estimates the infrastructure needs to 2030 and considers how this could be delivered. It outlines how far we have come in removing the barriers to implementing electric vehicle (EV) infrastructure and explores how the private and public sector can do more. This document is the executive summary of London's 2030 electric vehicle infrastructure strategy.

With the phase out of petrol and diesel cars and vans by 2030, along with other influences, we must ensure that infrastructure delivery keeps up with demand. As we move forward, we are targeting the needs of key user groups, who typically make high-mileage trips while performing an essential role, while encouraging everyone to switch to zero-emission transport.

Leading the way

London continues to lead the way in the electric revolution, with more than 8,600 public charging points installed across the Capital, a third of the UK's total, and an 85 per cent increase since 2019. London also has western Europe's largest zero-emission bus fleet, emissions-based road user charging and the strictest taxi and private hire licensing regulations for vehicle emissions, all backed by strong policies to encourage people to make the switch.

New forecasts

New modelling indicates that in the most likely scenario, where there is increased use of rapid, on-the-go charging, London will need around 40,000 to 60,000 charge points by 2030, of which up to 4,000 will be rapids. The proportion of EVs this infrastructure would support could result a reduction in carbon dioxide emissions of between 1.5 and 2.6 million tonnes per year by 2030.

Unlocking public sector land

Initial estimates show public sector land could accommodate a quarter of the 4,000 rapid charge points London may need by 2030. Our key commitment addresses one of the main barriers to charge point implementation, which is the availability of suitable land. Together with the Mayor, we are committed to unlocking GLA Group and other public sector land in prime locations to accommodate the infrastructure needed.

Key asks for Government

Government funding has been vital in recent years in enabling London to meet the demand for EV charging. Although we anticipate most of London's charge points by 2030

will be delivered by the private sector, London will still need ongoing funding to help maintain consumer confidence and accelerate the switch.

Driving the EV revolution

The commitments in this document will support the transition to EVs, initially in London, but also across the UK as London leads the way with new approaches and new policies. London's investment in EVs is already generating good quality jobs across the UK, whether it's electric buses in Yorkshire or electric taxis in Coventry. This strategy is a strong signal of London's commitment to decarbonising the transport network over the next decade.

Background

Our Electric vehicle infrastructure delivery plan, steered by the Mayor's EV Infrastructure Taskforce and published in 2019, identified how the public and private sectors could work together to ensure London has the right type and amount of charging infrastructure to serve London's needs to 2025.

Since the 2019 delivery plan, we have listened to the issues that road users have expressed about the difficulties with switching to EVs and user experience of EV charging. Taking this into account, as well as recent trends and policy changes, this strategy looks forward to 2030 and provides a comprehensive overview of recent industry developments. It also updates our understanding of typical user requirements as the transition to EVs accelerates beyond early adopters. While this strategy focuses on key users, it presents many commitments to help all user groups, so will contribute to the transition to zero carbon for all Londoners. The strategy also proposes our approach to working with the wider public sector and private sector and sets out what is needed to ensure sufficient levels of EV infrastructure in London by 2030.

This is an essential part of meeting our climate change and air quality objectives and achieving the Mayor's ambition for the Capital to be a net zero-carbon city by 2030. While this is not a programme of delivery, we have identified our commitments to enable the wider industry to help ensure London has the necessary charging infrastructure it requires.

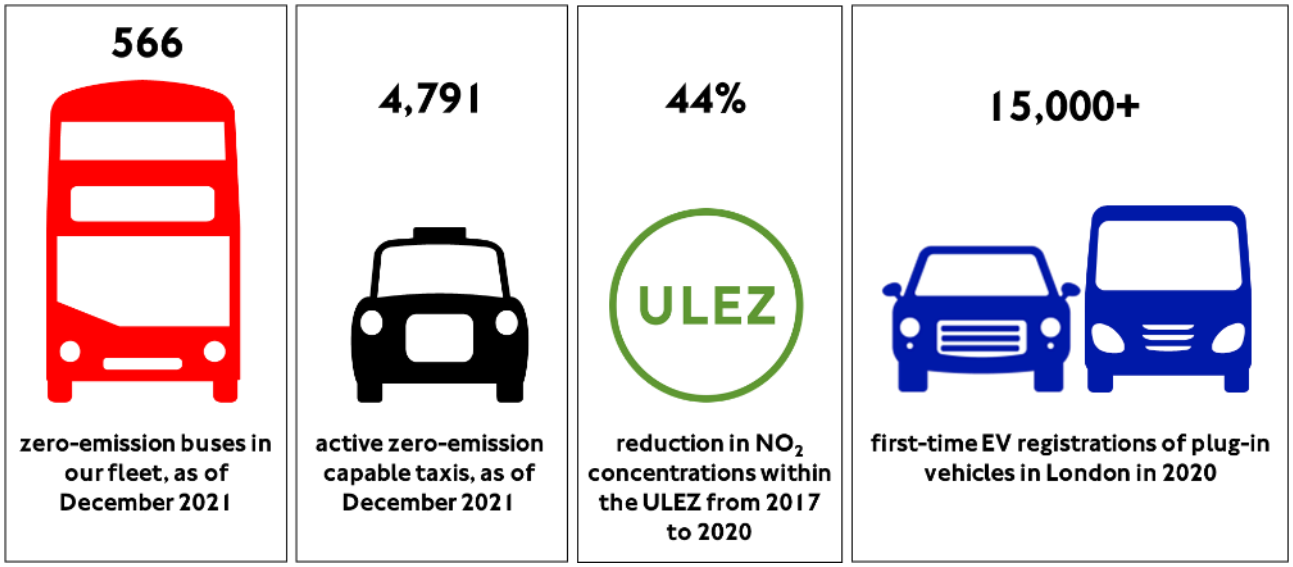
The scope of this strategy is limited to users of similar types of EV infrastructure. This includes light-duty vehicles, such as cars and vans, and excludes heavy commercial vehicles, such as heavy goods vehicles, buses and coaches. Heavy commercial vehicles, in addition to needing more space to park during charging, will require higher power levels. It also excludes lighter electric-powered two-wheelers, e-scooters and e-bikes, as these will not typically be using the same kind of public charging infrastructure.

London continues to lead the way

The number of EVs is increasing rapidly, with one in eight new cars registered in London in 2020 being electric, which includes battery and plug-in hybrid EVs, compared to one in 16 in 2019. It is essential that we support this growth with a world-class infrastructure network.

Much has been achieved over the past few years, and there are now around 8,600 publicly accessible charge points in London, delivered through both the public and private sectors. London's infrastructure now accounts for around a third of the UK's total charge points with the number of EV charge points increasing by 85 per cent between 2019 and 2021.

London has been a world leader in the shift to electric vehicles, as stated by the International Council on Clean Transportation. This has been achieved through the Mayor's strong policies, including the world's first Ultra Low Emission Zone and vehicle scrappage schemes that incentivise the switch to cleaner vehicles, including electric. We also set ambitious electric bus targets that have resulted in Western Europe's largest fleet of zero-emission buses. We have the strictest taxi and private hire licensing regulations for vehicle emissions, which have been supported by taxi delicensing payments and grants for those switching to zero-emission capable taxis, and now we have around a third of our taxi fleet driving these vehicles. Nationally, there have been financial incentives for purchasing EVs and a recent announcement to phase out the sale of petrol and diesel cars and vans by 2030.



Through this strategy, we will ensure that London continues to lead the way. While we have the infrastructure in place to support current levels of electric vehicle use, both London and national policies are expected to lead to higher than previously expected levels by 2030 and the infrastructure must be there to support this demand. Our strategy sets out what London can do using electrification to support the Mayor's ambition of becoming a net zero-carbon city by 2030, and the roles and responsibilities of all stakeholders, including the GLA and ourselves in facilitating this.

The need for a London-wide EV strategy

The 2019 delivery plan forecast how many charge points would be needed by 2025 and indicated that there would need to be a shift from public sector to private sector delivery. Almost two thirds of the slow-to-fast charge points and around half of the rapid charging points in London have been delivered by the public sector. Even before the coronavirus pandemic struck, private sector investment in infrastructure roll-out was less than originally expected. The Government has since introduced more ambitious policies to encourage the

switch to cleaner and greener vehicles. These policies should be considered in the context of the Mayor's Transport Strategy, which has sustainable travel at its heart. Other Mayoral priorities, shared by other strategies such as the London Environment Strategy, include improving air quality and reducing carbon emissions.

The electric vehicle industry is rapidly evolving, both in terms of vehicle and infrastructure trends, as well as user behaviour. In the full strategy, we aim to demystify some of the main myths about EVs, which include the driving range, production of carbon emissions compared to petrol or diesel vehicles, and power needs.

This EV infrastructure strategy updates forecasts for London's charging needs up to 2025 and 2030 and sets out how the public and private sectors can further support the delivery of EV infrastructure in London. It also outlines what further government support and funding is required and what other stakeholders in the private sector can do to support the EV rollout.

Electric vehicle infrastructure in London

Setting the vision

The Mayor's Transport Strategy sets out ambitious targets for trips to be made by sustainable modes, while predicting there will still be a need for some car and freight traffic to remain. For those remaining necessary trips, sufficient infrastructure will be required to enable them to be made by the cleanest possible vehicles.

It is also essential, however, that more widespread adoption of EVs does not undermine efforts to increase walking, cycling and use of public transport. Our strategy therefore focuses on the needs of key EV user groups and how we can support their transition. Key users have been identified as those making high-mileage trips performing an essential role, including taxis and private hire drivers, as well as other commercial vehicles. Not everyone will be able to walk, cycle or use public transport for all or any of their necessary trips, so it is important to ensure these trips can also be made by EVs, with appropriate access to charge points.

Our overarching vision will be realised through key principles, which fall into six thematic areas:

Theme	Principle
Environment	High quality, ethical and sustainable charging infrastructure that drives emission reductions and is resilient to climate change.
Sustainable mode shift	Delivery of EV charging should consider the type and location of infrastructure to ensure it does not incentivise additional car use.
Healthy Streets	Our EV charging should complement our Healthy Streets approach and support Vision Zero.
Accessibility	The EV infrastructure should be physically accessible, available, easy to use and should not impede or constrain people's movements on the footway.
Social inclusion	EV infrastructure should be affordable to use and accessible to all.
Commercial viability	We must ensure we create the right conditions for a self-sustaining charging market.

Our electric vehicle infrastructure vision

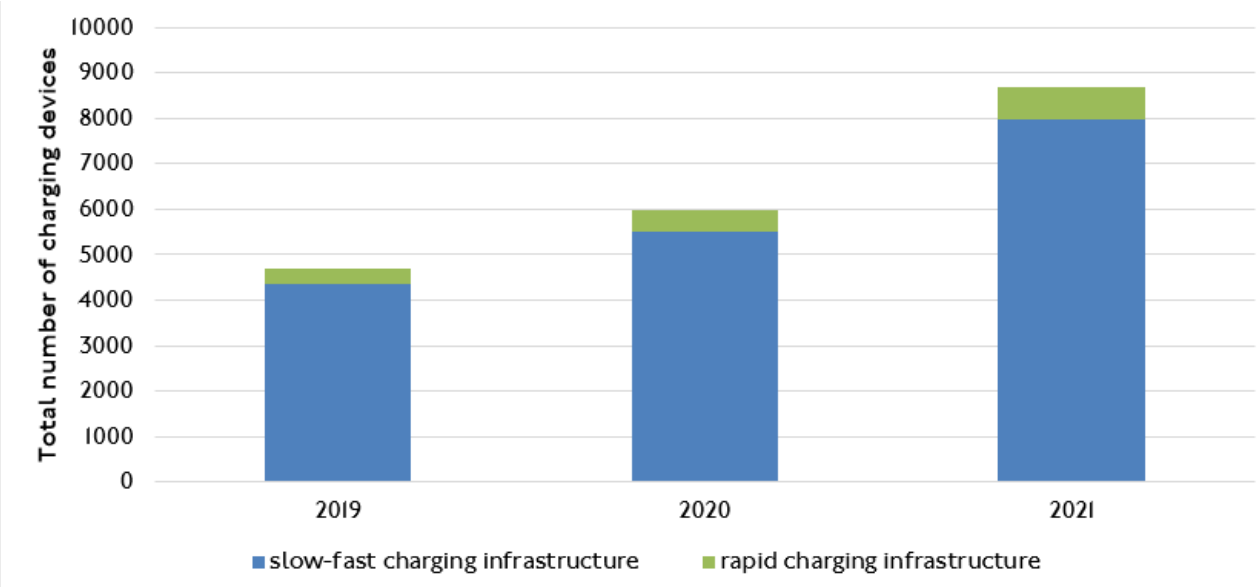
Supporting a net-zero carbon target for London by 2030, and better air quality for all, the London EV infrastructure strategy seeks to accelerate the transition to zero-emission vehicles by setting out the requirements for the provision of infrastructure, focusing on essential trips.

Removing barriers to delivery

The amount of charging infrastructure in London has grown considerably since we published the delivery plan, with significant investment from the public sector. By November 2021, London boroughs had installed around 4,800 slow-to-fast charge points, and we met our target of 300 rapid charge points being installed by the end of 2020. The delivery plan set out the need for five flagship rapid hubs, one in each sub-region, by 2025. A hub was defined as having a minimum of six rapid, or faster, chargers enabling six or more vehicles to be charged simultaneously. The public sector has supported the opening of two sites in Stratford and Woolwich, with Baynard House in central London expected to be delivered by spring 2022. The private sector has also delivered hub sites at Heathrow, Croydon and on New Kent Road. Further sites are being developed, some of which may also be supported by the public sector. Delivery is accelerating but must accelerate faster.

Our strategy assesses the lessons learnt from recent delivery of public charging points and identifies future opportunities. These include the need for a new and more flexible procurement model, for updated guidance documents in line with advances in technology and for enhanced mapping to identify viable sites. Working with private sector partners, we

have explored the barriers to further delivery and identified how we, together with the GLA and the London boroughs, could help unlock them going forward. The barrier of available and suitable land has been cited as one of the most prominent issues in London, but not the only barrier.



From recent engagement with stakeholders, we have built on the core challenges identified in the 2019 delivery plan. The following outlines our progress against key barriers and provides an update on how these challenges have been addressed.

Challenge identified in 2019 Delivery Plan	2021 update
Land and energy	
Ability to secure suitable charge point locations given competing demands and London's limited land availability.	New commitments to unlock suitable land in the right place and right condition.
Long lead times and complexity of installation.	London Councils set up a Coordination Function, and further guidance has been issued
Cost of energy grid upgrades.	UK Power Networks produced online mapping as per 2019 delivery plan commitment. Further refinement of heat mapping would help eliminate unviable sites and improve efficiency. Further engagement with central Government to ensure that grid upgrade costs are fairly distributed.
Investment uncertainty	
Lack of confidence in the availability of convenient charge points, such as perception that all are already in use or broken down, or not in convenient locations.	There are 85 per cent more charge points than in November 2019. Further data analysis has been done to indicate where optimum locations are, which are reported in the full strategy document and available to borough officers on London DataStore. Renewed

Challenge identified in 2019 Delivery Plan	2021 update
	commitment to ensure high service levels are maintained for all our delivered charge points.
Lack of confidence in the availability of convenient charge points, such as perception that all are already in use or broken down, or not in convenient locations.	New commitment to improve access to real-time availability and location of charge points to improve user experience.
Operational/users	
Uncertainty about what type of charge point needed, concerns about obsolescence – reluctance to invest until there is more confidence in the charging model.	Guidance on future proofing charge points issued by BEAMA. Further analysis done to refine understanding of appropriate charge point types. New commitment to provide demand data and evidence base to support private sector investment.

Our Analysis

Updated forecasts for London's EV infrastructure needs

	A) Higher rapid charging preference scenario				B) Residential charging preference scenario			
	2019 Delivery Plan forecast		**2021 new forecast**		2019 Delivery Plan forecast		**2021 new forecast**	
	Slow-to-fast	Rapid (50kW)	**Slow-to-fast**	**Rapid** (100kW average)	Slow-to-fast	Rapid (50kW)	**Slow-to-fast**	**Rapid** (100kW average)
2025	20,000-34,000	2,500-4,100	18,500 – 34,500	1,600 – 2,600	28,000-49,000	1,400-2,300	26,000-49,500	1,100-1,600
2030	N/A	N/A	40,000 – 55,000	3,000 – 3,900	N/A	N/A	60,000-90,000	1,700-2,100

We have updated our modelling to reflect wider technological changes, recent user trends and new policies that will affect the rate at which people switch to EVs. This has been used to update our existing estimates of charge points needed within Greater London for 2025, as well as providing an indicative outlook to 2030. By 2025, the forecasts suggest there could be between 0.3 and 0.6 million EVs in London, equivalent to between nine per cent and 21 per cent of London's total car and van fleet. By 2030, there could be between one and 1.4 million EVs, which is between 34 per cent and 49 per cent of London's total car and van fleet.

While these estimates are based on in-depth modelling, incorporating up-to-date industry data and insights, there is still a high degree of uncertainty. As such, we have used scenarios to cater for different trajectories of EV sales and charging behaviours. We will continue to update our forecasting to account for the greater level of uncertainty that emerges as we look further ahead and to account for new trends.

The first scenario assumes that there is a preference for faster public charging, with more on-the-go, top-up charging taking place, as well as a continued mix of speeds, with most still wanting slow chargers near their home. For those using faster charging, such as rapids and ultra rapids, there will be more similarities to current petrol station refuelling behaviour. The second scenario assumes that, although there will be some faster charging, there will be a strong preference for more on-street slower, residential-based charging, as well as a slightly higher proportion of private, at home charging on driveways.

Our modelling forecasts are projections and should not be treated as targets. They give a sense of scale of what could be needed and are based on many variables, principally the speed that Londoners are expected to switch to EVs. The updated figures for 2025 do not vary significantly from those predicted in 2019. This is due to the high proportion of public

charging needed for private hire demand, where some operators made very ambitious commitments to have an electric fleet from 2025, or even as early as 2023. These commitments remain in place, so the phase out of petrol and diesel vehicles has a much higher impact on uptake by 2030.

Another key factor in the differences between the 2019 forecast for 2025 relates to the assumptions made around rapid charging speed. Following extensive engagement with the industry and our assessment of technological advances, we have updated our assumptions to reflect a theoretical average speed of 100kWh in the future, assuming a split between continued roll out of 50kW and increasing numbers of 150kW charge points.

There is a significant difference in the overall numbers of devices needed between the two user preference scenarios, particularly by 2030. In the scenario where faster, on-the-go charging is favoured, we expect to need around 40,000 to 55,000 slow-to-fast charge points, and 3,000 to 3,900 rapid charge points by 2030. Where slower charging is significantly favoured, we could need between 60,000 to 90,000 slow-to-fast charge points, and 1,700 to 2,100 rapid charge points by 2030.

The first scenario is more desirable and aligned with our vision and principles. The focus of this strategy is to support key user groups who typically do higher mileage, and who are more likely to need top-up, on-the-go charging. Faster charging is more convenient and efficient. Technology is developing at pace and users can be offered a similar level of convenience to refuelling a petrol or diesel vehicle today. This scenario still includes a sizeable proportion of slower charging to accommodate the needs of lower mileage users or those who are more price sensitive. The forecasts projected to 2030 in the second scenario would not deliver so well against our vision and principles, owing to the implications of having so many devices along our streets on streetscape, as well as the competing demands on the kerbside. In addition, this scenario would require higher levels of public sector funding given the business case for slower chargers tends to be considerably lower.

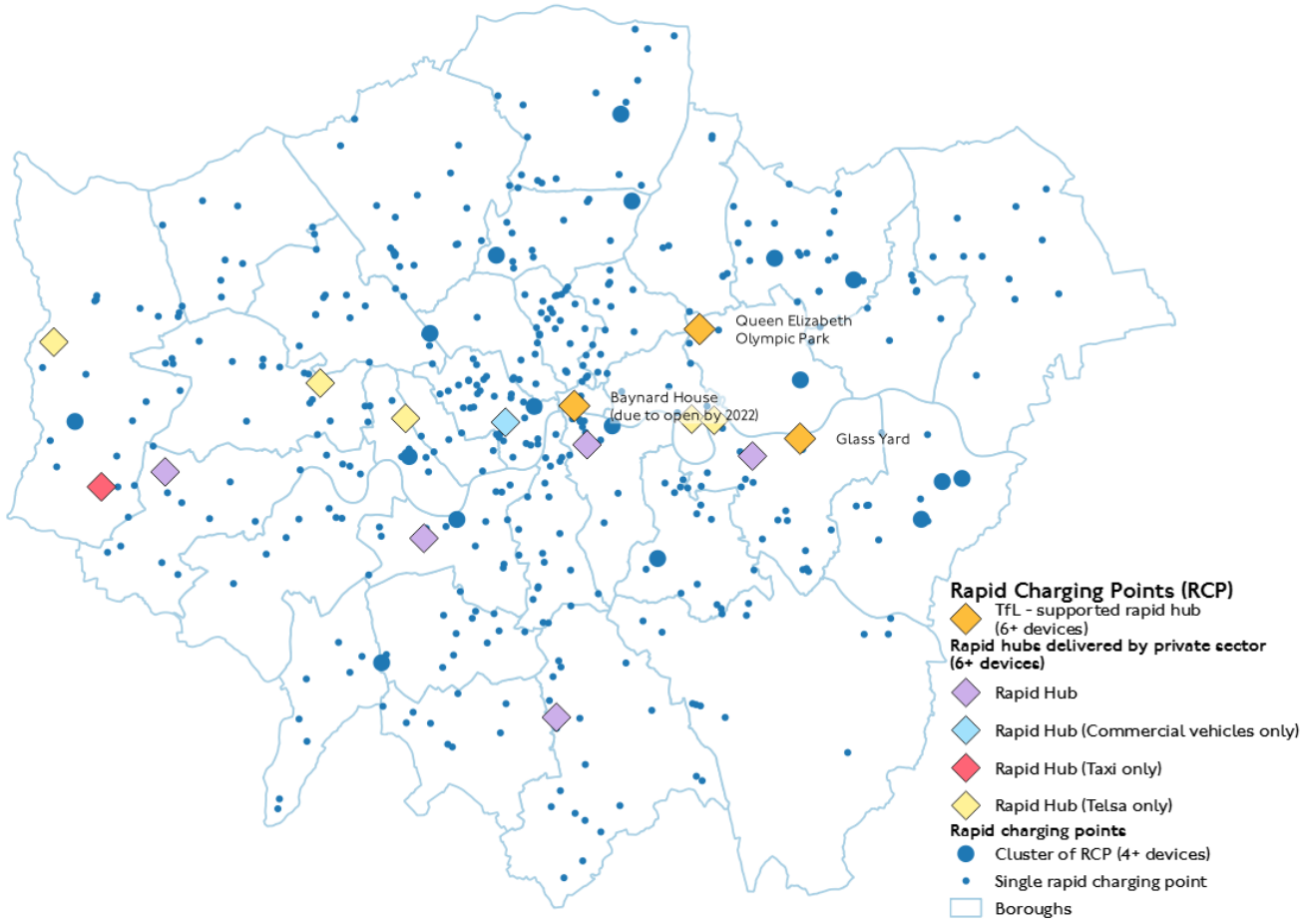
The delivery of infrastructure to support this scale of EV usage could result in around 46 per cent of the overall distance travelled by cars in London being by electric car. The proportion of EVs in the vehicle stock could reduce carbon dioxide emissions by between 1.5 million and 2.6 million tonnes per year by 2030. With much of the early shift to EVs expected to come from London's highest mileage drivers, this could represent between 40 and 84 per cent of London's total transport carbon emissions from cars.

Rapid charging points

The 2019 delivery plan advocated the advantages of rapid charge point hubs and set out an ambition for a rapid hub in every sub region of London by 2025. The public sector has supported on hubs opening at Glass Yard in south London and Stratford in east London and will be opening one at Baynard House in central London in 2022.

The private sector has delivered publicly accessible hubs near Heathrow on the M4, Croydon and New Kent Road, with a number of dedicated hubs also delivered to serve key user groups such as taxis and commercial vehicles. There is still no hub in north London, although rapid charge point coverage, including rapid clusters with up to four points, is increasing. A hub in north London remains a priority.

To meet demand, we need many more rapid chargers. These should continue to be delivered in central London, and town centres, including in outer London, as well as strategic routes such as A-roads. The public sector has delivered around half of London's rapid chargers, though private sector delivery is now accelerating. Of all the rapid chargers forecast to be needed in London by 2025, we expect around 20 to 30 per cent could be delivered with support from the public sector, equivalent to between 180 and 570 rapid charge points. This support could either be through direct delivery or by facilitating others, such as providing land. By 2030, we are aiming for little or no public sector funding being needed, as higher usage will make it more viable for commercial operators.



Slow-to-fast charge points

A good geographic spread of slow-to-fast charge points will be needed, particularly where priority users, such as private hire drivers, will need them. There were ambitious commitments set by private hire operators to switch to EVs by 2025.

There are large gaps in the slow-to-fast public infrastructure network in residential areas for each priority group. Further data will be sought to supplement vehicle registration data to ensure infrastructure is delivered where it is needed most. Investment should be focused in identified locations, detailed in the full strategy, to support these groups.

We must reduce the impact of charge points on the streetscape, to address accessibility concerns as well as avoid street clutter and redundant apparatus. Discreet, inclusively designed solutions, such as lamppost chargers and pop-up low-profile devices, are helping to achieve this.

The public sector has funded around 60 per cent of the slow-to-fast charging infrastructure installed. As usage increases and the infrastructure becomes more viable, we expect the private sector to deliver more charge points, so that by 2025, at least 50 per cent would be delivered with primarily private sector funding. Public sector delivery will depend on funding and contracts with operators that give boroughs a fair deal. By 2030, we anticipate most would be funded by the private sector, but certain locations may still need public sector support. All the charge points on borough land will continue to require public sector involvement.

Our commitments

Our keystone commitment to unlock GLA Group land for EV charging:

Unlocking GLA group land and repurposing it for EV charging will make the biggest difference to delivery that we, as the public sector, can make. This will involve:

We will assess all GLA Group land for its suitability to support the delivery of a network of rapid charge points and hubs across London. Initial estimates indicate up to 1,000 rapids could be accommodated on GLA Group land.

With a clear focus on high milage, essential road users, we will maximise emissions savings and support the goals of the Mayor's transport and environment strategies, while considering the need to encourage all road users to switch to zero-emission vehicles.

This work will also give greater support for London's boroughs in the future, who will be encouraged to continue and enhance delivery of residential slow-to-fast charge points on their land, where users can access lower cost energy for residential slow-to-fast charging, even if they don't have access to home charging. This will help make the procurement and delivery process more streamlined and efficient.

We will look at the procurement process to improve the user experience, fair pricing and longevity of the charging infrastructure, implementing high quality operational standards.

Working with the private sector, in the form of technical, commercial and, where possible, financial support to deliver public infrastructure.

Alongside this, there will be a separate worksteam to develop our own hubs. Our Commercial Development team is pursuing opportunities to roll out our own rapid charging hubs, using available land. These hubs will have environmental, social and economic benefits, providing significant ongoing revenue while supporting the transition to electrification. Planning, legal and technical due diligence is being done to assess ten initial sites, owned by us and the boroughs, for their suitability. It is intended that several hubs will come forward for development in 2022.

Commitments to support all user groups

We have identified the following ways to support the needs of all EV users:

Developing a real-time and open application platform interface
This bespoke application platform interface (API) would cover all charge points across London. We will improve the user experience and provide more reliable information on individual charge points. Subject to an initial feasibility study and Government funding, this will be initiated in 2022.

Support the delivery of shared charging facilities
These can be delivered between third parties, benefiting key user groups. We will pioneer the first bus garage shared infrastructure, which, subject to Government funding, will get under way in 2022.

Supporting the industry

To support the EV industry, we will:

Seek a partner to set up an EV Ethics and Sustainability Committee
This committee will engage with others, such as international cities, governments, trade bodies and non-government organisations to identify collective international action to address the ethics and sustainability of the supply chain for EVs.

Provide demand data and evidence base
This will support private sector investment in charging infrastructure, via the Charge Point Operators Forum, and potentially to wider audiences depending on the sensitivity of the data.

Work with energy distributors
Together with energy distributors (DNOs), we will identify localised grid constraints, so they can get Government support to fund upgrades, as required.

Explore green financing opportunities
Work with the private sector to find the best financing solutions to support the roll out of EV infrastructure.

Support charge point operators
We will support those who want to streamline the verification of driver licence status, improving efficiencies when applying preferential charging rates to key users.

Update EV infrastructure forecasts
London level forecasts will be updated every two to three years and we will support boroughs with granular level forecasts, starting in 2022.

Supporting key user groups

Taxis

Find technical solutions to enforce taxi dedicated bays
Working with charge point operators, these solutions will improve enforcement of taxi-dedicated bays. This work has already begun.

Continue to deliver taxi-dedicated bays
These will be in locations where taxi drivers frequently work, subject to funding. As demand grows from other key sectors we will also explore dynamic solutions to maximise utilisation.

Continue to explore innovative charging options
Including wireless charging on taxi ranks.

Light goods vehicles

Establish a commercial fleet database
This will assist with future planning and investment in infrastructure to support commercial fleet users, such as delivery companies, to switch to EVs. Subject to funding, this will begin from 2022.

Set up the London EV Business Leader's forum
Working with private fleets and commercial fleet operators to address specific issues, including their transition to EVs and how they support the delivery of London's charging needs. This will be achieved from 2022.

Car clubs

Encourage infrastructure in active car club locations
By focusing in areas where active car clubs operate, we will be able to support the electrification of these vehicles.

Work with operators and car clubs to explore dynamic solutions
Working together, we will explore how car clubs can make optimal use of the infrastructure, such as prioritised overnight rapid charging.

Private Hire Vehicles

Encourage delivery of slow-to-fast charge points where drivers live
These will be focused in areas with a high proportion of private hire drivers.

Support the delivery of rapid charging where drivers live and work
We will focus on rapid charging where private hire drivers live and work, such as town centres across the city.

Instigate a regular forum
From the end of 2021, this forum between charge point operators and private hire representatives will help solve specific issues.

Emergency service and public sector fleet vehicles

Support the transition
We will work with emergency services and public fleets, such as boroughs, via the GLA fleet forum to support their transition to EVs. Building on the joint EV infrastructure study, we will coordinate further EV charge point procurement, market engagement and explore joint funding opportunities.

Dedicated charge point bay
We will look at the feasibility of a dedicated bay for emergency services at one of our rapid charging points, with feasibility work starting in 2022.

Next steps, financing and further support

This document presents an initial summary of our findings and commitments to further support delivery of EV infrastructure in London. We are keen to seek feedback and discuss our findings and commitments with stakeholders over the coming months and will publish the full strategy document at the end of the year.

Government funding has been vital in enabling London to meet the demand for charging infrastructure and supporting the recent rise in consumer confidence in EVs. While we urge the private sector to also respond to this demand, with continued support from the GLA, London Councils and TfL, London will still need ongoing funding from Government to help maintain consumer confidence and accelerate the switch to electric vehicles. Continued Government funding will be essential to help address gaps in the charging network and ensure provision is equal across London.

Successor funding scheme

We would like to see a national successor funding scheme, to support the roll out of on-street and rapid charge points, which should be available for London to bid for. It would follow from the success of Go Ultra Low City Scheme (GULCS) and On-Street Residential Charge Point Scheme (ORCS).

With an estimate of £5,000 for an individual slow-fast charge point and around £85,000 on average to deliver 50kW rapid charge points or 150kW ultra rapid charge points, we estimate that an investment of between £15m and £48m would deliver between 180 and 570 rapid charge points, which is 20 to 30 per cent of London's likely rapid charging need by 2025. Investment of between £26m and £66m would deliver up to 5,250 and 13,250 slow-to-fast charge points, which is around half of London's likely needs by 2025.

The percentages we expect to be delivered by the public sector have been estimated from our current understanding of the market and extensive stakeholder engagement, enabling us to set a clear vision for the future.

Real-time information system

The lack of open data for charge points is one of the key challenges that EV drivers face. Government funding of up to £1m would enable us to start developing a world-leading real-time information system for EV charge points, which could be scaled to operate at a national level.

Shared access

We are closer to maximising the use of charge points by creating shared access to infrastructure for public and commercial fleets, having identified potential locations, including a bus garage. We are seeking £20m in Government funding, via the Comprehensive Spending Review, to deliver shared infrastructure at bus garages in London and pioneer this new business model.

Commercial fleet database

There is a clear need to support the uptake of plug-in commercial vehicles. The charging needs of these fleets is less understood, owing to a number of reasons including vehicle registration data being less reflective of where these vehicles operate and where charging infrastructure will be needed, so the first step will be to gather data. We are seeking Government funding of up to £1m to develop a pilot database of commercial fleet activity and set the context for a scalable national version to be developed.

Realising our vision - our role

Since we published the 2019 delivery plan, the delivery of EV infrastructure in London is well ahead of demand estimates, but we can see how demand is now rising rapidly. Our strategy considers what might be needed and what more can be done to help people transition to zero-emission vehicles, ensuring all essential car trips can be made by EVs, with access to charge points. To achieve this, we will continue to work closely with the GLA, London boroughs, London Councils and across the industry, following our overarching vision and our key principles.

Environment

By supporting infrastructure delivery, we can enable the switch to EVs, which would reduce carbon emissions and improve air quality. We will address battery supply chain transparency, working with partners, such as Electronics Watch. We will set specifications that all EV infrastructure delivered through our frameworks must operate using renewable electricity. This can also be adopted by boroughs.

Sustainable mode shift

We will prioritise essential road users' EV charging requirements, while also enabling other users who need to make essential trips by car to access a charge point, providing strategic vision and development of forecasting tools to support this.

Healthy Streets

We will promote our guidance to ensure EV infrastructure aligns to our design principles. We will update our London electric vehicle charge point installation guidance to reflect feedback and new accessibility guidance.

Accessibility

Working with Government, we will support a national-level solution for roaming payments and for a switch to pence-per-kilowatt hour tariffs to ensure users know what they will be charged. This needs to be consistent with energy sector pricing for home charging.

Pay-as-you-go options will be mandated on all publicly available EV infrastructure and contactless payment on all rapid charge points that are delivered through TfL frameworks and ensure these requirements can be adopted by boroughs.

Social inclusion

Using available and suitable land, a consistent, fairly priced network of slow-to-fast and rapid charging infrastructure must be delivered across London.

The case for funding must be made for sites that, although less commercially viable, would bridge gaps in London's charge point network.

Working with the Government, we will support the lowering of VAT so that it is consistent between public charging points and home charging use.

Commercial viability

We will support a strategic approach to site selection, providing data and analysis, to improve the business case for private investment. Using a flexible procurement model, we will vary the contract lengths delivered on GLA or our land to reflect the viability of the site, while also seeking a fair deal for us and boroughs.

Chapter 1 – Introduction and vision

London has been a world leader in the shift to electric vehicles (EV), with around 30 per cent of the UK's EV charge points[1]. This has been achieved through the Mayor's strong policies, including the world's first Ultra Low Emission Zone and vehicle scrappage schemes that incentivise the switch to cleaner vehicles, including electric. We also set ambitious electric bus targets that have resulted in Western Europe's largest fleet of zero-emission buses, and we have the strictest taxi and private hire licensing regulations for vehicle emissions, which have been supported by taxi delicensing payments and grants for those switching to zero-emission capable taxis.

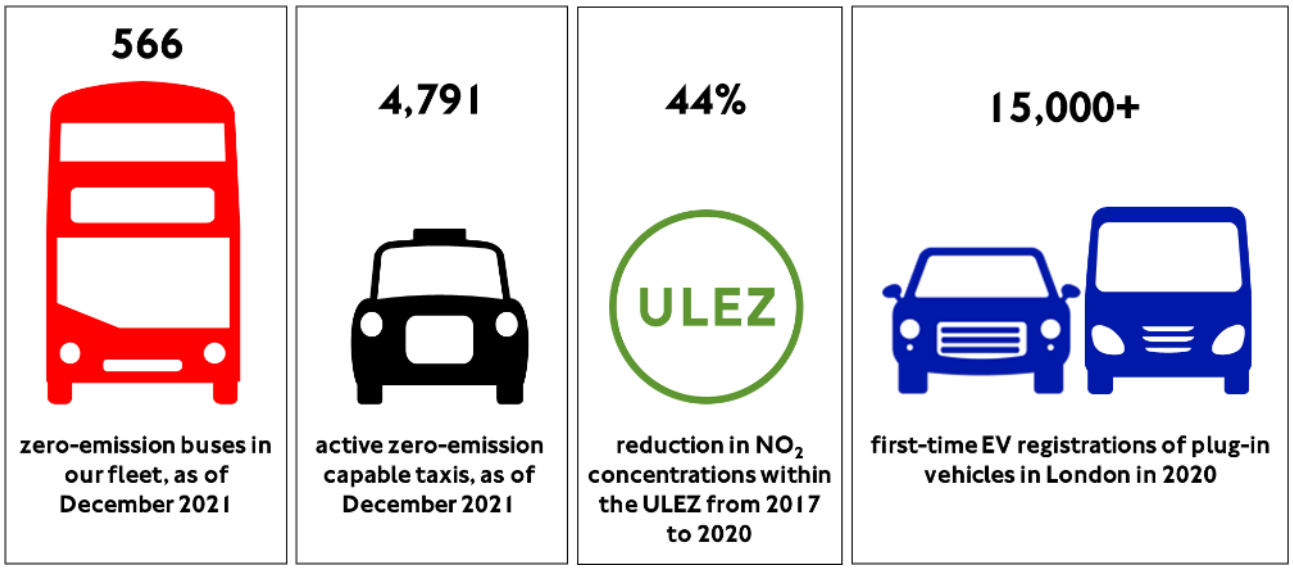


Figure 1: Success of London's strongest policies to tackle air quality

Steered by a taskforce established by the Mayor of London, in 2019 we published the London EV Infrastructure Delivery Plan. This set out clear recommendations for a continued mix of charging types, but with an emphasis on more rapid charging hubs, with a good spread across London. It also included the action to set up a coordination body to help support the roll-out of EV infrastructure. Our achievements since the Taskforce was established can be seen in Figure 2. The Delivery Plan estimated how many charge points would be needed by 2025 and indicated that there would need to be a shift from public sector to private sector delivery. However, even before the pandemic struck, private sector investment was lower than anticipated.

The Government has since introduced more ambitious policies to encourage the switch to cleaner and greener vehicles, including the phase-out of petrol and diesel cars and vans by 2030, a move the Mayor had been lobbying for as a priority given the significant impact of London's toxic air on health and social justice. These policies should be considered in the context of the Mayor's Transport Strategy[2], which has sustainable travel at its heart. Other Mayoral priorities, shared by other strategies such as the London Environment

[1] Zap-Map Statistics, 2021
[2] Mayor's Transport Strategy, 2018

Strategy[3],include improving air quality and reducing carbon emissions, alongside his own ambition for a Zero Carbon London by 2030.

Figure 2: Recent and future EV infrastructure achievements and milestones in London

This Strategy document is structured as follows:

- The first chapter introduces the vision and principles of the Strategy, and summarises the current EV context in London and across the UK
- The second chapter focuses on an assessment of the EV market, expected developments and user experience with EV infrastructure
- The third chapter covers the charging requirements of the key user groups identified, along with their current behavioural trends and priority areas for investment to support key user groups
- The fourth chapter looks at the delivery of EV infrastructure along with current tools that enable implementation. Key challenges to private sector delivery and future options are also explored in this chapter
- The fifth chapter presents London's overall charging requirements based on expected EV uptake between now and 2030, and the carbon savings expected from the switch to EVs
- The final chapter sets out the actions and recommendations of the Strategy, including TfL's commitments, funding requirements and further work and research that is required

[3] London Environment Strategy, 2018

1.1. EVs and charging infrastructure in London and the UK

EV registrations

Despite the impacts of the pandemic, 2021 has continued to be a strong year for battery electric vehicle (BEV) sales in the UK, with 88 per cent growth on the year to date[4]. The proportion of EVs registered for the first time in relation to all new vehicle registrations nationally also increased from 3.2 per cent in 2019 to 10.7 per cent in 2020[5]. Despite these recent trends, overall, Ultra Low Emission Vehicles (ULEVs) still only make up 1.25 per cent of all UK vehicles illustrating the scale of the challenge in switching to EVs.

At a London level, Department for Transport (DfT) data for 2020 indicates first-time registered ULEVs[6] hit a record high in London that year with more than 15,997 registered, which represents more than 12 per cent of all new vehicle registrations in London (Figure 3) or one in eight, which is greater than the national total and double what is was when the 2019 Delivery Plan was published. The London picture remains just as challenging though when considering London's vehicle fleet of more than 2.9 million vehicles with ULEVs accounting for just two per cent.

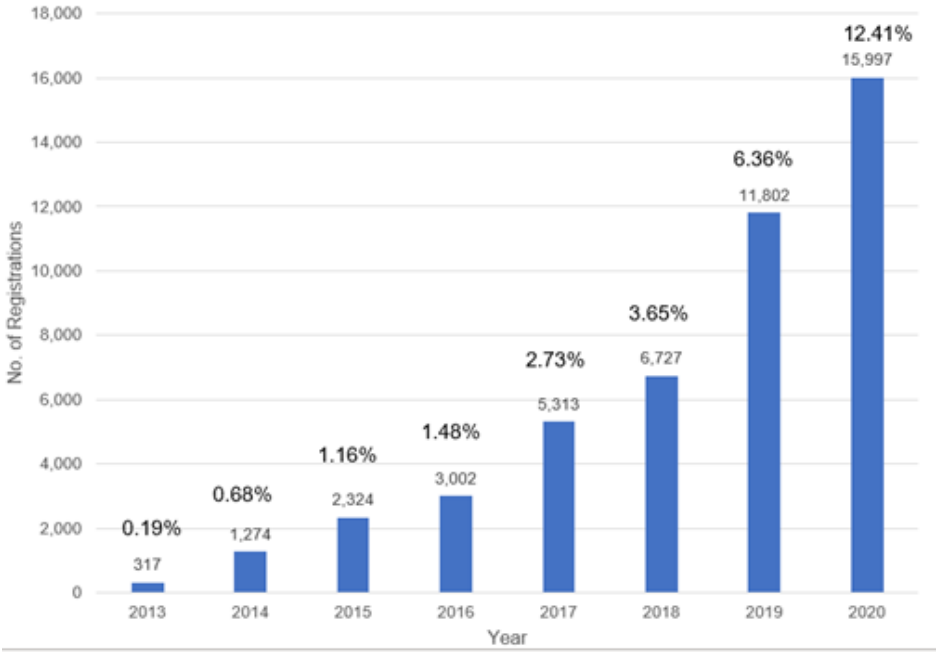


Figure 3: Number of first-time registrations of plug-in vehicles in London[5]

EV infrastructure: London

Infrastructure continues to be delivered at pace in London to support users switching to EVs. Figure 4 shows how charging infrastructure across London has grown considerably,

[4] EV Registration July 2021, SMMT
[5] DfT Statistics, Datasets VEH0132a, VEH0254, VEH0354, VEH0454, VEH0131
[6] Ultra-Low Emission Vehicles (ULEVs) are defined by the DfT as any vehicle that uses low carbon technologies and emits less than 75g of CO2/km from the tailpipe.

with more than 8,600 public charging points installed across the Capital, nearly a third of the UK's total. The new total represents an 85 per cent increase since 2019.

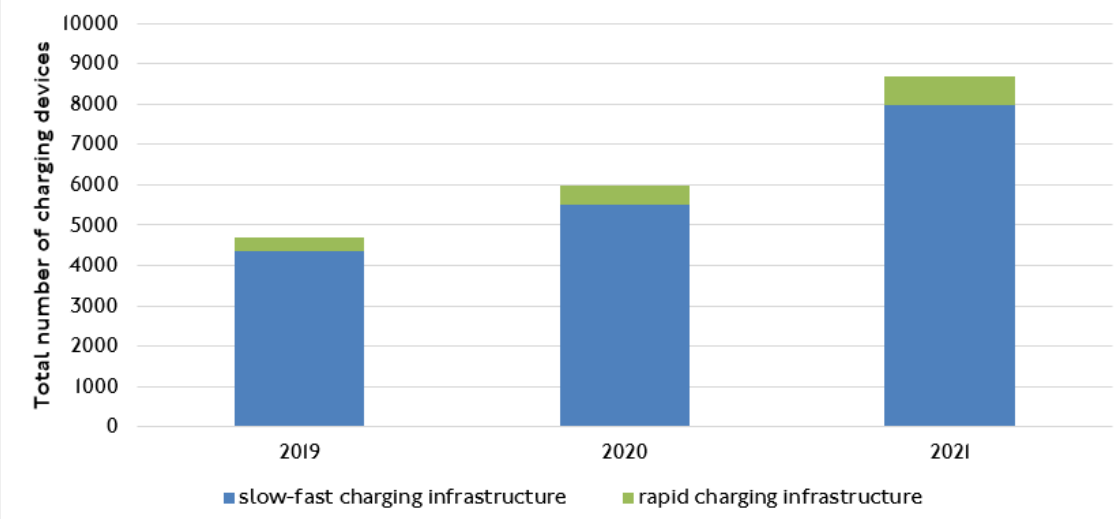


Figure 4: Growth in total charging devices by type across London[7]

Figure 5 highlights the spatial distribution of this delivery, showing the number of charging devices across London boroughs with clear concentrations emerging in West London.

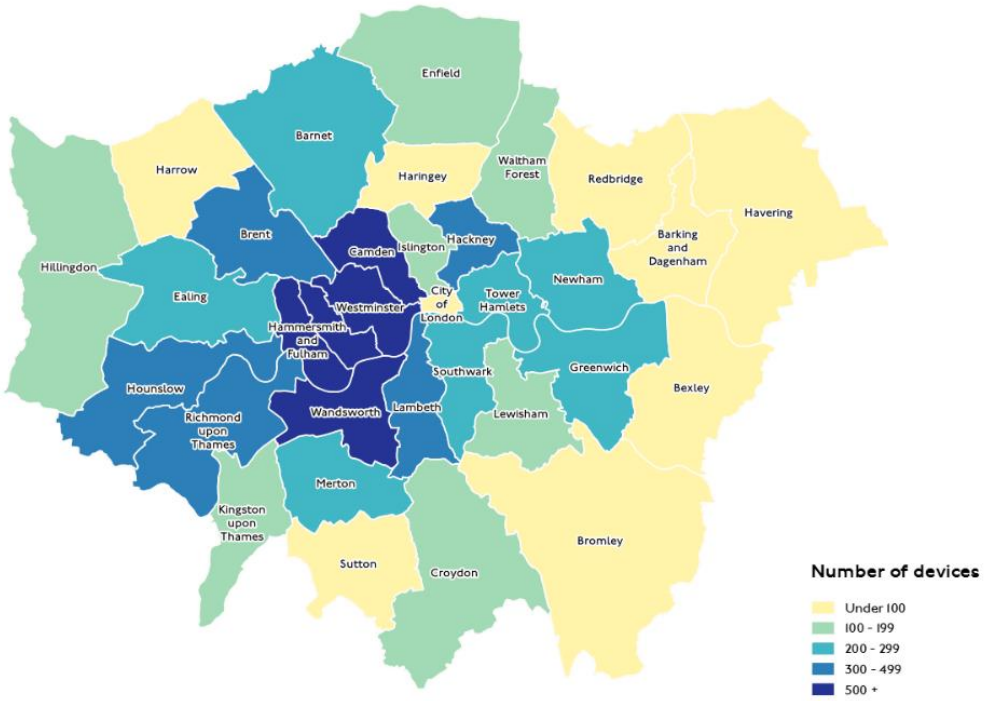


Figure 5: Number of charging devices by London borough November 2021[8]

Following a successful bid to the Office for Zero Emission Vehicles (OZEV) in 2016 for Go Ultra Low Cities Scheme (GULCS) funding, London was awarded £13.2m. Since delivery

[7] Source: Zap-Map, November 2021
[8] Zap-Map database, Nov 2021: www.zap-map.com

begin in 2018, the London boroughs have been allocated £7m of this funding to install on-street, predominantly lamp post column, charge points to meet the needs of residents without off-street parking.

The programme has supported delivery of more than 4,800 charge points to date, with a further 500 planned for delivery by the end of March 2022. More recently London Councils has supported the boroughs to secure c. £6m further funding through the On-street Residential Charge point Scheme (ORCS) to deliver more than 1,500 additional charge points by March 2023. As of November 2021, London now has more than 8,600 charging points, including over 700 rapid charging points accounting for nearly 30 per cent of the UK's total charge points.

As part of the Mayor's first-term commitments, starting in 2017, TfL ran a rapids delivery programme which achieved, ahead of schedule, the Mayor's target of 300 rapid charge points installed by the end of 2020. In the 2019 Delivery Plan, we set out the need for five flagship rapid hubs, one in each sub region of London by 2025.

Two sites have already been supported by the public sector, in east and south London, with Baynard House in central London expected to be delivered in 2022. The private sector has delivered sites in west London near Heathrow on the M4 and in South London in Croydon and on New Kent Road, with a number of dedicated hubs also delivered to serve key user groups such as taxis and commercial vehicles. There is still no hub in north London, although rapid charge point coverage, including rapid clusters with up to four points, is increasing. A hub in north London remains a priority.

EV infrastructure: UK

According to the latest quarterly figures published by the DfT, there are currently 24,375 public EV charging devices available across the UK, with 4,551 being rapid charging devices[9].

Since 2015, the number of public devices has on average grown by 44 per cent per year (see Figure 6). Rapid devices in particular have increased at a much higher rate, with an average annual increase of 62 per cent.

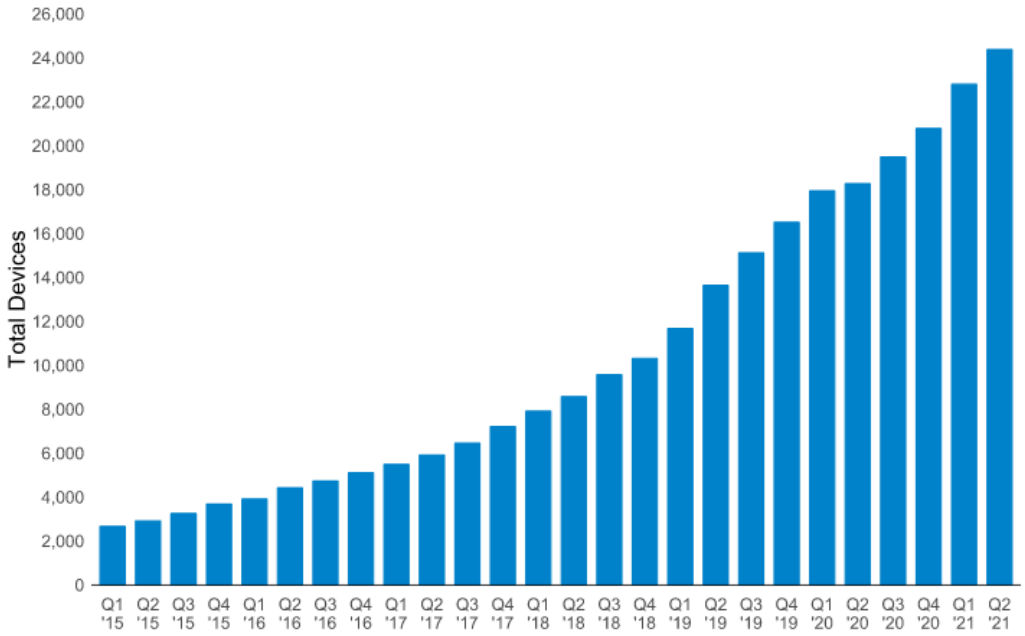


Figure 6: Year on year increase of EV charging infrastructure across the UK, 2015 to 2021[9]

The Government has acknowledged the importance of a network of high-speed public charging infrastructure along motorways and major A-roads as a key part of the transition to zero-emission transport. It launched a Rapid Charging Fund in March 2020, to help fund a portion of the costs for rapid chargers along the strategic road network across the country, expecting that by 2030 there will be around 2,500 high-powered charge points across England's major motorways and A-roads[10]. This will be key to consumer confidence, reassuring Londoners who might be concerned that - although the city's charge point coverage is good - they may not be able to travel long distances outside urban areas.

Impacts of the coronavirus pandemic

Following the first lockdown announcement in March 2020, the number of vehicles recorded entering London fell for all motorised modes. However, while the pandemic caused a relatively large reduction in demand for public transport, car use has recovered much more quickly, threatening to undo efforts to make walking, cycling and public transport the natural first choice and risking the worst effects of a car-led recovery.

The long-term impacts of changed travel behaviour due to the pandemic may take some time to distinguish, as a great deal of uncertainty remains around the implementation of new restrictions and our ability to live with, and manage, the coronavirus pandemic. The Travel in London Report 13[11] sets out five scenarios for the future of travel in London following the pandemic, with a nominal time horizon of 2030. These scenarios are being

[9] Electric vehicle charging device statistics: DfT, July 2021
[10] Government vision for the rapid chargepoint network in England: DfT, OZEV, OLEV, DfBEIS, May 2020
[11] Travel in London Report 13, TfL 2020

used to inform our medium and longer-term plans, by reviewing emerging evidence that might identify possible 'directions of travel' more clearly as time progresses.

The report goes on to analyse rapid charge point usage throughout the year and says that the impact of the coronavirus pandemic is clearly visible, with the number of weekly charges dropping dramatically from more than 8,000 in February and March, down to 3,000-4,000 shortly after the lockdown announcement. However, a sharp increase followed in May and June, with total charges back up to pre-lockdown levels in early July. By September weekly charge numbers had risen to the highest level observed in 2020, with a total of 11,000 charges across the TfL rapid sites per week.

Our analysis suggests EV uptake and the use of infrastructure have withstood the impacts of the pandemic to reveal record number of sales of EVs (Figure 3) and strong utilisation rates of charge points. However, it is clear that we cannot pile ever more cars onto our congested roads, and that electrification of transport will not be a panacea to all our transport challenges. Avoiding a car-led recovery from the pandemic has informed our approach to focus on key user groups through this strategy, as set out in the vision and principles section below.

1.2. Policy Context

In 2018, the London Environment Strategy outlined the key UK and London policies required to put London on the path to create a better future for the health and wellbeing of its citizens. Since then, the Mayor of London has continued to ensure policies are in place so that London is greener, cleaner and ready for the future. He declared a climate emergency in 2018, with an ambitious plan, Zero Carbon London: A 1.5 Degree Action Plan, compatible with the Paris Agreement aim of limiting the rise of global average temperatures to 1.5 degrees compared to pre-industrial levels.

In addition, the Government announced in November 2020 that the sales of new petrol and diesel cars and vans are set to be phased out in the UK by 2030[12]. Step 1 will see the phase-out date for the sale of new petrol and diesel cars and vans brought forward to 2030 from 2040. Step 2 will see all new cars and vans being fully zero emission at the tailpipe from 2035 - the Government has also published a delivery plan to ensure the 2035 target is met[13]. Alongside this, the Government has also recently consulted on ending the sale of all non-zero-emission HGVs from 2040, with lighter HGVs from 2035–2040[14].

The Government has pledged a £2.8bn package of measures to support the switch to EVs, including £1bn to build an internationally competitive EV supply chain to help the UK meet its needs[15]. Of this, £500m will be delivered through the Automotive Transformation Fund, securing investments in battery cell manufacturing and other technologies[12]. A further £1.3bn will be invested to accelerate the roll-out of charging infrastructure, including rapid charge points on major roads, and installing more on-street charging near homes

[12] New Petrol and Diesel vehicle phase out by 2030: DfT, 2020
[13] Transitioning to zero emission cars and vans: 2035 delivery plan, July 2021
[14] Decarbonising Transport: a better, greener, Britain- DfT, 2020
[15] Powering out Net Zero Future: UK Government, 2020

and workplaces. Building on the £1.9bn from Spending Review 2020[16], £620m has been committed by the Government to support the transition to EVs in the Net Zero strategy; this will support the rollout of charging infrastructure, with a particular focus on local on-street residential charging, and targeted plug-in vehicle grants[17].

Last month, the Government announced plans to, by law, require all new homes and buildings in England to install electric vehicle charging points from next year. The announcement stated this will also include new-build supermarkets, workplaces and buildings undergoing major renovations. It is expected that this will lead to 145,000 new charging points at the national level each year.

The London Plan[18] published in March 2021, led the way with a policy to provide 20 per cent active and 80 per cent passive charge point provision at new developments; the Plan stated that retail car parks must provide rapid charge facilities, operational parking must provide suitable charging infrastructure for EVs or other ultra-low emission vehicles, and new or re-provided petrol stations must provide rapid charge hubs or hydrogen refuelling facilities.

1.3. Vision and Principles

The Mayor's Transport Strategy sets out ambitious targets for trips to be made by sustainable modes, while acknowledging there will still be a need for some car and freight traffic to remain. For those remaining necessary trips, sufficient infrastructure will be required to enable them to be made by the cleanest possible vehicles.

It is also essential, however, that more widespread adoption of EVs does not undermine efforts to increase walking, cycling and the use of public transport. Our strategy therefore focuses on the needs of key EV user groups and how we can support their transition. Key users have been identified as those making high-mileage trips performing an essential role, including taxis and private hire drivers, as well as other commercial vehicles. Not everyone will be able to walk, cycle or use public transport for all or any of their necessary trips, so it is important to ensure these trips can also be made by EVs, with appropriate access to charge points.

As part of this Strategy, we have set out a number of principles informed by user needs, which sit under an overarching vision:

> **Supporting a net zero carbon target for London by 2030, and better air quality for all, the London Electric Vehicle Infrastructure Strategy seeks to accelerate the transition to zero-emission vehicles by setting out the requirements for the provision of infrastructure, focusing on essential trips.**

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[16] Spending Review 2020: UK Government, 2020
[17] Net Zero Strategy: Build Back Greener: UK Government, 2021
[18] The London Plan, The Mayor of London, March 2021

The overarching vision of this strategy will be realised through a set of key principles which fall into six thematic areas, as set out in Table 1, and are expanded on in the following paragraphs.

Table 1: Identified key principles

Theme	Principle
Environment	High quality, ethical and sustainable charging infrastructure that drives emission reductions and is resilient to climate change.
Sustainable mode shift	Delivery of EV charging should consider the type and location of infrastructure to ensure it does not incentivise additional car use.
Healthy Streets	Our EV charging should complement our Healthy Streets approach and support Vision Zero.
Accessibility	The EV infrastructure should be physically accessible, available, easy to use and should not impede or constrain people's movements on the footway.
Social inclusion	EV infrastructure should be affordable to use and accessible to all.
Commercial viability	We must ensure we create the right conditions for a self-sustaining charging market.

To ensure **the environment** is considered at each step, we must ensure that infrastructure is resilient to climate change, being high quality, ethical and sustainable. As such, the manufacturing, operation and maintenance of serviceable life must be considered in order to futureproof the infrastructure and reduce any negative impact during implementation and throughout the lifecycle; including end of lifecycle the recycling of EV infrastructure and batteries considered. Carbon emissions must be decreased through enhancing procurement standards, ensuring all energy used for the charging infrastructure is renewably sourced. This allows the CO_2 benefits over petrol and diesel vehicles to be realised.

A focus on **sustainable mode shift** is another key priority. Efforts should be targeted at achieving an overall reduction in private car use across the road network. Public sector investment should primarily be focused on key user groups to ensure those making the highest mileage trips and in the most polluting vehicles are prioritised to switch to zero emission vehicles sooner, and further policies and programmes need to be explored to facilitate a sustainable switch to EVs, while also reducing private car usage.

The delivery of EV charging infrastructure needs to **fit within the Healthy Streets Approach and support Vision Zero**. The impact on the public realm must be considered to keep street clutter to a minimum and maintain pavement access.

Infrastructure must be **accessible for all**, available and easy to use. Operations and maintenance standards, physical dimensions, availability of infrastructure and interoperability are all factors that need to be considered.

There also needs to be careful consideration of **social inclusion,** including adequate coverage of charging infrastructure that is affordable to use and equitable. Inequalities can be intensified where those without access to home charging can only use more expensive public charge points which are also less convenient for them to access. The cost of charging needs to be consistent and fair for all.

And finally, to ensure the long-term **commercial viability** of EV charging infrastructure delivery, it is essential to create the necessary conditions for a self-sustaining market.

Identifying key EV users

Given our commitment to shift toward sustainable modes in London, it is important that while we welcome a switch to zero emissions for all, our policies should not encourage avoidable car use. Our focus is therefore on **key EV user groups who make high mileage, essential trips, including taxis, PHVs and other commercial trips,** as this will also be where the biggest emissions reductions will be achieved by switching to zero emissions.

More comprehensive analysis of key user groups and their charging requirements can be found in Chapter 3.

Strategy Scope

The scope of this Strategy is limited to users of similar types of EV infrastructure. This includes light-duty vehicles such as cars and vans, and excludes heavy commercial vehicles - such as HGVs, buses and coaches. It also excludes lighter electric-powered two-wheelers, e-scooters and e-bikes, as these will not typically be using the same kind of public charging infrastructure. Battery electric heavy commercial vehicles, in addition to needing more space to park during charging, will require higher power levels than for cars and vans. Some heavy commercial vehicles may use hydrogen, but it is currently uncertain which vehicle types will use it widely and from when. In addition, while most recent and emerging vehicle and infrastructure-related trends are considered in this strategy, the potential widespread use of autonomous vehicles in the future is out of scope due to the high degree of market uncertainty associated with this area.

Chapter 2 – Latest technology and trends

This chapter covers current and anticipated technology developments, as well as other considerations, such as ethics of the supply chain, that may impact the type and volume of infrastructure required by 2030. It also includes a 'myth busting' section tackling the most common misconceptions about EV usage, identified through our own experience in delivery of infrastructure, research and stakeholder engagement.

2.1. Vehicle-related developments

This section considers the developments directly related to EVs, including technological trends in terms of battery performance, capability and range: availability and affordability.

Technological trends:

EV driving range

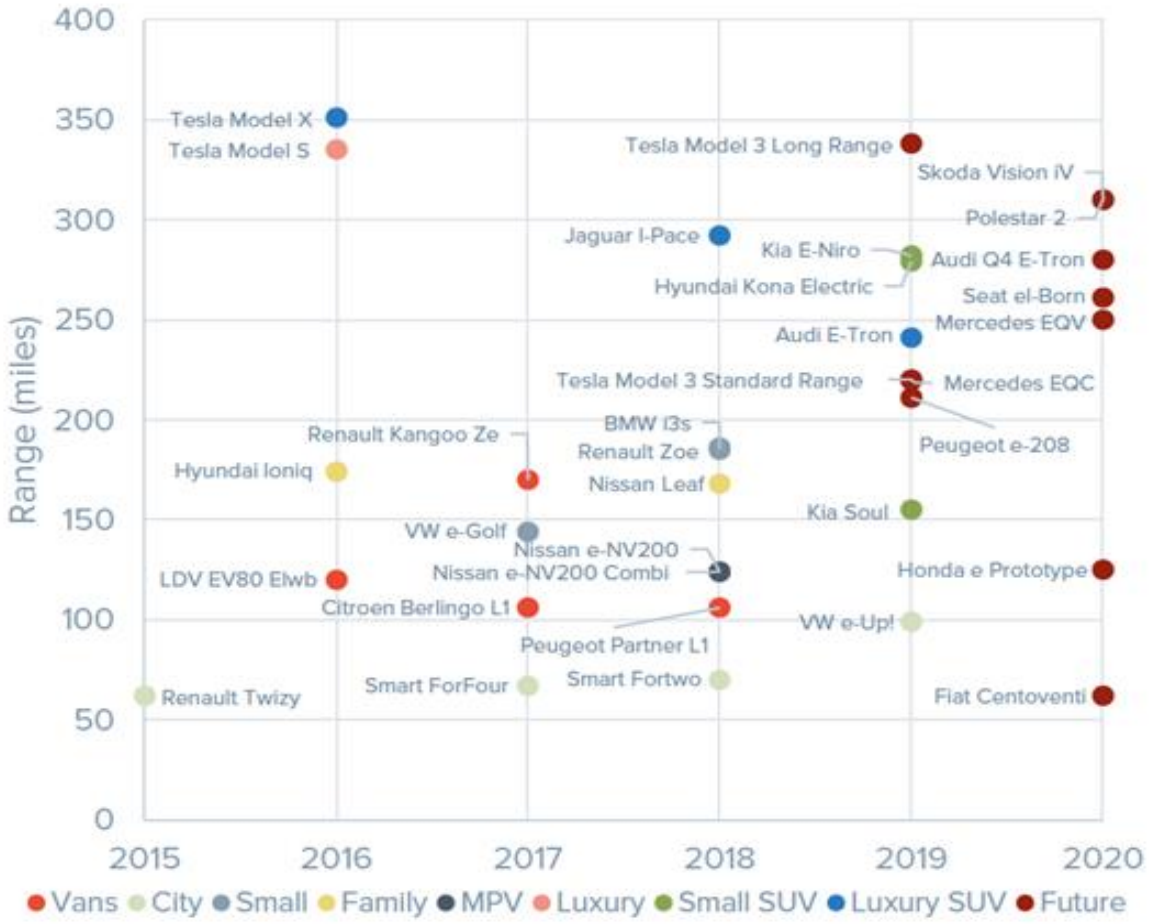
MYTH #1 EVs don't have a long enough driving range yet. **FALSE** – new models in 2020 had an average range of 220 miles

Range anxiety has often been cited as a key barrier to switching to EVs despite the average driving trip[19] for London residents being less than three miles (4.4km). Driving range has improved considerably from the first generation of EVs, due to a combination of better battery design, chemistry improvements and more efficient vehicle technology. For example, in 2011 the first-generation Nissan Leaf with its 24kWh battery, had a driving range of up to 124 miles on the official test cycle[20]. The real-world range was around 81 miles - the latest generation of the Leaf has a battery capacity of 62kWh and a Worldwide Harmonised Light Vehicle Test Procedure (WLTP) range of up to 239 miles (more than 200 miles in real-world driving).

While premium sports cars and Sports Utility Vehicles (SUVs) tend to have the greatest EV range (and highest price), many mainstream saloon cars and hatchback models recently introduced[21] have a driving range of well over 200 miles. In 2020, Castrol published a report[22] suggesting that the 'tipping point' for switching to an EV for most

[19] For London residents and for trips undertaken wholly within London – calculated using statistics from the London Travel Demand Survey 2019/2020
[20] The New European Drive Cycle, 'NEDC' – now replaced with a more realistic test known as the Worldwide Harmonised Light Vehicle Test Procedure, or 'WLTP'
[21] Including the VW ID.3 & ID.4, Hyundai Kona and Kia e-Niro
[22] "Accelerating the EVolution: The tipping points to mainstream electric vehicle adoption"; Castrol/ BP International Limited, 2020

motorists in the UK is based on a driving range of 285 miles. New models in 2020 had an average range of 220 miles[23], with some high-performance cars exceeding 375 miles. Despite promises of EVs with a range of 500+ miles, range will not rise indefinitely as sheer battery size and associated expense would become a limiting factor. The International Energy Agency (IEA)[24] has observed a slowing trend in EV range increases, with range is expected to plateau later this decade.



Source: Cornwall Insight

Figure 7: Increasing range of EVs by year and vehicle segment[25]

[23] IEA Global EV Outlook 2021. 220 miles is 350km
[24] ibid
[25] Fleet News, Average EV range exceeds 200 miles, April

Summary:

- New vehicle battery capacity is now two to three times the average size of first-generation EVs of five to 10 years ago; 200+ mile real-world EV range is now typical
- Driving range is expected to plateau in the coming years, with consumer research suggesting the 'tipping point' for switching to an EV is a range of just under 300 miles

Battery charging capability

While EVs are advertised as having a charging power of 'x kW' (such as 50kW), whether the vehicle will charge at that maximum power level is dependent on many factors. Some of these factors include the specific battery chemistry and materials used, battery temperature and the voltage that the vehicle battery and motor are designed to operate at.

The State of Charge (SOC), or percentage of the battery's full charge also has a significant effect on the maximum power and hence time to charge. When batteries are nearly empty and have a low SOC, maximum charging can normally occur. However, as the battery charge increases, the charging rate tails off. On many EVs designed to charge at up to 50kW, this happens at around 80 per cent of the SOC, with the final 20 per cent charge taking as long as the initial 80 per cent. However, some newer EVs – while able to charge at much higher power levels, they may only sustain the highest charge rates across a smaller SOC range. While we expect that battery EV charging capability will further improve in the future, our research shows that maximum power levels of up to 150kW are likely to be sufficient for most EV models.

Summary:

- The average rapid or high-power charging capability is today more than twice of first-generation EVs
- Charging of more than 200kW is possible on high performance cars, but maximum power levels of up to 150kW are likely to serve most EVs for some time

Battery and vehicle availability

There are two issues that are likely to have the largest impact on EV supply: material availability, specifically for batteries; and legislative issues arising from Brexit.

MYTH #2 There will not be enough batteries for all the EVs we need. **FALSE** – EV battery production in the UK and Europe will increase very significantly by 2025, although supply constraints are possible for the next few years

Battery material availability

The IEA[26] forecasts a global EV battery capacity increase from 170 GWh in 2020 to between 1,500 and 3,000 GWh per year in 2030, requiring 10 to 20 times today's manufacturing capability. This translates directly to raw materials used in lithium-ion batteries, being lithium, cobalt, manganese and nickel. Scaling up supply chains quickly enough is a significant challenge, with shortages possible.

BloombergNEF (BNEF)[27] reports that the prices of lithium and cobalt rose by more than 50 per cent in the first quarter of 2021, but as demand for battery materials increases and prices rise, both supply and demand patterns will change. On the supply side, more investment will flow into extraction and refining, although bottlenecks are likely to appear in some areas. On the demand side, vehicle and battery manufacturers will continue to adjust battery chemistries to reflect changes in underlying prices. The EV industry has already made considerable progress in reducing the amount of cobalt used in some lithium-ion battery chemistries.

New battery chemistries which use different materials - such as silicon, sodium, iron and copper, are under development. While some years from production, there is a reasonable expectation that lower-impact EV battery technology will become available in the near future.

Legislative and Brexit impacts

Brexit will have a potential impact on EV availability in the UK. Firstly, one of the key factors driving supply of EVs has been the EU new car and van CO_2 regulations, with vehicle manufacturers facing possible multi-million Euro fines if their fleet average CO_2 emissions are too high. Now the UK has left the EU, European manufacturers may not benefit from selling EVs in the UK because their CO_2 credits from low and zero emission vehicles will not count towards their EU fleet-average targets. There could be less incentive to prioritise EV supply to the UK in the event of increased demand elsewhere in Europe. The DfT has been consulting on a new post-EU CO_2 regulatory regime for the UK, and published a White Paper[28] in July 2021.

The second factor is associated with the 'rules of origin' agreed in the Brexit settlement. Batteries in EVs manufactured in the UK and exported to the EU must meet 30 per cent UK or EU content requirements, rising to 65 per cent in 2027, which means at least 30 per cent of the materials used in manufacturing of EV batteries must be made in the EU or UK.

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[26] IEA Global EV outlook 2020
[27] Hitting the EV Inflection Point: Electric vehicle price parity and phasing out combustion vehicle sales in Europe; BNEF for T&E, May 2021
[28] Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, DfT, 2021

At present there is one UK EV battery factory in Sunderland. The factory currently manufactures around two GWh of batteries per year. A second 'Gigafactory' in Northumberland has been approved and the supplier, Britishvolt, expects to supply more than 300,000 EV batteries by the mid-2020s. Coventry City Council is developing proposals for battery manufacturing by 2025 and Nissan has announced plans to build a further battery plant in Sunderland, which will produce nine GWh of batteries for an additional 100,000 EVs a year from 2024. The plant could expand to produce 25 GWh by 2030 and has the potential to eventually reach 35 GWh. Without facilities for domestic battery production, UK EV manufacturers would lack access to more sustainable and affordable batteries with manufacturers then subject to higher prices for materials which in turn results in a loss of market share and hence EV availability.

Summary:

- EV battery production is ramping up fast; multiple 'Gigafactories' are in construction – but raw material supply constraints are possible in the next few years
- Alternative battery chemistries can avoid some scarce materials, such as cobalt; bottlenecks in supply may occur but longer-term shortages are believed unlikely
- Leaving the EU's CO_2 regulatory regime could dis-incentivise manufacturers from prioritising the UK market; Government has been consulting on a new CO_2 emissions regulatory framework for the UK

Affordability

Cost of ownership and second-hand EV market

Achieving price parity with petrol and diesel vehicles will be critical for EV adoption as Government incentives are gradually withdrawn. The date by which this is reached differs by vehicle type and model and is a matter of debate among forecasters and commentators. However, the majority of projections suggest that most EVs will reach price parity – either purchase cost or total cost of ownership (TCO) - within the next five years. For some EVs such as vans, TCO price parity already exists (depending on the type of fleet operation).

Achieving price parity will be driven by a number of developments:

- Falling battery costs: for the past decade, the battery pack has been the single most expensive part of an EV: in 2016, the pack accounted for almost 50 per cent of the cost of a medium-sized electric car; it is now closer to 30 per cent and will continue to fall. KPMG[29] reports battery costs declining by more than 70 per cent in the past seven years and are expected to further halve by 2030.

[29] KPMG Mobility 2030: Future of Mobility, Chapter 2, the acceleration of electric vehicles

- Lower running costs, predominantly driven by lower 'fuel' costs: EV charging can be significantly cheaper than petrol/ diesel on a per mile basis[30], this is due to EVs being exempt from road tax, lower servicing and maintenance costs due to fewer moving parts than a conventional petrol or diesel vehicle, and, often exempt or discounted parking rates offered to EV drivers. Recent energy price volatility might mean that some charging tariffs erode that benefit, although the market is currently affected by exceptional international geo-political events and once energy costs trend back to their long-term range, the benefit of lower overall costs should still stand.

- EVs have many fewer moving parts in their electric motors ('drive-trains') than the engine and transmission of a petrol or diesel, this should result in lower service, maintenance and repair costs once more servicing technicians and garages are qualified to service EVs.

- Future improved residual values for EVs: these values have been volatile and for some EV models have fallen much faster than for petrol and diesel equivalents, due to concerns about battery degradation (and the risk of replacement), and declining prices for new EVs.

- Increased range resulting in so-called 'productivity parity': this predominantly affects buses and vans, which are highly utilised and can carry a payload. Productivity falls when a vehicle is off the road to charge, but improvements in battery range, charging network coverage and charging speeds should help to mitigate this.

- EV choice and performance: mass-market availability is still limited but is starting to improve. Demand for some EV models has outstripped available supply from manufacturers, both a promising indicator and a call to action to raise production.

- For full battery EVs, with zero vehicle CO_2 emissions, there is no Vehicle Excise Duty (VED), which depending on the list price and CO_2 from an ICE car, can save hundreds of pounds a year. For company car drivers, the Benefit in Kind (BiK) tax liability is one percent in tax year 2021/22 and is frozen at two percent until at least 2025. This can represent a saving of hundreds of pounds each month compared with high emission petrol and especially diesel cars – with BiK tax rates currently as high as 37 percent.

Price of new EVs

MYTH #3 EVs are more expensive than new petrol or diesel cars. PARTLY **TRUE**, while still currently more expensive, EVs cost less to run and are expected to reach upfront cost price parity in the next few years

Recent estimates show that BEVs will reach the same upfront price as equivalent petrol and diesel vehicles between 2025 and 2027, as shown in Table 2 below. Vans are

[30] Costs of running an electric car, Buyacar, 2021

expected to reach price parity first, followed by larger saloon cars and SUVs and lastly B-segment vehicles (smaller hatchbacks).

Table 2: Years at which BEVs reach upfront cost price parity with equivalent ICEs.[31]

Segment	Year	Segment	Year	Segment	Year
B	2027	SUV-B	2026	Light vans	2025
C	2026	SUV-C	2026	Heavy vans	2026
D	2026	SUV-D	2026		

Source: BloombergNEF. Note: we define price parity as the year at which a BEV becomes cheaper than the equivalent ICE.

Castrol (2020[32]) suggests that the 'tipping point' for switching to an electric car for most motorists, is based on an average purchase price in the UK of less than £22,000.

Second-hand EV market

Nearly new EVs can be more expensive to run than petrol or diesel equivalents[33] when the TCO is considered; this is illustrated in Figure 8. 'Nearly-new' (used) EVs are claimed to be more expensive due to three things: they don't benefit from the Government's plug-in car grant; they often don't receive dealer incentives, such as a deposit contribution; and monthly finance packages often have a higher APR interest charge because they are not supported by the manufacturer and their finance business. However, Auto Trader's research suggests the TCO of nearly-new / second-hand EVs does get nearer to parity with petrol or diesel cars over time (after three years), and savings are currently possible for both brand-new cars and for older used EVs.

[31] 'Hitting the EV Inflection Point. Electric vehicle price parity and phasing out combustion vehicle sales in Europe.' BloombergNEF for Transport&Environment T&E, May 2021
[32] Ibid, 2020
[33] Driving, The Sunday Times, April 2021

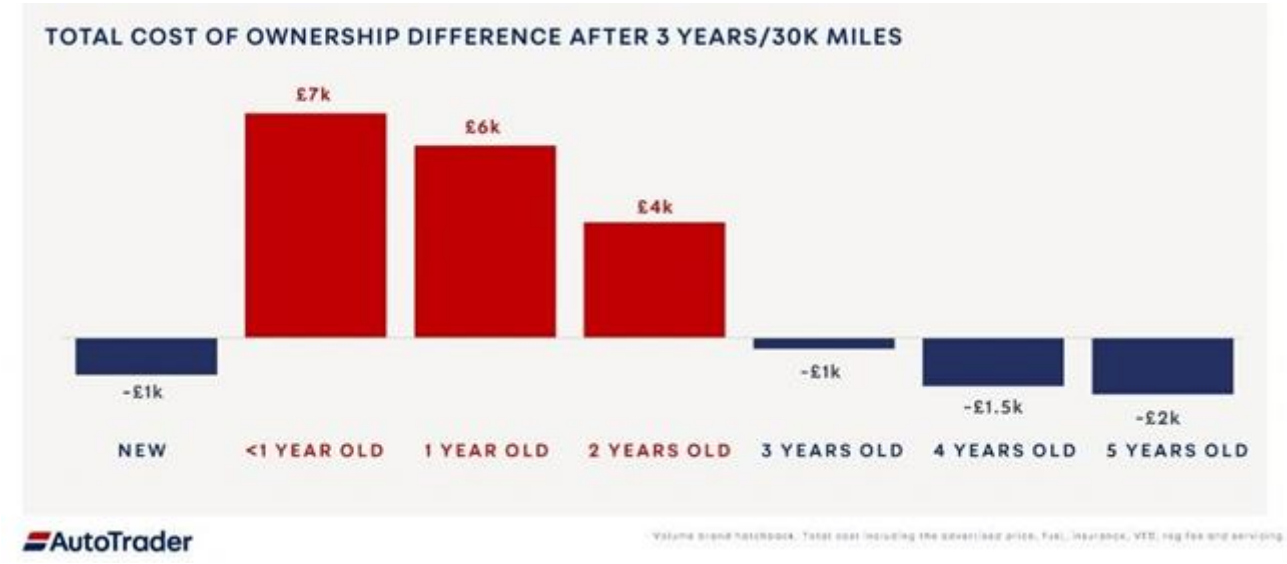


Figure 8: Total Cost of Ownership Difference between an ICE vehicle and an EV at different ages of purchase[34]

Demand for second-hand EVs is increasing, and nearly-new electric cars are increasingly available, although used prices are currently higher than those of equivalent petrol or diesel cars. There may be some imbalance in the used EV market for a while, but 'normal' supply/ demand forces should correct any short-term price anomalies.

Additional measures to bolster used EV sales could include battery health checks as part of used vehicle inspection standards. Leasing a second-hand EV or purchasing an insurance policy are also means of mitigating battery problems, such as replacing defective battery cells or modules. Some car manufacturers are planning to lease second-hand EVs and keep control of used batteries because of the residual value in them.

Summary:

- Most BEVs are expected to reach price parity (upfront cost) with petrol and diesel equivalents by 2025-27
- The total cost of ownership is already in favour of battery electric vans due to low running costs
- Battery manufacturing costs are predicted to fall by 50 per cent from today by 2030, after a 90 per cent reduction since 2010
- User confidence in the second-hand EV market could be raised by industry standards on battery health checks
- Leasing and (after-market) insurance can de-risk the costs of potential battery replacement for used EVs

[34] Source: Auto Trader, 2021

2.2. Infrastructure related developments

Technological Trends:

Rapid and high-power charging

> **MYTH #4** EVs take hours to charge or must charge slowly overnight. **FALSE** – most EVs can charge quickly at rapid charging hubs when undertaking a longer journey. Where possible, overnight charging is still the best way to minimise the cost of charging, lower carbon emissions and take pressure off the grid

Rapid Direct Current (DC) chargers provide power at up to 50 kW and are fitted with either the Japanese CHAdeMO connector and/ or the European-agreed standard, known as the Combined Charging System (CCS). They are the most common type of rapid EV charge points. These typically charge an EV to 80 per cent capacity (or SOC) in anything from 20 minutes to an hour, depending on battery size and how much charge is left when plugged in.

The recent generation of EVs are designed and purpose-built as electric, rather than being based on combustion models. They have ever-larger driving ranges due to improved battery chemistry, together with much higher charging speeds. For these new models, it is likely that 'rapid charging' power of 50kW will no longer satisfy the requirements of drivers wanting the convenience of a short top-up, or opportunity charge. This has prompted charge point equipment manufacturers to develop next-generation, higher-power chargers. Some of the highest-powered DC chargers even have cooled charging cables to remove the heat generated by the very high electric currents.

Ultra-rapid or High-Power Charging (HPC) typically refers to power at 100kW or above. They may be rated at 100kW, 120kW, 150kW, 175kW, 200kW, 300kW or 350kW – although many are modular and upgradeable to higher power output as more HPC-capable EV models are released. For those EVs capable of accepting 100kW or more, charging times are kept down to 20-40 minutes for a typical session.

Europe's claimed most powerful EV charging hub is being built in Oxford, opening in 2022. Pivot Power's 'Energy Superhub Oxford' at one of the city's Park & Ride sites is the first of 40 similar hubs planned[35]. The hub will be home to ten 300 kW high-power chargers, capable of charging 14 EVs at once – plus twelve 250kW Tesla Superchargers and sixteen 7-22kW AC charge points. At present, only the most advanced EVs on the market can charge at the highest power, but more models will be launched with this capability in the future.

Another charging hub operator, Gridserve, opened its first electric forecourt in Braintree, Essex, in December 2020 – with a further 100 sites planned over the next five years. Gridserve Braintree provides high-power charging for up to 36 EVs at the same time with

[35] Current News, Work kicks off at 'UK's largest' public EV charging hub, November 2021

twelve 350kW chargers, twelve 90kW chargers, six AC chargers of up to 22kW and six Tesla Superchargers. The site is powered by 100 per cent renewable energy from a Gridserve-owned solar farm, supplemented with a 200kW solar panel-covered roof.

More specifically in the capital, there are now a number of rapid hubs. Work has started on Shell's first dedicated all-EV hub in west London, which will convert a conventional forecourt into an EV charging hub, with 10 high-powered, 175kW charge points. Opening in 2022, the hub will include a small supermarket and coffee shop and features two prefabricated timber canopies sourced from sustainable forests to create the structure for a solar array above.

There is a need for existing/legacy EVs, such as Nissan vehicles, to access rapid chargers with the CHAdeMO charging connection. Even if an EV is only able to accept a maximum of 50kW DC, they may use ultra-rapid or HPC charge points, but the power will be restricted to whatever the vehicle can deal with. There is a question whether, in the future, charge point operators (CPOs) might dis-incentivise EV drivers who are only able to charge at 50kW from using a 350kW HPC which is a much more valuable asset than a 50kW one, given it will draw relatively less energy and make less revenue for the operator. Gridserve appears to have considered this legacy access and equity issue by providing several rapid 90kW chargers alongside the newest HPC ones.

Castrol (2020[36]) suggests that the 'tipping point' for switching to an EV for most motorists in the UK is based on a charging time of less than 30 minutes. One means of achieving this is to swap a depleted battery with a fully charged one. EV battery swap technology has been trialled a number of times but has faced big challenges. These included the significant cost of battery swap stations, and the difficulty of establishing a sufficiently standardised and readily removable battery common across vehicle manufacturers with many different EV models. Advances in ultra-fast charging for new EVs have largely eroded the benefit in time saving offered by battery swapping.

Summary:

- High-power chargers of 175+kW are being installed at new charging hubs; maximum of 350kW is possible in the future but power levels of up to 150kW is likely to serve most EVs for some time
- High-power charging requires large grid connections; energy storage and smart grid management is essential to manage peak demands. Consequently, the cost of high-power charging is significantly more than domestic electricity tariffs
- There is a need for legacy vehicle rapid charging, such as 50kW/ CHAdeMO for Nissan and Mitsubishi EVs

[36] Ibid, 2020

Evolution of on-street charging technology

The design of charge points is important from both an aesthetic and safety perspective. Position and height are key to safety, acceptability, and accessibility. New designs and technical solutions have been developed to address these issues – some of which have been deployed across boroughs, with others in the pilot/ demonstration phase. These are as follows:

Lamppost: charging equipment built into lamp posts is a way of charging that utilises existing highway infrastructure, helping to reduce overall installation costs and visual impact. The first service to emerge in the UK was ubitricity, a member of the Shell Group, from whom customers purchase a smart cable enabling them to use their charging outlets on lampposts. Recent upgrades to LED street lighting mean that spare power is available for EV charging without having to upgrade lamp post wiring since LED lamps use up to 60 per cent less electricity than conventional lamps.

Figure 9: Lamp post charge point, Source: Ubitricity (member of the Shell Group)

Kerbside: several companies, including Connected Kerb, have developed kerbside chargers which are less obtrusive than many existing pillar-style charge points. They may be post-mounted at a low level (but may pose accessibility restrictions) or they may be a ground unit with socket outlets almost at kerb level.

Figure 10: Gecko charging point by Connected Kerb

Pop-up: pop-up chargers from Urban Electric are being trialled by Plymouth and Dundee City Councils. These chargers are installed underneath the pavement, hidden from view, rising out of the ground when needed for use. They auto-retract when not in use, offering a lower risk of vandalism, but whether they are sufficiently robust to have the service life of a surface-mounted charge point remains to be proven.

A variation of pop-up chargers is one where the charging cable is attached to a lance, which the EV user keeps in the vehicle and when charging inserts into a ‘flat and flush’ ground unit. This has the benefit of fewer moving parts underground and is visually (almost) unobtrusive. This type of charge point from Trojan Energy is being trialled in the boroughs of Camden and Brent.

Figure 11: Urban Electric dual socket pop-up charge point

Figure 12: Pop-up charge points, Image courtesy of Trojan Energy Ltd

A further consideration for on-street charging is payment methods. Card payment is not commercially viable with on-street EV charge points due to its high cost. CPOs have variously developed smart phone apps, have installed quick response (QR) codes on the charge points themselves, or issued Radio Frequency Identification (RFID) tags or cards to authenticate the user, initiate charging and generate a bill.

Given the number of CPOs in London and across the UK, and lack of interoperability, many EV drivers have multiple charging network apps or memberships. The current

payment set-up results in a poor consumer experience, as discussed in section 0. An alternative method of authentication and payment may in the future be facilitated through an approach defined in the International Standard ISO15118. There are also other 'plug and charge' solutions being developed and trialled.

Summary:

- Provision of overnight/off-peak charging is important for the majority of EV users, due to cost and grid/carbon intensity considerations
- There are many innovative charging solutions, such as lamppost, kerbside, pop-up, retractable and extendable versions, which can improve the streetscape
- Planning and co-ordinating a network of on-street chargers is more cost effective from a grid connection and load management perspective
- Customers prefer to avoid multiple apps, RFID cards and different membership schemes, while paying by card is too expensive to deploy for on-street residential charging
- The ISO standard 15118 'plug and charge', which enables authentication via the charging cable, could be a future solution but requires industry cooperation or legislation. Other similar solutions are being developed

Wireless charging

Wireless charging is a technology successfully employed in low-power consumer products such as smartphones and in industrial settings. In a vehicle, it requires a coil or charging pad to be typically located under the floor – and when stationary or even moving over a charging plate embedded in a road or parking space, the vehicle's battery is automatically charged without any driver intervention.

Wireless charging for EVs has been in development for a number of years and demonstrated in several pilot projects (including on TfL's bus route 69 in east London, as part of the EU-funded 'ZeEUS' project[37]). The costs of developing and testing this technology and the previous lack of standards, have meant that the time to introduce wireless charging as a mainstream offering has been far longer than anticipated.

In late 2020, the US Society of Automotive Engineers announced[38] a global standard for wireless electric-car charging, which could help accelerate the technology's roll-out. BMW and Daimler have agreed to develop and use standardised inductive charging technology for their next-generation EVs.

[37] EU funded Zero Emission Urban Bus System: https://zeeus.eu/
[38] Society of Automotive Engineers, Wireless Charging Standard, 2020

TfL is a partner in one of Innovate UK's wireless charging demonstration projects[39] ('WiCET'), following an earlier feasibility study looking at the benefits and obstacles to this technology being used by taxis. Wireless charging at taxi ranks could provide an alternative to plugging into a conventional charge point, supporting drivers to charge more easily and more often while waiting for their next passenger.

Nissan and LEVC electric taxis in Nottingham will be fitted with wireless charging hardware and will take part in wireless charging trials that started in late 2021.

With wireless charging, one of the challenges to overcome is the business case, and whether the convenience and automated nature of induction (also known as wireless) charging is more attractive than conventional (plug-in) charging, even if at cost premium. However, for some sensitive urban locations, the benefit of unobtrusive (or less obtrusive) wireless charging infrastructure can have large benefits to the public realm.

Smart charging

MYTH #5 There won't be enough power for EVs – **FALSE** - in the short to medium term there may be supply issues; UKPN have confirmed that by managing demand and smart charging, this can be mitigated[1]. Could become a concern in the longer term as the nation's whole vehicle fleet moves to zero emission, but National Grid and other energy system stakeholders are planning how to manage this.

Switching to EVs will increase energy demand across electricity networks, making it more challenging to balance demand with intermittent renewable energy generation, especially as other energy sectors (such as heating) are increasingly electrified. Technical solutions, such as managed or smart charging, can reduce EV charging loads during peak demand. This can mitigate or delay the need for upgrades to electricity generation, transmission, and distribution networks.

'Managed charging' reduces or pauses charging in response to real-time signals from grid operators and is often referred to as 'V1G'. The move to fully smart charging is where an EV battery can discharge back into the grid and actively support the network at times of stress. This is known as 'Vehicle-to-Grid' or V2G. Its potential depends on the availability of vehicles being plugged in at suitable times, requires consumer acceptance, and adequate revenues to incentivise voluntary participation. This technology is suitable for EV users with dedicated parking/ charging at home or at their workplace – and potentially fleets too, when plugged in for longer periods of time. Managed or smart charging isn't expected to be suitable for many types of public charging such as rapid or high-power, where interrupting charging is clearly not desirable.

This new technology requires change to the energy system's regulatory and commercial frameworks and the development of new business models. Government, regulators, and business are actively engaged in tackling these challenges, and public funds are being invested in projects to evaluate both technology and appropriate standards and

[39] Cenex, Wireless Charging for Electric Taxi (WiCET) Feasibility Study, 2020:

governance needed. In the UK, the world's largest consumer trials suggest[40] that V2G technology could save customers around £340 annually compared with £120 when using one-way managed charging (V1G). By enabling V2G chargers to provide additional grid services, this figure could rise to £725 a year, although the cost of hardware needs to reduce further for it to be a more attractive proposition. Vehicle manufacturers are responding to this[41].

Summary:

- Wireless charging is likely to become attractive in some cases, such as for convenience (for example, residential off-street parking) and for productivity (such as at taxi ranks), or where there are sensitive streetscape issues
- A global standard for wireless charging should now enable hardware to be developed at lower cost; premium vehicle manufacturers are already starting to incorporate wireless charging as a factory-fitted option on some EVs
- Managed and smart EV charging will be essential over the coming decades to alleviate pressure on the grid, especially in local Distribution Network Operator (DNO) networks. This could impact residential on-street charging but is less likely to affect destination charging and very unlikely to affect rapid/ high-power hubs
- Bi-directional EV charging (V2G) is viewed as a key component of a smart grid, although costs of hardware are currently too high, and the business case needs to be improved to become viable
- Wireless and smart charging are not likely to have a material impact on how much and which types of public charging infrastructure are needed in the near term. There may be a need to future-proof some charge points (on-street, used for overnight charging) to meet technical standards where appropriate

2.3. Other considerations

Hydrogen

Given the significant improvements in EV battery technology in the past decade, the wide choice of new electric car and van models and much faster charging capability, hydrogen as an energy source for road transport is more likely to be targeted at heavy passenger, commercial and specialist vehicles. As part of ongoing research and development, TfL has

[40] Cenex, Sciurus: Domestic V2G Demonstration, 2021

[41] Volvo's next-generation XC90 SUV, which will launch in 2022, is expected to have V2G charging capability built in as standard in the fully electric version

invested in twenty hydrogen fuel cell double deck buses to better assess their cost-effectiveness and performance.

For hydrogen, while standards have been agreed for quality and refuelling infrastructure, availability of the cleanest 'green' hydrogen (created from water by electrolysis using renewable energy) is limited, and 'blue' hydrogen (created from natural gas) depends on carbon capture and storage to minimise carbon emissions. Commercialisation of green hydrogen at scale is likely to take a number of years, during which time battery technology will continue to improve. Most commercial vehicle manufacturers are developing multiple technology paths to zero carbon, including battery electric and hydrogen. It is currently uncertain which vehicle types will use which technology (although for smaller HGVs, battery electric versions are already available), and it is possible that some will be offered with a choice.

Life cycle emissions

MYTH #6 EVs produce more carbon emissions over their lifetime than petrol or diesel. **FALSE** – carbon emitted while manufacturing EVs can be more than recovered over their lifetime from not burning fossil fuels.

The total emissions from any vehicle are known as 'lifecycle emissions'. These include emissions from manufacturing the vehicle, powering, or fuelling it through its life, and scrapping, recycling or re-purposing. Several studies have assessed EV life cycle emissions, with varying conclusions based on the methodology and assumptions used by the researchers. This is known as Life Cycle Analysis (or Assessment – LCA), and usually considers Greenhouse Gas emissions, principally CO_2. LCA includes factors such as the size of the car, annual mileage, driving and efficiency assumptions, and where the car is manufactured and recharged.

A recent report[42] on lifecycle emissions of EVs in Europe found that, while EVs have higher emissions at the manufacturing stage than petrol and diesel equivalents – primarily because of the carbon embodied by making the battery – these can be more than recovered over the lifetime of the car from not burning fossil fuels[43]. However, recent estimates of battery manufacturing emissions vary considerably according to studies, indicating the need for additional research in this field.

Since vehicle production and emissions from power generation are based on a country-specific energy mix, the lifecycle emissions of EVs vary between nations, regionally and even locally. This national variation of the different lifecycle emissions is summarised in Figure 13.

[42] Report 'Global EV outlook 2020' by International Energy Agency (IEA)

[43] International Council on Clean Transportation: "Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions", February 2018

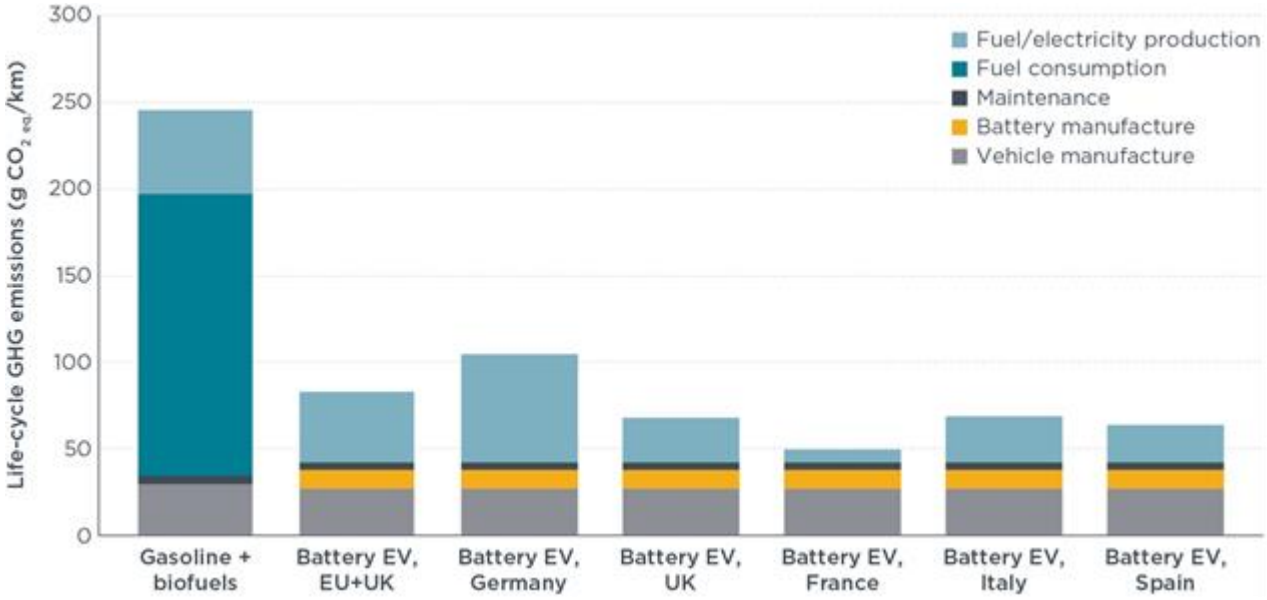


Figure 13: Life-cycle GHG emissions of lower medium segment BEVs registered in Europe in 2021, with the vehicle lifetime average electricity mix compared to gasoline ICEVs[44]

Analysis from the International Council on Clean Transportation, the IEA and the BNEF demonstrate there is potential for manufacturing emissions to either increase or decrease in the near future, but in the longer term they are expected to fall significantly. Most lithium-ion batteries are currently manufactured in Asia, where higher proportions of electricity are generated by coal. While manufacturing emissions could become more substantial as longer-range EVs with larger batteries become more common, trends point to reduced emissions from battery production in the future due to the significant investment in new battery factories in Europe, further increasing lifecycle emission savings offered by European-built EVs. Carbon emissions in the battery manufacturing process are therefore forecast to fall significantly in the coming years.

BNEF analysis[45] suggests that the lifecycle CO_2 emissions of a BEV bought in 2020 and driven for 250,000km (156,000 miles) – would be 70 to 80 per cent lower than an equivalent medium-sized internal combustion engine (ICE) car in the UK.

To further understand the issues associated with the EV battery supply chain, the Zemo Partnership (formerly the LowCVP) has proposed a programme of work looking at LCA for 2021-22. TfL will be part of this research as a member of the Zemo Partnership.

[44] ICCT, 2021
[45] "The Lifecycle Emissions of Electric Vehicles", February 2021

Summary:

- 'Embedded' CO_2 emissions during EV manufacturing are higher than for petrol and diesel vehicles, due to their batteries
- The in-use phase, using low/zero-carbon electricity, means whole life emissions from EVs are lower – and very much lower in high-mileage fleets
- Emissions from batteries continue to fall; battery production using low carbon energy close to vehicle production minimises emissions
- Further research could help provide a greater understanding of lifecycle emissions of different vehicle types, power-train technology, and origin of manufacture

End of life and recycling/re-use

MYTH #7 Old EV batteries will end up polluting the planet. **FALSE** - although current low volumes will grow, with technological advancement (such as solid-state batteries), better recycling capabilities, and more opportunities for 'second-life' use, this can be managed.

The metals and compounds used in lithium-ion EV batteries can pose risks if they are not disposed of (or recycled), properly. This is true of other batteries too, such as those containing lead. Today's EV batteries usually contain a liquid electrolyte which, as well as being flammable, can be toxic to humans and the aquatic environment and some chemicals are carcinogenic[46]. The EV battery industry is developing alternatives to liquid electrolytes, such as polymer or so-called 'solid state' batteries which should be available commercially later this decade, thereby reducing some of the potentially harmful impacts.

Government rules on waste batteries mean producers are responsible for their disposal, and the EU has regulated the practice since 2006 through its Battery Directive. However, the viability of recycling used EV batteries has been limited so far because of generally low raw material prices and small volumes of used batteries. Recycling can also be difficult due to largely unique battery designs, size and shape, and specific chemistry for every EV manufacturer. The IEA (2020) estimates that 100-120 GWh of EV batteries globally will be retired by 2030, a quantity roughly equivalent to current annual battery production. Without effective measures to address these volumes, they could become a significant

[46] 'Toxicity of lithium-ion battery chemicals -overview with focus on recycling'; Mats Zackrisson & Steffen Schellenberger, Research Institutes of Sweden, June 2020

environmental liability, so the development of an effective recycling industry will be key to the sustainability of Lithium-ion batteries. The Government has acknowledged[47] this need.

Battery collection and recycling policies have until recently focused on consumer electronics or lead-acid batteries, but in December 2020 the EU proposed changes[48] to its battery regulations, most of which target lithium-ion batteries. These include targets for collecting used EV batteries and recycling rates for cobalt, copper, lead, nickel and lithium, together with mandatory levels of recycled content in new batteries by 2030. By 2026 a battery passport or electronic record for each EV battery should be available and from 2027, batteries should be marked with a label or QR code to identify key information such as lifetime, charging capacity, hazardous substances, and safety risks. EV batteries should contain a battery management system storing information on state of health and expected lifetime. This system should be accessible to both EV owners and independent operators, to facilitate the reuse, repurposing or remanufacturing of the battery.

Before an EV battery reaches the end of its life and requires recycling, it may be suitable for reuse or repurposing in a second life. This can include stationary storage applications for electricity network operators, commercial or residential customers and high powered EV charging hubs. Extending the useful life of EV batteries can help reduce their overall environmental impacts and avoids the manufacturing of some new batteries. Despite some challenges for second life EV battery uses around competing with the decreasing cost of new batteries and a complex refurbishing process, a second-life industry is starting to emerge, made up of automotive manufacturers, utilities, and specialised start-ups. Manufacturers are considering how to maximise the value of EV batteries, such as leasing second-hand vehicles in order to control the supply of used batteries.

Summary

- An EV battery recycling ecosystem must be developed in the next several years
- Enforceable targets for lithium-ion battery recycling and material recovery should be set and the UK should adopt or mirror any upcoming changes made to EU regulations on EV batteries
- Standardisation of battery design can promote circular economy principles and make components easier to recycle/dismantle. Repurposing EV batteries for stationary energy storage extends their useful life and supports the transition to a cleaner and smarter electricity network if they can compete on cost

[47] In an October 2018 report ("Electric vehicles: driving the transition"), a UK government Business, Energy and Industrial Strategy (BEIS) Committee said that further recycling facilities for lithium batteries will be required as the number of retired electric vehicles increases and highlighted calls for waste disposal options to be addressed by policy (from House of Commons Briefing Paper No CBP07480, 4 Dec 2020: "Electric vehicles and infrastructure").

[48] New EU regulatory framework for batteries, European Parliament, July 2021.

- Regulation, incentives, and investment have complementary roles in creating the ecosystem needed to effectively deal with used EV batteries

Ethics of raw materials sourcing for battery production

MYTH #8 The mining of raw materials used in batteries is unethical. **PARTLY TRUE** – there are still important ethical issues associated with certain materials but the industry is looking to move away from those causing harm. It is recognised that as EV numbers grow it will be paramount to stop using these materials or to develop alternative and more sustainable methods for their extraction.

A United Nations Report[49] highlighted the urgent need to tackle both the impact of an expected EV battery production boom, and to address the social and environmental impacts of the extraction of raw materials, including human rights abuses. The EV industry has already made considerable progress in reducing the amount of cobalt used in some lithium-ion battery chemistries, and certain types of EV batteries use no cobalt at all. Research is underway to find alternative means of extracting lithium, for example from seawater. New battery chemistries that use completely different materials, such as silicon, are under development. While some years from production, there is a reasonable expectation that lower-impact EV battery technology will become available in the near future.

Nickel-manganese-cobalt (NMC) continues to be the dominant chemistry for EV batteries. Demand for raw materials, while increasing significantly over the coming decade, will fall as a proportion of each kWh of lithium-ion battery manufactured due to improvements in battery manufacturing technology and chemistry improvements which will drive down the amount of critical raw materials needed. According to T&E[50], the average amount of lithium may fall by half – from 0.1 kg/kWh in 2020 to 0.05 kg/kWh by 2030. For cobalt, where there is a trend towards lower and even no-cobalt battery chemistry, the average amount could fall by three-quarters from 0.13 kg/kWh in 2020 to 0.03 kg/kWh by 2030.

The House of Commons Public Accounts Committee published a report[51] in May 2021, encouraging the automotive industry to maintain proper environmental and social standards throughout supply and recycling chains as the zero-emission car market grows.

The Committee recommended that the DfT and the Department for Business, Energy & Industrial Strategy should set out their approach to encouraging car manufacturers to

[49] Commodities at a Glance: Special issue on strategic battery raw materials, UN Conference on Trade and Development – UNCTAD, 2020
[50] "From dirty oil to clean batteries. Batteries vs. oil: a systemic comparison of material requirements" study, T&E, March 2021: From dirty oil to clean batteries. Batteries vs. oil: a systemic comparison of material requirements
[51] Low emission cars, House of Commons, Committee of Public Accounts, First Report of Session 2021-22, May 2021

maintain proper standards throughout their supply and recycling chains. They recommended that the industry should;

- Publish information on lifecycle emissions;
- Provide details of relevant reporting standards on environmental and social stewardship; and
- Outline future plans to develop reporting standards.

On 10 December 2020, the European Commission (EC) proposed its first ever sustainable battery law, aiming at ensuring that 'only the greenest, best performing and safest batteries make it onto the EU market'. In its proposed regulation, the EC has asked for the implementation of mandatory due diligence standards based on the Organisation for Economic Co-operation and Development's (OECD) Due Diligence Guidance for Responsible Supply Chains[52] of lithium, nickel, cobalt, natural graphite and of chemical compounds necessary for the manufacturing of the active materials of batteries. This will apply to the global supply chains of batteries placed on the EU market, and so will have a global impact.

Procurement has an important role to play in ensuring transparency of EV battery supply chains. Requirements attached to tender specifications could relate to mandatory reporting and disclosure, together with the need for verifiable action plans to reduce dependency on sourcing unsustainable materials and the ending of unethical practices such as child labour. The GLA's Responsible Procurement Implementation Plan (RPIP; published in September 2021) commits the GLA family to:

> **"Continue to collaborate with partner organisations, such as the Ethical Trading Initiative and Electronics Watch, to improve supply chain transparency of the mining and manufacturing of minerals used in the provision of batteries for electric vehicles with respect to socio-economic and environmental impacts."**

Given the international nature of EV battery supply chains, and the importance of standards and regulations to improve suppliers' environmental and ethical performance, it will be necessary for the UK to adopt legislation that mirrors future changes made to relevant EU regulations. The Mayor will ask Government to accelerate its response to the current ethical issues associated with EV battery supply chains, and lobby for the urgent implementation of standards, governance and legislation.

[52] Organisation for Economic Co-operation and Development

Summary:

- Manufacturers should be encouraged or required to publish information on life cycle emissions and ethical aspects of their supply chains
- Reporting standards should be transparent and standardised/ consistent
- Regulations (such as for batteries) can require mandatory due diligence standards of global supply chains. The UK will need to mirror future EU regulations in this area
- Procurement has a role to play in ensuring transparency of EV battery supply chains through leverage from appropriate clauses and requirements in tender specifications

Charge point user experience

A number of pain points for users of EV infrastructure were identified in the 2019 Delivery Plan, and, as EV uptake has accelerated, some of these have become more pronounced for users.

Awareness

EV charging is inherently different to refuelling petrol and diesel vehicles and will require a step change in behaviour as EV adoption accelerates. LTDS data[53] shows us that 76 per cent of car owning households in London have access to off-street parking, so could in theory charge at home. This is an average percentage and in reality the proportion with off street parking varies considerably from borough to borough.

Awareness of the location of infrastructure is often limited. Location, how to register with operators and how to use infrastructure are among issues cited as areas of confusion for users. Research has shown that users value the ability to easily locate infrastructure when refuelling is required[54] – opening up charge point data is key to this through the development of consumer-friendly apps, improving the customer experience and encouraging innovation.

An important initial step to improve consumers' awareness and knowledge of EVs and EV infrastructure is make sure information is readily available on how the technology works, how and where to charge, what models are available, costs, and where to find more information[55].

Availability

Whether charge points are working and available is also a concern for many drivers. Maintenance and reliability of infrastructure are imperative to keeping confidence in the

[53] London Travel Demand Survey (LTDS) 2016/17, as reported in Travel in London Report 12, 2019
[54] The consumer experience at public chargepoints, DfT, 13 February 2021
[55] Driving and accelerating the adoption of electric vehicles in the UK, Behavioural Insights Team and Transport Research Laboratory on behalf of DfT and OZEV, 2021

network. TfL's contracts for delivery of infrastructure mandate a minimum of 97 per cent reliability with CPO, and in future delivery we will seek to maintain or improve on this.

Affordability

Users are often unsure of how much they will be charged due to the disparity between providers and between the different costs at different times of the day. Consumers should be able to understand and compare pricing across all of the UK's charging network to enable them to make informed decisions about price, as is currently the case for petrol and diesel. Standardisation of tariffs to a pence-per-kilowatt hour basis would enable a simple, consistent pricing framework. This would also help users compare the cost of at-home charging with the public charging network.

While rapid and high-power charging is appropriate for many users and journey types by EV, this solution can be more expensive, particularly versus home charging. Unless rapid charging hubs are built with battery storage to buffer high energy demand, there may be significant loads on the electricity networks, sometimes coinciding with other peaks in demand.

Currently, users who are unable to charge at home face higher costs at public charging infrastructure. This is due in part to higher rates of VAT applied to public charging infrastructure, at 20 per cent, compared to electricity at home which sits at five per cent[56]. Addressing this would help to reduce the cost of public charging for EV users.

Some CPOs now also provide preferential charging rates to some key user groups including taxis and private hire vehicles (PHVs). Through our engagement with operators through the London Charge Point Operators' Forum, set up in 2019 to promote better standardisation and interoperability of systems, we will continue to work closely to improve the overall user charging experience.

Accessibility

To use a public charge point, customers typically need to download an operator specific app, go to a website or have a pre-registered RFID card that will allow a charge to start by tapping against the reader, but this account also has to be managed online. Nine CPOs in London have delivered nearly all the charge points in London, and all require a different app, website or RFID card for a user to initiate a charging session. The lack of interoperability between providers is cited as a major barrier and makes charging less convenient than refuelling a conventional vehicle.

Users should be able to charge and pay with ease as they would for any other service. TfL's 300 rapid charge points across London have a standardised requirement for all charge points to provide pay-as-you-go payment options at the terminal to improve the customer experience and enable use of infrastructure without having to rely on smartphones. A roaming solution would provide access to all charge points through one membership card or app. As smartphone technologies advance, it is preferable to move towards having fewer apps that can access the entire UK ChargePoint network.

[56] Zero Emission Vehicles, House of Commons Transport Committee, First Report of Session 2021-22

Accessibility, in terms of design of charge points, is also a key consideration to ensure charge points are fully inclusive and can be used by drivers with disabilities or those driving larger vehicles such as vans. Different vehicle types have different charging needs. Some vehicles cannot be charged at certain locations due to cable length, charger position or vehicle size. The DfT has commissioned the British Standards Institution to develop accessibility standards for EV charge points across the country, which will provide the industry with guidance on how to make individual charge points more accessible. The guidance will consider aspects such as kerb height, adequate space between bollards, and charge points being of a height suitable for wheelchair users[57]. The guidance will also provide a new clear definition of 'fully', 'partially' and 'not' accessible charge points to be communicated to users.

[57] UK Government partners with disability charity to set standards for electric vehicle chargepoints, 2021

Chapter 3 – EV user requirements

3.1. Understanding EV users

Given our commitment to mode shift towards walking, cycling and public transport in London, it is crucial that, while encouraging and facilitating a switch to zero-emission vehicles, we do not encourage avoidable car use. Our focus is therefore on key EV user groups who make essential trips, in particular high-mileage trips, as this will also be where the biggest emissions reductions will be achieved.

Within this chapter, we set out our understanding of the EV user requirements for key user groups and the locations and type of infrastructure required to support them to switch to EVs. The key user groups we have identified are:

- Taxi drivers
- Private hire vehicle (PHV) drivers
- Emergency service vehicles and public sector fleets
- Light goods vehicle (LGV) drivers
- Car club users

The focus on these user groups reflects their relative priority to this strategy, with these vehicles typically used for much higher annual mileage than the average private car owner in London. The exception to this is car club users, whose needs are being prioritised in recognition that convenient EV car club use can provide an alternative to private ownership of petrol or diesel vehicles. Intervention and investment to accelerate these key user groups to switch to EVs in the short to medium term will make a significant contribution to reaching zero emission road transport. A key priority emerging from this strategy is the need to expand over time our evidence base and insight on all key user groups.

For those remaining necessary trips by car, it is important that sufficient infrastructure is in place to support them being made by the cleanest possible vehicles so an understanding of private car drivers' requirements are also covered within this section.

We have updated previous work on specific user needs undertaken for the 2019 Delivery Plan through engaging stakeholders and EV infrastructure taskforce members, as well as looking at TfL's data and wider studies of EV use in London and beyond.

Taxis

Taxi drivers

Since 1 January 2018 all newly licensed taxis must be zero emission capable (ZEC). We have seen considerable growth in the ZEC taxi fleet, as a result of licensing requirements, grant incentives and delicencing payments. Around one third of London's taxi fleet is now ZEC.

As of 7 December 2021, the number of active licenced ZEC taxis is at 4,791, including 108 fully electric taxis. From 2019 to 2020, the number of licensed ZEC taxis increased by over 70 per cent. Around a third of the active taxi fleet is now ZEC or fully zero emissions. Many taxi drivers live in less densely populated parts of London with a majority living in east London and, to a lesser extent, southeast London, as

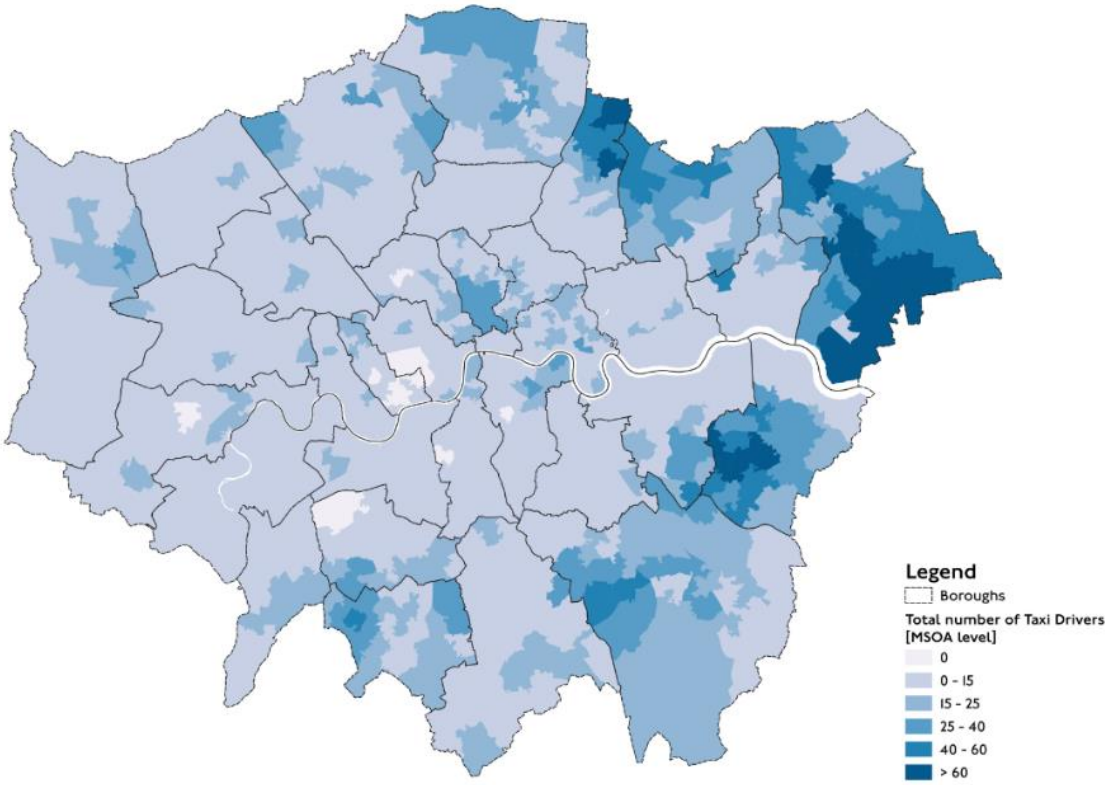


Figure 14 shows. We are able to compare this to where current ZEC taxi vehicles are registered in which unsurprisingly coincides with areas where higher concentrations of taxi drivers live.

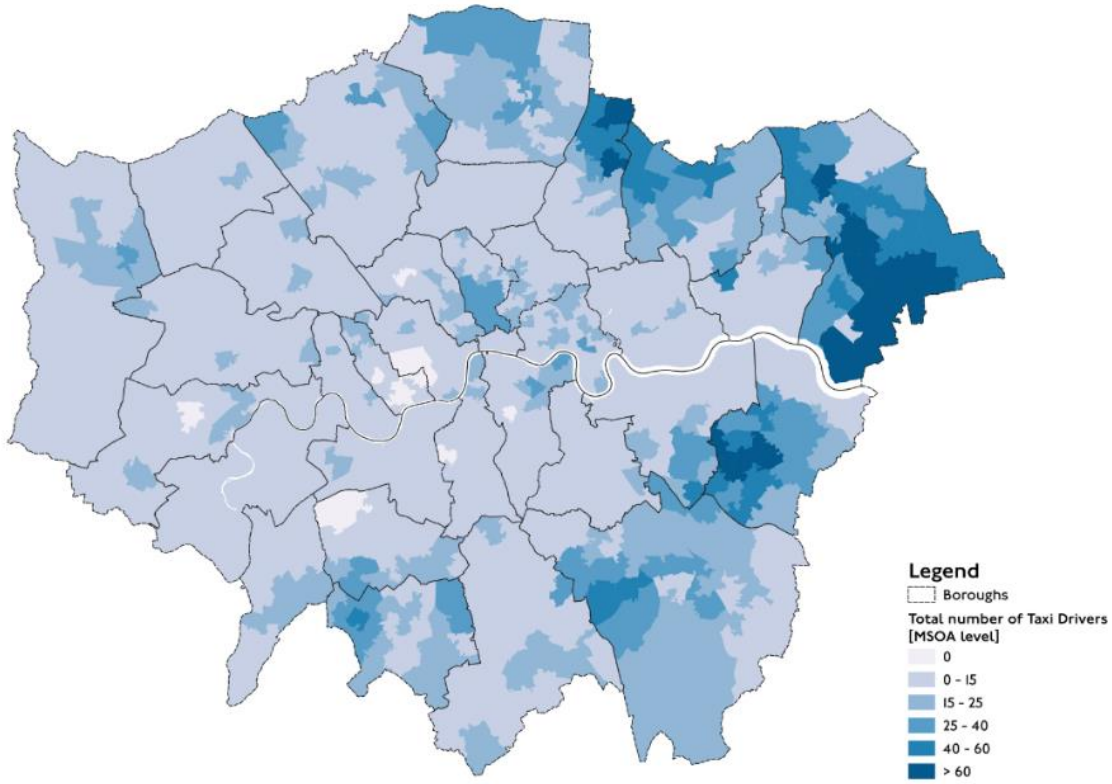
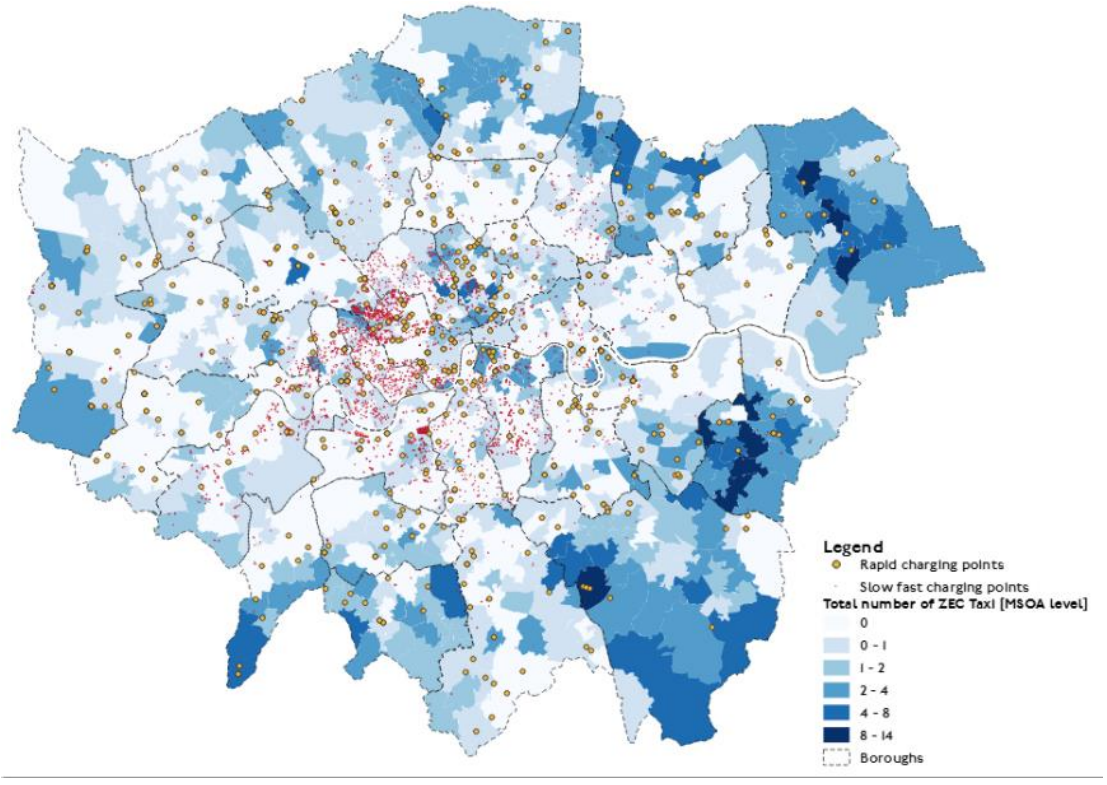


Figure 14: Spatial distribution of registered taxi drivers in London[58]



[58] TfL, July 2021 data

Figure 15: Spatial distribution of registered ZEC taxi vehicles in London and current distribution of charge points in London[59]

Slow-to-fast charging needs

Taxi drivers who are able to charge overnight (or between shifts) at or near home are likely to want to continue to do so, as current rapid charging speeds mean that time may otherwise be lost in their working day. As more taxi drivers choose to switch to BEVs with greater battery range (and, accordingly, longer charging time) than the current range-extended models, this demand for slow-to-fast charging at or near to home is set to grow.

As many as three in four drivers of taxis licensed to operate in London live in outer areas, where more households have private driveway access and therefore the option of home-based charging. However, there are still many drivers in these locations who do not have this option, as well as significant numbers of drivers who live in other areas of London where very few households have off-street parking[60]. For example, there are more than 300 drivers living in areas of Islington where fewer than 20 per cent of households have a driveway.

Rapid charging needs

While access to public slow-to-fast charging is crucial to support close-to-home overnight charging for drivers who do not have access to driveways, it will not be a complete solution for taxi drivers who drive an average of 98 miles per work day[61]. LEVC taxis in London have a pure electric battery range of around 63 miles (with a petrol range extender increasing the range to more than 300 miles)[62] and currently represent 95 per cent of the zero emission capable (ZEC) taxis licensed to date. As a result, a lot of our focus until now has been on providing rapid charging to enable drivers to maintain zero-emission travel throughout their shift.

Convenient access to rapid charging points for taxi drivers is needed across London to provide drivers with confidence that charge points are accessible, reliable and available when needed. Patterns of existing rapid utilisation and engagement with the industry highlight that the greatest demand for additional rapid charging will be within and around central London, where most taxi drivers work. This is supported by taxi survey data shown in **Error! Reference source not found.** which illustrates the strong concentration of trips to and from locations in this area.

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[59] TfL, July 2021 data
[60] Based on analysis of driveway access using London Travel Demand Survey Data and taxi driver license information.
[61] A feasibility study into a rapid charge point network for plug-in taxis, Energy Saving Trust for TfL, 2016
[62] LEVC, TX Electric Taxi overview

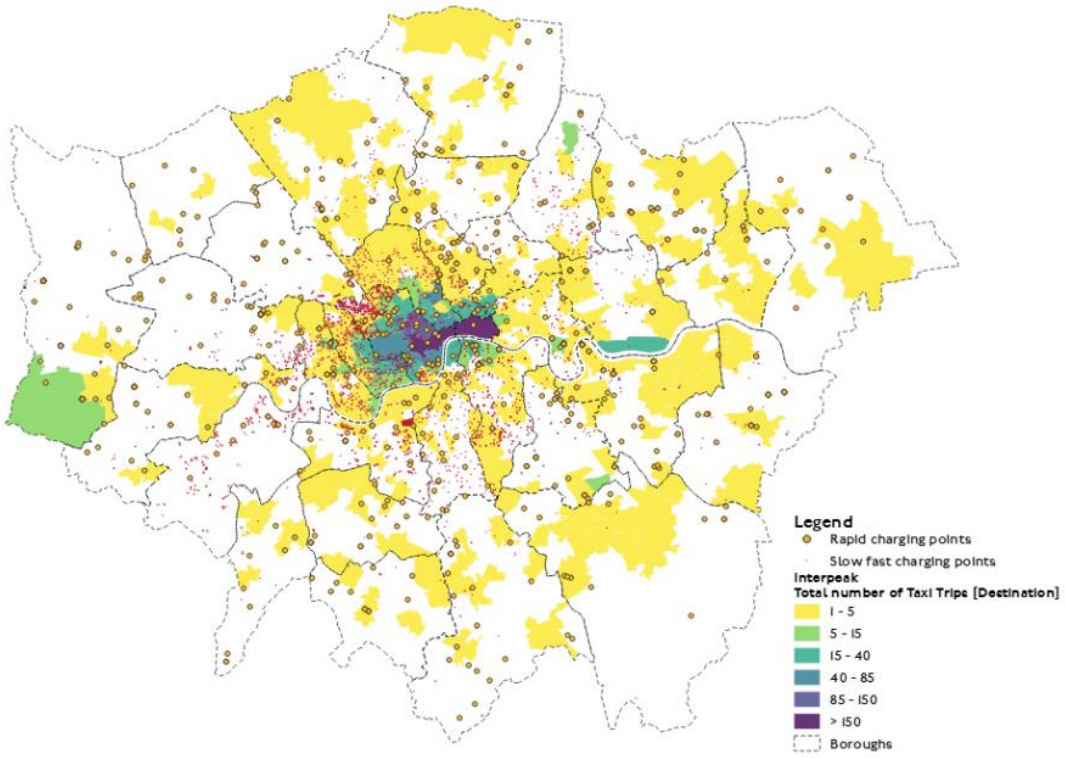


Figure 16: Heatmap of major taxi trip destinations[63]

Rapid hubs in particular will provide access to fast and available charging with multiple charge points in known locations and will also continue to be delivered in suitable locations where taxi drivers operate.

Other key locations will include those where drivers are able to top-up before a shift, during planned breaks or between rides. These include:

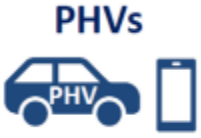
- Sites on or adjacent to major arterial routes into the centre of London and inner orbital routes (including the North and South Circular)
- Locations on route / close to Heathrow and London City airports
- Locations near taxi ranks
- Other town centre locations where drivers have other tasks to do while charging.

In response to concerns raised by the taxi trade that some dedicated rapid charging bays are being misused, TfL has used CCTV to monitor taxi-only rapid charging bays to understand the extent of non-compliance. To date, this has revealed very little evidence of non-taxi use. However, TfL is working with CPOs to explore technological solutions (in addition to current patrolling by traffic enforcement officers) to ensure continued compliance of these bays.

Summary:

[63] Source: London Taxi Driver Survey, TfL

- Many taxi drivers live in less densely populated parts of London with a majority living in east and, to a lesser extent, southeast London
- There is lack of slow-to-fast charge points in more residential areas in outer London suburbs where drivers lack access to driveways.
- Drivers require a rapid charging top-up during a shift in key taxi demand areas, particularly in central London
- The public rapid charging network should be expanded to other areas outside central London where demand from taxi drivers is also expected around key hotspots such as town centres, and Heathrow airport.



Private hire vehicles

PHV drivers are among the highest mileage drivers working in London. An average London PHV travels up to eight times the distance in a year of a typical private car. And even with a fuel-efficient hybrid vehicle, tailpipe emissions at this mileage are up to five times those of an average London-based petrol car[64].

The PHV trade saw a record number of vehicles licensed in 2019 with a peak of 94,712 that year. It has since declined to around 77,700 for the year 2020/21[65] as a result of the impact of the coronavirus pandemic. The volume and geographic spread of PHV licences across London differs from taxi licences, with a higher clustering of drivers around the northwest, south (around Croydon) and northeast London boroughs, as shown in Figure 17.

[64] Based on a typical annual distance travelled of 60,000km per London-based PHV and 5,000km per London based car and vehicle CO2 emissions calculated by the 2018 ICCT 'Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions' study.
[65] TfL TPH Licensing Information (2021)

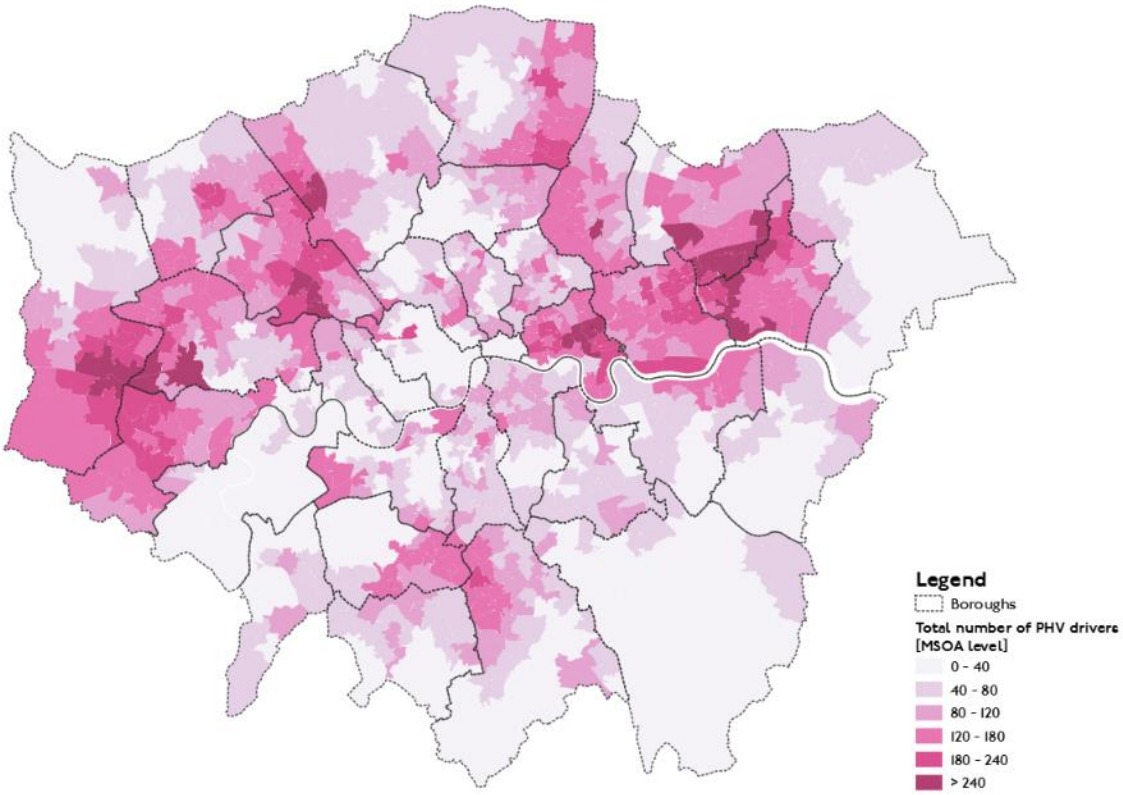


Figure 17: Spatial distribution of licensed PHV drivers in London[66]

The Mayor and TfL cannot limit the number of licenses issued to PHVs but are able to set the requirements for those operating in London. TfL's licencing requirements differ for PHVs than for taxis; currently, only PHVs less than 18 months old and being licensed for the first time in London need to be ZEC. As of January 2023, all newly licensed PHVs will need to meet this standard. There has been an enormous increase recently in the proportion of ZEC PHVs being licensed. In September 2021, 89 per cent of PHVs registering for a licence were ZEC, compared with 55 per cent in October 2020.

Currently, 18 per cent of the whole PHV fleet are estimated to be compliant with the PHV ZEC requirement[67], almost 5 per cent of these are pure electric and around 13 per cent ULEV with 75g or less CO_2 and so maybe less reliant on charging infrastructure than full electric.

Several of London's major PHV operators have pledged to support their drivers in the switch to EVs, setting themselves challenging targets for electrification. This includes two of London's largest PHV operators, Uber and FREENOW, who both state that all rides booked through their platforms will be delivered using ZEC vehicles by 2025 – with Uber

[66] Source: TfL, July 2021 data
[67] TfL licencing requirement – emission standards, 2020

aiming to deliver a 100 per cent BEV fleet by then[68]. Addison Lee has also stated that it will switch its fleet to fully EV by the end of 2023.

With approximately 45,000 drivers working for Uber alone, meeting these pledges will require that well over half of London's PHVs are EVs by 2025 – with most of these BEVs.

Progress so far, though, has been modest, with BEVs comprising approximately five per cent of the PHVs licensed in London[69]. Achieving these ambitions will therefore require a substantial effort to incentivise drivers to switch, ensure there are sufficient vehicles available and provide necessary charging infrastructure.

Slow-to-fast charging needs

With the average PHV travelling more than 100 miles each day, being able to start a shift with a full charge is likely to be highly desirable for many drivers. Until vehicles can be charged quickly using ultra-fast charging, drivers are likely to seek to charge vehicles overnight to avoid lost working time.

PHV drivers are typically less likely than taxi drivers to have access to private off-street parking to enable them to charge with a private connection. More than two-thirds of London's PHV drivers live in areas where less than half of households have access to private parking[70].

Although London's PHV drivers are dispersed across the city, there are some key locations where large numbers of drivers live and where public charging needs are expected to be high:

- Inner east London – and especially within the boroughs of Tower Hamlets, Newham, Barking and Dagenham and Redbridge
- West London – particularly within Brent, Ealing, Hillingdon and Hounslow

Rapid charging needs

The high daily mileage travelled by PHV drivers requires that access to rapid charging to top-up battery levels will be an important component in the charging mix.

As with London's taxi drivers, we expect most PHV drivers to charge during break periods or between rides. Locations identified for taxi drivers are therefore likely to be similarly suited to PHV drivers.

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[68] Details on Uber's pledge, announced in 2018, are available at: https://www.uber.com/en-GB/newsroom/uber-helps-london-go-electric/.
Free Now's pledge, announced in 2021, can be found here: https://free-now.com/uk/green-pledge/
[69] PHVs licensed by TfL to operate in London as of September 2021.
[70] Based on TfL licensing information on registered drivers and TfL analysis of driveway access.

Central charging locations, in particular, are likely to be in high demand, with TfL analysis suggesting that up to 40 per cent of traffic within central London is made up of PHVs at certain times[71]. However, a key difference between taxis and PHV trips is that the latter are less concentrated within central and inner London. Access to rapid charging outside central areas, particularly at city or town centres within London, or other key destinations, is likely to be highly important.

Summary:

- Rapid charging is expected to play a key role for this user group, with a requirement for access to rapid charging outside of central London
- A number of locations with high numbers of licensed PHV drivers are significantly underserved with close-to-home public charge points, particularly in boroughs such as Hillingdon, Hounslow, Ealing and Tower Hamlets

Emergency services and public sector fleet vehicles

Electrifying emergency services vehicles brings many challenges. These include the wide variety of specialist vehicles across the fleet, such as ambulances and fire engines; the specific operational characteristics (vehicles are often in operation 24 hours a day), the wide geographic spread of vehicle depots; and the variety of trip lengths and destinations across London. Engagement with stakeholders revealed vehicle utilisation is at an all-time high, with many response vehicles not returning to base for up to 24 hours which makes duty cycles for EV charging difficult to plan for.

Many emergency services vehicles operating in London are overseen by the GLA, including those from the London Fire Brigade and Metropolitan Police Service. These fleets must comply with their Memorandum of Understandings with TfL for achieving compliance with the Ultra Low Emission Zone, and the Mayor's commitment[72] that all cars in the GLA fleet must be fully ZEC *by* 2025. This commitment also states that all newly purchased or leased cars and vans be ZEC from 2025, and that heavy vehicles must be fossil fuel free from 2030. The GLA fleet equates to more than 5,000 vehicles, many of these being heavy or specialist vehicles.

Heavy vehicles, in addition to needing more space to park during charging, will require higher power levels. Standards for high power charging for commercial vehicles are being developed alongside new charging connectors that may differ to those for conventional vehicles. EV requirements for heavy vehicles and buses are therefore out of scope of this

[71] As reported in TfL's Travel in London, Report 12, (2019)
[72] Mayors Transport Strategy, 2018-Proposal 32.

Strategy (as set out in Chapter 0) where they are not expected to rely on public charging infrastructure to meet their needs due to the specialist infrastructure required.

Studies commissioned by the GLA suggest emergency services and public sector fleets will not be able to accommodate 100 per cent of EV charging requirements within their own estates (as with many commercial fleet operators), due to space constraints, but also grid capacity constraints for upgrading existing energy supplies. TfL is also working on a fleet electrification project that looks to electrify TfL's support fleet of approximately 1,000 vehicles. It will identify the associated charging infrastructure needed to support this and explore whether TfL land can accommodate these requirements.

Furthermore, due to the 24-hour operation of emergency response vehicles within these fleets, resilience plans are required even where charging requirements can be accommodated in the event of site power failure or another disruptive event.

Ad-hoc public or shared access (either with another GLA Group fleet or private sector fleet) to rapid charging infrastructure should therefore be considered as a priority for this user group to support their transition to EVs. With larger or specialist vehicles such as an ambulance or fire engine, practical considerations of space should also be a factor at public charging points where a standard dimension bay will not be sufficient.

Engagement is also taking place with relevant local authorities to identify suitable on-street parking bays close to vehicle depots which could provide an opportunity to support emergency service and TfL fleets if charge points (either slow-to-fast or rapid depending on requirements) are installed. We are also exploring opportunity to upgrade road and river EV charging requirements at the same time, where river charging needs are close to road upgrade opportunities.

The Public Fleet Charging Study 2021 carried out by Element Energy on behalf of the GLA looks at the requirements and challenges of charging electrified public sector fleets – looking at opportunities to utilise shared infrastructure. The study highlights that most of the fleets studied are unable to offer use of their depots due to the operational and space constraints – however fleets that are within a short distance of one another could allow for a co-ordinated charging strategy to improve efficiency. There is high potential for future electrified fleets to use public rapid hubs in locations that are in close proximity to fleet depots, even more so as the rapid charge network is expanding across London; engagement with hub operators needs to be considered to ensure site design is appropriate and usable by the electrified fleets.

Summary:

- Emergency services vehicle utilisation is at an all-time high with many response vehicles not returning to base for up to 24 hours – this makes duty cycles for EV charging difficult to plan for

- Access to public rapid charging infrastructure on an ad-hoc basis in strategic locations across London will be required to support the transition of emergency services and public sector fleet vehicles to EVs

- The use of GLA estate should be considered to enable shared infrastructure access to support public fleets' EV charging requirements

Light goods vehicles (LGVs) Drivers

There is a wide range of different users who drive LGVs on a daily basis. These can be broadly split between those who are part of a company fleet, and those who own their own vehicles for commercial use. For the purposes of understanding user requirements, it has been assumed that typically privately owned LGVs return home at the end of shift and will require either residential private charging or public on-street infrastructure. Company fleet vehicles on the other hand are assumed to typically return to a depot location at the end of shift to fulfil charging requirements. Of course, there will be exceptions within these broad assumptions.

There are now around 650,000 LGVs registered in the southeast (many of which may travel into London) and more than 200,000 in London[73]. Sixty-two per cent of LGVs in London are registered to a business and make up 75 per cent of total van kilometres. This suggests that the EV charging requirements for this group, particularly rapid charging, are going to be considerable. Figure 18 shows the spatial split of registered LGVs in London with Hillingdon accounting for the highest proportion of van registrations, around 10 per cent, which could be due to its proximity to Heathrow airport. Other boroughs with considerable LGV registrations include:

- Croydon
- Bromley
- Ealing
- Brent
- Enfield
- Havering

Figure 18 should be interpreted with caution, noting the split mentioned above that more than half of those LGVs are registered to businesses. This could mean that vehicles are registered at head office locations but are not stabled or returned to these locations on a daily basis, so this does not directly translate to EV charging requirements. We are looking to overcome challenges of understanding the public EV charging requirements of LGV drivers and explore this further in section 6.4.

[73] DfT Van Survey (2020)

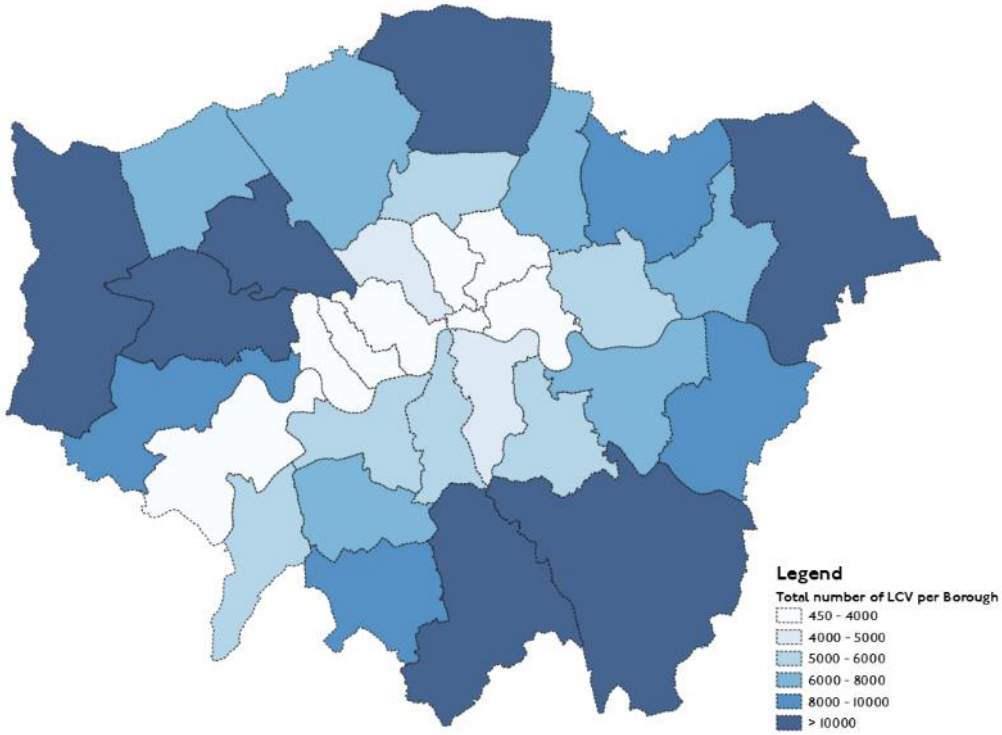


Figure 18: Registered LGVs in London[74]

Progress to date in the electrification of London's LGVs has been modest but is expected to significantly accelerate as more vehicles become available. The sales uptake used for our analysis assumes between 12,500 and 28,000 EV LGVs will have been registered in London by 2025, compared to fewer than 1,500 in 2020.

TfL/GLA are engaging with commercial fleets to explore last mile/consolidation hubs opportunities. TfL is also currently researching ways of using vacant land or re-purposing land resulting from the pandemic to identify opportunities for LGVs and more widely the logistics sector as part of the green recovery.

Engagement with this sector revealed the biggest issue remains availability and range of EV models to purchase or lease. Small businesses are finding it particularly difficult to access vehicles, with large batch orders placed directly to manufacturers from multi-national fleets.

Privately owned LGVs

Of the 38 per cent of vans in London that are privately registered, slightly more than half are used for business purposes[75]. It is difficult to draw conclusions on travel trends and charging needs for these vehicles as many may be registered to an address that the vehicle does not regularly operate from or to.

[74] Source: Registration Data, SMMT, 2021
[75] SMMT Registration Data (2021)

Stakeholder engagement reveals that LGV owners face a similar challenge to that of PHV drivers with regard to charging, as they also have limited access to off-street parking and higher dependency on public charging for slow-to-fast overnight charging. These drivers are also typically high-mileage users, on average travelling up to 12,800 miles per year[76], who may need to charge during their shift at rapid charge points to top-up or 'graze' at destinations they are serving.

Van trips are typically less concentrated towards central London than those of some other priority user groups, with most in outer London. Additionally, there are significant numbers of LGVs travelling into Greater London from across the UK, but especially the southeast, with many of these vehicles likely to require top-up charging.

Stakeholders expressed the view that charging needs for this group are likely to change over time, with slow-to-fast public charging the priority in the short to medium term. However, rapid charging is likely to increase within the next 10 years as the economics of rapid charging become closer to those of refuelling petrol or diesel vehicles today (in price and time).

Depot stored LGVs (return-to-depot)

The distances travelled and private charging options available to this group also vary considerably. There is limited data available on the group's specific travel behaviours, which makes it challenging to define the public charging requirements to support their transition.

Engagement with this sector sought to update the findings of the 2019 Delivery Plan which stated that fleet owners are likely to seek their own private depot-based charging solutions where space allows and minimise use of public charge points. However, it is now apparent that many of these fleets are not able to accommodate 100 per cent of their fleet charging needs, mainly due to spatial constraints of their sites. In this instance, fleet managers are looking to explore innovative solutions to increase the charging capacity of their depots and reduce costs.

Engagement also revealed that many fleets operating across London with multiple sites do not cover high-mileage distances and so daily charging may not be necessary. However, with businesses wishing to minimise time lost to charging during a shift, fleet operators are likely to prioritise access to rapid charge points.Smaller businesses are most price sensitive in their charging decisions and will require greater access to public slow-to-fast charging or destination charging while out on business. There was consensus among the representatives engaged that fleet operators and businesses are likely to need confidence that there are sufficient options available to charge in order that they have long-term certainty to encourage the switch. EV charging hubs, with a mix of charge point speeds, will play an increasingly crucial role in providing efficient and accessible infrastructure to the commercial fleet sector.

Space requirements to accommodate larger vehicles at public charging locations was also emphasised. This should be taken into consideration at the planning stages, as well as ensuring locations are open for charging at all times of day. Some public charging

[76] Light Commercial Vehicles- Delivering for the UK Economy, SMMT (2019)

locations, for example at council leisure centres or shopping car parks, are closed overnight, limiting their usefulness. More work is required to understand the travel behaviours, location and size of these fleets to establish user requirements and to ensure infrastructure delivery is prioritised to adequately support this user group to switch to EVs.

Summary:

- Limited access to off-street parking for privately registered LGVs will result in a higher dependency on public charging for slow-to-fast overnight charging in the next five years
- LGV users will look more towards rapid charging to fulfil their charging requirements in the long term
- Fleet managers are looking to explore innovative solutions to increase the charging capacity of their depots and reduce costs
- EV charging hubs will play an increasingly crucial role in providing efficient and accessible infrastructure to the commercial fleet sector. Space requirements to accommodate larger vehicles at public charging locations also need to be considered
- More work is required to understand the travel behaviours, location and size of these fleets to establish user requirements and to ensure infrastructure delivery is prioritised to adequately support this user group to switch to EVs

Car clubs

Car clubs provide a temporary option for individuals to hire a car, either on a round trip of flexible basis and may encourage Londoners to give up their cars and free up space for more active, sustainable, and efficient modes, while still providing access to cleaner cars for infrequent travel in London and beyond. They are a formed of shared transport and the Mayor, through TfL and the boroughs, will support the provision of car clubs for residents when paired with a reduction in the availability of private parking to enable Londoners to give up their cars while allowing for infrequent car travel (proposal 19 of MTS). London has one of the largest car club networks in the UK, in terms of fleet size and membership, with more than 450,000 members[77]. Car clubs offer a convenient solution for customers, which could be less appealing if the vehicles need to be charged during a booking and if reliance is wholly on the availability of a public infrastructure charging system to do so.

Car club operators that are incorporating EVs into their fleets have thus far mainly relied on the public rapid charging network, with a dedicated member of staff charging vehicles, typically overnight when the demand for charge points is at its lowest. The map in Figure 19 shows the most used rapid charge points in London by one of the biggest car club

[77] Driving London Forward, CoMOUK (2020)

networks. This is considered the most efficient way to recharge the fleet and minimise downtime. The decision not to ask members, for the most part, to recharge vehicles is due to the potential inconvenience of travelling to find a charge point and the limited geographic spread and volume of rapid chargers, meaning that members could be forced to use slower charge points, with potential delays to their journeys. This would detract from the convenience of the car club business model.

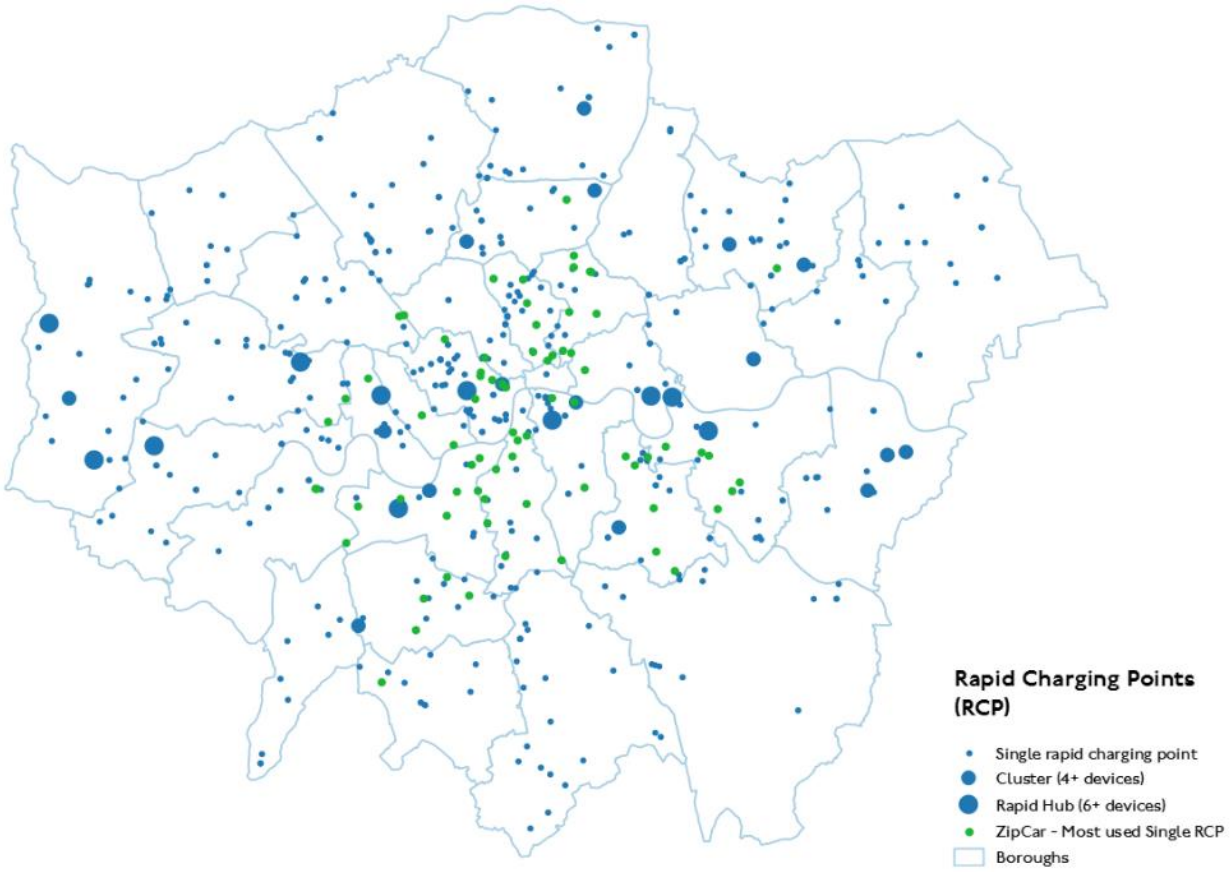


Figure 19: Rapid charge points most used by Zipcar[78]

The current approach to charging the EV car club fleet is only possible due to the relatively low number of EVs. As this continues to grow, it will not be economically viable to have staff making daily trips to re-charge EVs overnight, in addition to the added mileage and traffic this contributes to London's roads. Ultimately, there needs to be an adequate volume and distribution of rapid charging infrastructure across London to support car club users to recharge at the end of a trip, or in the case of a higher mileage trip, on-route charging.

Summary:

- There needs to be an adequate volume and distribution of rapid charging infrastructure across London to support the car club fleet. This applies particularly to

[78] Data provided by Zipcar, November 2021

south and southeast London where there is a high density of car club users, and across the expanded ULEZ in inner London[79]

Considering the needs of private car owners

We recognise that, for many in London, car use for some trips will still be necessary. We have therefore considered how best to support a more widespread switch to EVs in this Strategy, in line with the wider objectives of the Mayor's Transport Strategy. Car ownership varies significantly across London with only 40 per cent of inner London households having access to a car, compared to 70 per cent in outer London where there is greater access to off-street parking (see Figure 20).

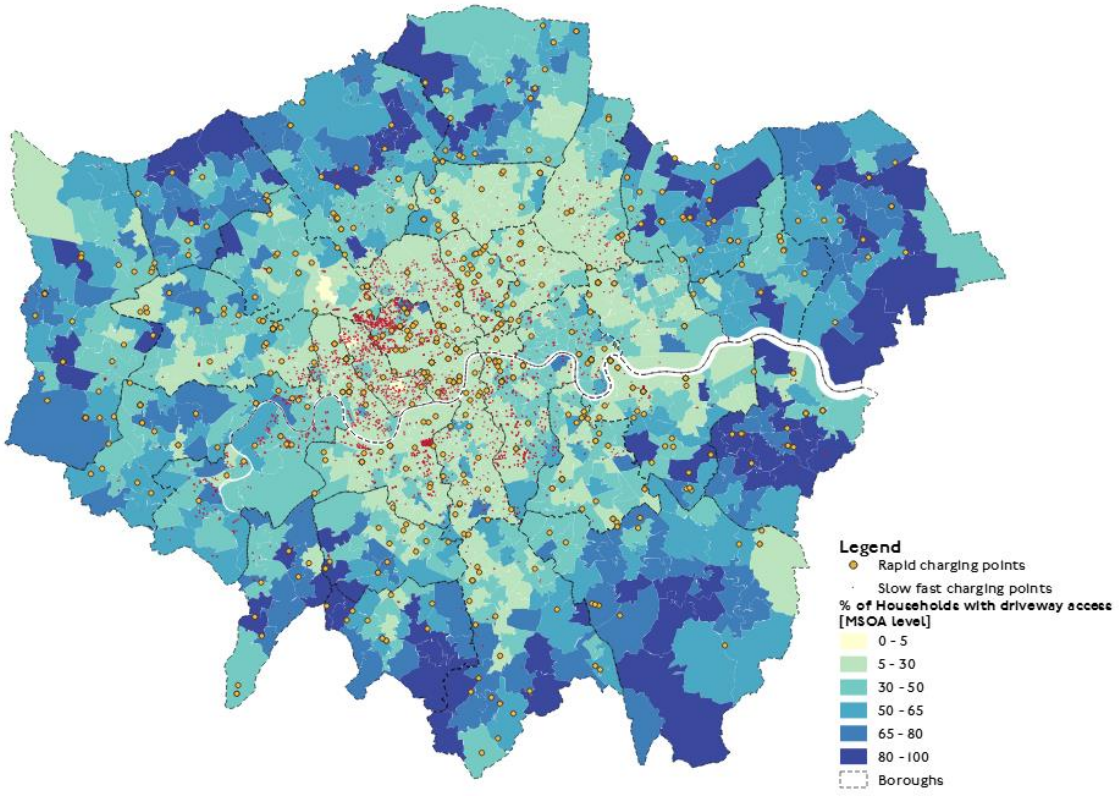


Figure 20: Percentage of car owning households with access to a driveway and current distribution of public charge points across London[80]

EV uptake among private car owners is illustrated in Figure 21, using a reference of households rather than absolute numbers to ensure analysis reflects car ownership levels. It shows that, uptake of EVs has been highest in west and east London boroughs, particularly in the boroughs of:

[79] Como UK, Car Club Map. 2021
[80] Source: TfL LTDS, ZapMap, London DataStore (2021)

- Redbridge
- Waltham Forest
- Newham
- Barking and Dagenham
- Brent
- Ealing
- Hillingdon
- Enfield

Figure 21 also illustrates the large concentration of slow-to-fast charge points in the boroughs with the highest absolute numbers of EV uptake, such as Westminster, Kensington and Chelsea and Hammersmith and Fulham, illustrating the demand-led approach to delivery of infrastructure to date to predominantly serve these private EV owners. This also confirms the findings of the 2019 Delivery Plan, which stated that most private users without access to off-street parking will rely on near-to-home slow-to-fast charging to meet their charging requirements. Engagement with CPOs has revealed that drivers who rely on on-street residential charging infrastructure are typically charging once to twice a week to meet their requirements.

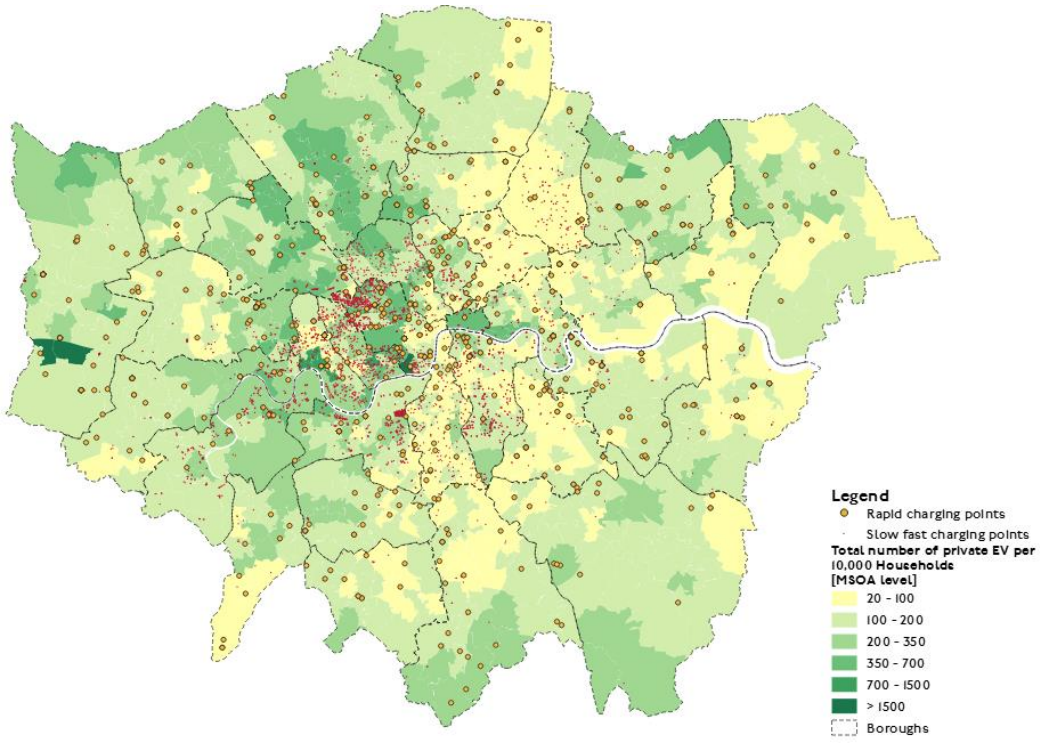


Figure 21: Privately registered EVs per 10,000 households and public charge point locations in London[81]

Modelling indicates that, on average, car owners in London drive fewer than seven kilometres on a typical day, suggesting that drivers are unlikely to need to charge their vehicles more than once or twice per week. There are of course variations in the average daily distances travelled, with some boroughs having higher daily mileages and trip

[81] Source: SMMT, 2021

lengths. Kingston-upon-Thames and Richmond-upon-Thames are two of these boroughs, with average daily mileages up to nine kilometres. In areas of London, particularly the southwest and east, where drivers tend to travel further and more frequently by car it will be important for drivers to be able to access convenient charging more regularly. These are areas where provision of public charging infrastructure is currently more limited.

Focus for public charging provision will be required in denser residential areas, where on-street charging solutions, or indeed residential charging hubs (with slow-to-fast or mixed speed chargers), would be suitable.

Another factor for consideration is access to alternative travel. Drivers living in areas where there is less public transport connectivity (measured by Public Transport Accessibility Levels (PTALs) are more likely to rely on their car for their travel needs with fewer public transport options. They also typically travel more than the average distance of other London private car drivers.

The typically low density of areas with low PTAL scores means that many of these households will have driveway access and the ability to charge at home. However, there are car drivers in these areas who will not and may find it difficult to access nearby charging. Such examples include:

- Norwood Green ward in Ealing, where more than 3,500 households have access to a car, but only around 1,300 households have private parking
- Harefield ward in Hillingdon, where there are more than 2,500 households with access to a car, but only around 600 households with private parking.

Public charging is therefore likely to be needed in areas like these to support drivers from these households to switch to an EV.

While close-to-home charging is expected to be the predominant source of charging to meet these users' requirements, higher daily distances means that destination charging, for example at supermarkets, shopping centres or leisure centres, could offer an additional opportunity for drivers to meet their charging needs.

Summary:

- Close-to-home or home charging is expected to be the main source of charging to meet private car owners' requirements due to, predominantly, daily low mileage
- In some southwest and east London boroughs, drivers travel higher than average daily distances, so destination charging could offer additional opportunities to meet these drivers' charging needs

3.2. User requirements summary

A summary of the assessment of user requirements is provided in the table below.

Table 3: Key user groups summary of public EV charging requirements

Key User	What public infrastructure will they predominantly rely on?	How regularly will they charge?	Where will more charging infrastructure be needed	Other public infrastructure required to support EV charging requirements	How regularly required	Where will they need charging
Taxis	Slow-to-fast on-street for close to home charging to support drivers with limited access to driveways	Daily	Some Inner London locations such as Islington and Camden as well as Outer London areas with limited driveway access in East and South East London.	Rapid chargers	Daily	Central London, town centres, airports
PHVs	Slow-to-fast on-street for close to home charging to support drivers with limited access to driveways	Daily	Boroughs such as Hillingdon, Hounslow, Ealing and Tower Hamlets	Rapid chargers	Daily	Town centres
Emergency services & public sector fleet vehicles	Rapid chargers	Opportunity - support resilience plans	Strategic locations across London	N/A	N/A	N/A
Privately owned LGVs	Slow-to-fast on-street	Daily	Outer London	Rapid chargers Destination slow-to-fast	Opportunity Opportunity	Strategic locations across London
Depot-stored LGVs	Rapid chargers	Opportunity	Strategic locations across London	N/A	N/A	N/A
Car club users	Rapid chargers	Daily	Expanded ULEZ, south and southeast London	Slow-to-fast on-street	Daily	Residential on-street locations across London

Key User	What public infrastructure will they predominantly rely on?	How regularly will they charge?	Where will more charging infrastructure be needed	Other public infrastructure required to support EV charging requirements	How regularly required	Where will they need charging
Private car owners	Slow-to-fast on-street	Weekly	Residential on-street locations	Destination slow-to-fast	Opportunity	Southwest and east London boroughs

Chapter 4 – EV infrastructure delivery

This chapter discusses London's EV infrastructure delivery to date and considers future delivery options. It sets out our definitions of the types of EV infrastructure currently available and how they are monitored. We explore the challenges, opportunities and lessons learnt from charge point delivery to date as well as opportunities for further delivery. It will also consider the delivery tools available to the public sector to support further EV infrastructure delivery and the role of Government funding.

4.1. Public sector delivery of EV charging infrastructure

The dominant types of publicly accessible charging infrastructure were set out in the 2019 Delivery Plan and have been updated in Table 4 below. The public sector has invested significantly in charging infrastructure since 2011, when Source London was launched, through to the present day. London boroughs have delivered thousands of, more predominantly, slow-to-fast, charge points and TfL have delivered more than 300 rapid charge points. Private delivery has mainly been undertaken by CPOs, vehicle manufacturers, petrol station companies and retail chains.

Table 4: Types of publicly accessible charging infrastructure

Category Power kW Type of connector	**Common applications**	**Typical delivery partners**	**Key points to note**
Residential slow-to-fast AC 3-22kW (Type 2)	• Free standing charge point • Lampposts • Pop-up kerb chargers	• Boroughs • CPOs	• Meets the needs of households without access to off-street parking • Slower charging speeds (~22kWh/~120km of range in three hours for a 7kW fast charger and six hours for a 3.6kW slow charger) • Lower capital cost ~£7-15,000 for a fast charger and as low as £2-5,000 for a slow charger • Lower prices (9-15p/kWh)

Category Power kW Type of connector	**Common applications**	**Typical delivery partners**	**Key points to note**
Destination slow/fast AC3-22kW (Type 2)	• Retail/public car parks • Urban centre streets • Leisure centres • Hospitality	• Retail companies • Car park operators • Boroughs	• Slower speeds (~22kWh/~120km of range in three hours for a 7kW fast charger and six hours for a 3.6kW slow charger) • Lower capital cost ~£7-15,000 for a fast charger and as low as £2-5,000 for a slow charger • Lower consumer prices (9-15p/kWh)
Rapid DC 50+kW (CCS/CHAdeMO/SU-percharger) AC 43kW (Type 2)	• Rapid charge hubs • Fuel stations • Taxi rest ranks • Urban centre streets	• Petrol station operators • Retail companies • TfL • CPOs	• Faster charging speeds – 43kW AC and 50kW DC. (~22kWh in 30mins providing ~120km range) • Higher capital cost (~£50,000) and higher consumer prices (20-40p/kWh)*
Ultra-rapids Typically 100+kW	• Rapid charge hubs • Fuel stations	• Petrol station operators • CPOs	• Fastest charging speeds – up to 350kW, but 125-150kW more typical. (~22kWh in 12-15mins at 125kW providing ~120km range) • Highest capital cost (>£50,000) and highest consumer prices (24-40p/kWh)

Monitoring charge points in London

In 2020 London Councils, the London Office for Technology and Innovation (LOTI) and the GLA collaborated on a project to collate and analyse data for public charge points across London to support borough knowledge of existing charge point delivery and usage, and inform future planning and delivery.

CPOs included in TfL's procurement framework, were required to share location and usage data for all charge points procured through the framework, providing an initial data set. Data was subsequently collated on the London Datastore and used to create an online dashboard providing a heat map showing locations and utilisation levels for each charge

point. The tool also includes graphs that display trends and patterns of usage at a pan-London and individual borough level (Figure 22).

Figure 22: London Datastore charge point analysis dashboard[82]

The dashboard was launched in November 2020 and is updated on a quarterly basis. As of November 2021, it included data for more than 5,100 charge points, which accounts for around 60 per cent of all slow-to-fast charge points in London.

The dashboard now holds one of the largest public charge point datasets for London and has been used to inform data standards for future procurement. Operators who do not currently provide data are being encouraged to do so, to provide boroughs and other stakeholders with rich and up-to-date information for future planning and delivery purposes.

Slow-to-fast charge point delivery by public sector

Slow-to-fast charge points enable drivers to charge overnight, near home, providing convenience particularly for those who bring their vehicles home such as local residents, tradespeople and some commercial drivers.

TfL and London Councils have enabled borough delivery of slow-to-fast charge points by securing funding from the Office of Zero Emissions Vehicles (OZEV) through the Go Ultra Low City Scheme (GULCS) and On-street Residential Charge point Scheme (ORCS) programmes. The funding covers 75 per cent of the capital costs of delivery, with the remaining 25 per cent typically provided by the London boroughs. Access to Government funding has enabled the boroughs to deliver 60 per cent of London's slow/fast charging network. In addition to facilitating access to funding, London Councils and TfL have worked closely with the boroughs to ensure a consistent approach to charge point delivery across London. This has included developing a public sector procurement framework

[82] Source: London Councils, LOTI, GLA

which has already been utilised by 28 of the London boroughs. More recently, and as a follow-on recommendation from the 2019 Delivery Plan, a EV Charge Point Coordination Function has been established by London Councils to further support in this field. Best practice guidance documents have also been developed for the boroughs including the Streetscape Guidance[83] and London's EV charge point installation guidance[84] the latter also as a recommendation from the 2019 Delivery Plan.

Future considerations for slow-to-fast infrastructure

Slow-to-fast charge point delivery is currently highly dependent on public sector funding through OZEV-funded schemes such as GULCS and ORCS, which has been managed by London Councils.

While the utilisation rates of slow-to-fast charge points cannot be compared to that of rapid charge points due to the distinct nature of their use cases, the commercial viability of slow-to-fast charge points is much more challenging than that of rapid chargers mainly due to the considerably slower rate of charging which impacts vehicle turnover. However, there are recent signs that the market is maturing as London Councils has secured a 25 per cent match funding contribution from CPOs for delivery of infrastructure utilising ORCS funding, reducing the financial strain on boroughs.

Engagement with boroughs has also revealed that CPOs are increasingly able to offer fully-funded models for slow-fast delivery of infrastructure, which relieves boroughs of any capital investment for infrastructure. However, in a bid to improve the commercial viability of the infrastructure, contract lengths offered to boroughs are often long, sometimes between 10-20 years, which carries a risk of the infrastructure becoming redundant through the lifetime of the contract, particularly considering the pace of technological development in the EV industry. While long contract lengths may improve the commercial viability of the infrastructure for CPOs, it is not an attractive option for the many boroughs that are uncertain about what charging infrastructure is required and where, in the short to medium term.

In addition, there is currently no simple way to procure fully-funded charge point offers from CPOs so as to ensure competition and value for money and allows boroughs to easily set their own requirements and compare offers from the market. Moreover, to date, the approach to slow-to-fast charge point delivery has generally been demand led, through residents submitting a request for on-street charging infrastructure close to their home. As Figure 23 illustrates, this has resulted in a clustering of infrastructure in certain parts of London to serve these users. There is an opportunity here to take a more strategic approach – the updated forecasts, findings and commitments contained in this Strategy will facilitate this and will help deliver infrastructure to support key user groups in line with the principles of this Strategy.

Boroughs own and manage 95 per cent of London's roads, including the majority of residential roads. Even as we enable an increasing shift of delivery of this infrastructure by the private sector, London boroughs will continue to play a fundamental role in delivering on-street charging. We acknowledge the significant resource constraints boroughs face

[83] TfL Streetscape guidance, 2019
[84] London's electric vehicle charge point installation guidance, 2019

and the impact this may have in future. TfL, the GLA and London Councils will support the boroughs, through mechanisms such as:

- Supporting access to funding,
- Providing procurement frameworks,
- Maintaining the London Datastore of all public charging infrastructure to inform future delivery
- Providing the London EV infrastructure Coordination Function (led by London Councils), and
- Supporting consistency in standards across London through guidance documents

Parking pressures on borough roads are also a well-cited issue. Due to the lack of off-street parking in certain parts of London and particularly where there are space constraints, emissions-based parking charges are in place for more polluting vehicles in some boroughs.

Our engagement with the industry has raised further potential parking pressures in the form of the delivery of on-street infrastructure in residential locations without a traffic regulation order (TRO) to enforce the occupation of parking bays in front of chargers by EVs only. This is commonly known as being 'ICE'd'. With the high cost of TROs the business case to install them can be weak and it may not always be appropriate depending on the street type. Although in the longer term, with more EVs this issue will dissipate, in the next few years it could cause problems, including customer dissatisfaction and reduced utilisation for charge point operators. One way to approach the issue in problem areas could be to ensure more charge points are available nearby, and combined with education or advertising campaigns run by local authorities or charge point operators, to promote proper usage, user behaviour may be improved. This should be considered as part of TfL and the boroughs' future approach to managing kerbside space.

Rapid charge points delivery by the public sector

Rapid charging is important for supporting high-mileage, commercial vehicles that need to charge on the go.

Utilisation of TfL's rapid charging network has increased over time (Table 5). Some of the rapid chargers have been particularly popular, with the top ten sites averaging 23 to 26 charging events per day (monthly average for November 2021). The majority of the top ten most used sites are taxi dedicated rapid charging points.

Between July 2020 and November 2021 London's average rapid charge point utilisation rate (assuming 24-hour availability) across all sites has been more than 23 per cent, at our top 10 most popular sites around 46 per cent utilisation rate has been recorded over 24-hour availability.

Table 5: TfL rapids utilisation from 2020 (full year) to 2021 (January to November)[85]

Frequency	2020	2021 (January to November)
At least one charge a day	91 per cent	97 per cent
Three or more charges a day	71 per cent	84 per cent
Five or more charges a day	52 per cent	74 per cent

On street rapid delivery

TfL has delivered more than 300 rapid charging points in London: 45 per cent on TfL roads and land, 38 per cent on borough roads and 17 per cent in-off street locations, including two rapid hubs. The vast majority have been in single devices on the roadside, or 'on street'. Although more complex than delivering slower-speed devices, delivering single rapid units is faster than several in a hub, as the power requirements are lower, less space is needed and there will usually be lower site preparation costs. In some locations rapids have also been delivered in pairs, or clusters, where space allows and access is suitable.

Rapid hubs

We define a hub as a site that offers at least six rapid charge points. While we acknowledge the cost, complexity and long process for delivering rapid charging hubs (explored further section 4), recognised benefits include:

- Offering 'on-the-go' charging
- Increasing customer confidence as multiple charge points are provided at a single site, availability is highly reliable and wait times are minimal
- Offering similarities to the fuel station model which drivers are familiar with
- Providing an opportunity to offer additional facilities, which can increase footfall and improve commercial viability

Our 2019 Delivery Plan outlined an aim for at least five flagship rapid hubs, one in each sub region of London. In conjunction with private partners, TfL supported the delivery of London's first rapid charging hub at Stratford International car park in December 2019 (Figure 23) which consisted of six charge points. A further eight charge points (two of which are dedicated taxi bays) were delivered at Glass Yard, Greenwich in August 2021 (Figure 24). Another hub is in development at Baynard House, City of London. Both TfL and third parties have found that delivery of rapid hubs can be slower than anticipated. This is due to a range of factors including the complexities, restrictions and considerations when developing hubs in urban areas. Delivery of private sector rapid charging hubs is covered in section 4.2.

[85] Source: TfL Strategic Analysis

Figure 23: Stratford rapid charging hub

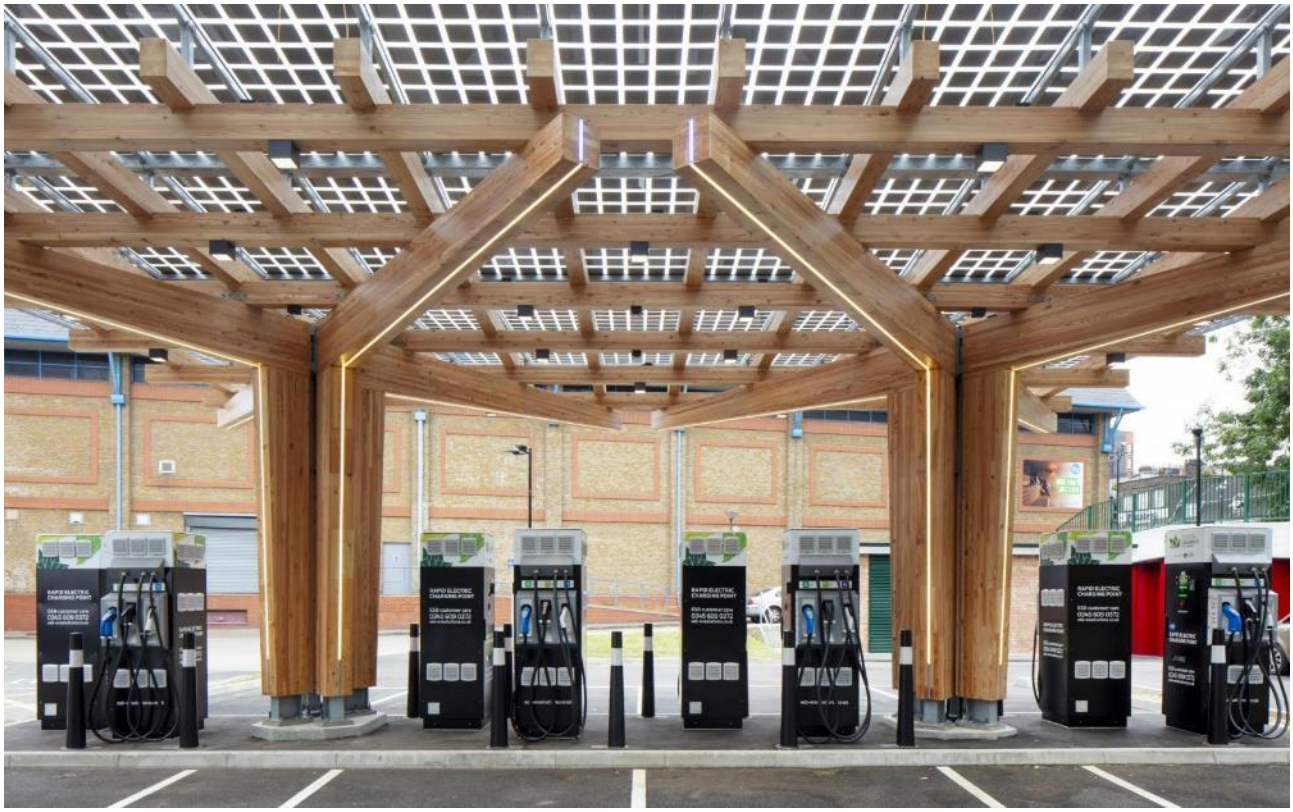


Figure 24: Glass Yard rapid charging hub

Future considerations for rapid charge points

Recent years have seen growth in the number of CPOs offering rapid chargers in London. We have now seen about 55 per cent of rapid charge points in London delivered by the private sector. We welcome the increase in private sector commitments to deliver rapid charging infrastructure. However, access to land is a key issue for commercial operators, and as a significant landowner, one that the public sector could help address.

We anticipate that, without continued public sector funding, gaps in the rapid charging network could emerge, which could reinforce imbalanced distribution of delivery. There is a need for a strategic approach to site selection of all rapid charging infrastructure in future to help maximise charge point utilisation, and therefore commercial viability, while also ensuring equitable delivery.

A key aim of this Strategy is to consider how the public sector can help accelerate further private sector delivery through removing existing barriers, improving the conditions for private sector investment and supporting further growth. Over time and as demand grows, our aspiration is for the private sector to grow and to be able to operate a self-sustaining public network of charge points.

Shared charging infrastructure

We also need to further consider how we can support and encourage sharing of private charging infrastructure. Peer-to-peer sharing of charging infrastructure has the potential to complement the network of publicly accessible charge points. In addition, through stakeholder engagement, we have identified that some key users, for instance emergency services fleets or commercial operators, do not have sufficient land to meet their charging needs.

Land in London is a scarce and expensive commodity, under increasing pressure to meet housing needs, to provide jobs, and to create attractive public spaces. We therefore encourage fleet operators without access to land, or who are unable to fully meet their charging needs through their existing land, to utilise the public charging network and to explore peer-to-peer sharing of charging assets. As part of this Strategy we will consider how public bodies and private sector partners can ensure that the EV infrastructure needs of key user groups are met with TfL setting specific proposals and commitments to achieve this (see Chapter 6).

Lessons learnt from public sector delivery in London

Outlined below are the lessons learnt and opportunities as they emerge, from the most recent public sector delivery of charging infrastructure in London explored further in **Error! Reference source not found.** and

Table in Appendix B. Across both slow-to-fast and rapid chargers, we have identified several common themes which include:

- **The benefits of a London-specific procurement framework**: the boroughs have valued the efficiency, ease, assurance and consistency provided by a public sector procurement framework. TfL's procurement framework has been extended to July

2022 to support further public sector delivery of charging infrastructure. While boroughs welcome this, there is consensus that a new and more flexible procurement route is required to provide better access to new technology and enable access to private finance

- **The benefits of providing guidance documents to support London borough delivery:** TfL has produced a range of guidance documents, which have been widely welcomed by the boroughs for supporting consistency in standards across London and sharing best practice. A review and, where appropriate, a refresh of the documents is required in order to reflect recent advances in technology. For instance, London boroughs would welcome advice on trailing cables, EV signage, futureproofing infrastructure, and kerbside guidance on where to prioritise infrastructure delivery

- **The challenges of identifying feasible sites:** A large proportion of sites are rejected at site assessment, usually for three reasons:

  a) Supplier site constraints/restrictions tightened in 2020 for example, exclusion areas on electrical units, the minimum safe distance that must be kept from live electric cables. increased from 5m to 15m

  b) Installers are becoming reluctant to install charge points near trees or drain covers.

  c) There is a limited number of suitable lampposts. Siemens/Ubitricity lamppost column charge points, for example, are only suitable for modern lamp columns. Heritage, ornate and back of footway columns are not suitable.

  Enhanced mapping of sites could potentially help eliminate unsuitable sites pre assessment, which would help improve efficiencies.

- **The misuse of charge point parking bays:** in areas of high parking demand and where charge points have been delivered without a TRO to mandate the use of a parking bay by EVs only, boroughs have reported receiving persistent complaints from residents who have been unable to access charge points due to non-EV drivers blocking the bay. CPOs often opt not to submit a TRO due to the high costs associated, which can often exceed the capital cost of installing infrastructure. In future, guidance documents should recommend that, in areas of high demand, delivery of multiple charge points is the best way to ensure adequate access. Operators can also manage access through technological fixes and flexible tariffs that discourage overstaying for EV drivers plugged in longer than they need to charge

- **The need to minimise street clutter:** retaining Streetspace accessibility for pedestrians (especially those in wheelchairs or with pushchairs) is a key priority for TfL and the London boroughs. As a result, boroughs tend to favour the more discreet charging solutions such as lamppost, charging which help minimise street clutter

4.2. Private sector delivery of EV charging infrastructure

A key aim of this Strategy is to consider what market conditions are needed to embolden the commercial market and maximise the value of public funding. Through engagement with key private sector EV infrastructure stakeholders, we have identified the main barriers to further private sector delivery and how we could help remove them.

Slow-to-fast charge point delivery by the private sector

Of the 35 per cent of slow-to-fast chargers delivered in London by the private sector, different business models exist with different regulations and means of accessing. Source London offers two different subscription options: either 'full', which is a yearly subscription of £4 per month; or 'flexi', which is a one-off payment of £10. It also provides members with an option to reserve a charge point up to 40 minutes in advance for a fee through their website or mobile app. Pay as you go users are not required to have an RFID card to use Source London charge points. Pod Point, on the other hand, offers a free service at the majority of its devices, of which there are currently more than 1,000, there is no upfront membership cost and where there are costs to charging, they are priced per hour or per kWh. To access its network, users must either use their smartphone app or their web app.

Most of this private sector delivery, not including the match funding provided by some private partners for chargers installed by boroughs using Government funding sources, has been on privately owned land such as supermarkets or areas where there is a desire for destination charging. Tesco, for example, has recently teamed up with both Volkswagen and Pod Point to provide free EV charging bays at 400 sites across the UK[86].

As delivery and demand for slow-to-fast charging has increased across London, boroughs have increasingly been able to secure 25 per cent match funding from operators to deliver infrastructure via Government funding streams thereby enabling 100 per cent funded slow/fast charge points – although staff costs remain uncovered. This funding allows boroughs to purchase the charge points and enter into a contract with an operator to supply/install/operate/maintain them for a fixed period, providing a fixed share of revenue to the borough.

Both the private and public sector have a continued role to play in the delivery of slow-to-fast charge points. CPOs are not landowners and thus will remain dependent on boroughs providing access to land. Delivery to date also highlights that if we left the private sector to deliver slow/fast charging infrastructure, investment would not meet projected demand,

[86] Tesco PLC, Working with Volkswagen and Pod Point to provide carbon neutral energy, June 2021

emphasising the need for continued support from the public sector to provide London's infrastructure requirements to 2025 and 2030.

Rapid charge point delivery by the private sector

The private sector is responsible for the delivery of around 55 per cent of all rapid charging points in London to date, illustrating that public funding to support this sector of the industry is decreasing. The distribution of the delivery of rapid chargers, by both the public and private sector, can be seen in Figure 25, with a growing network across London and significant increase in rapid charging infrastructure from 2019.

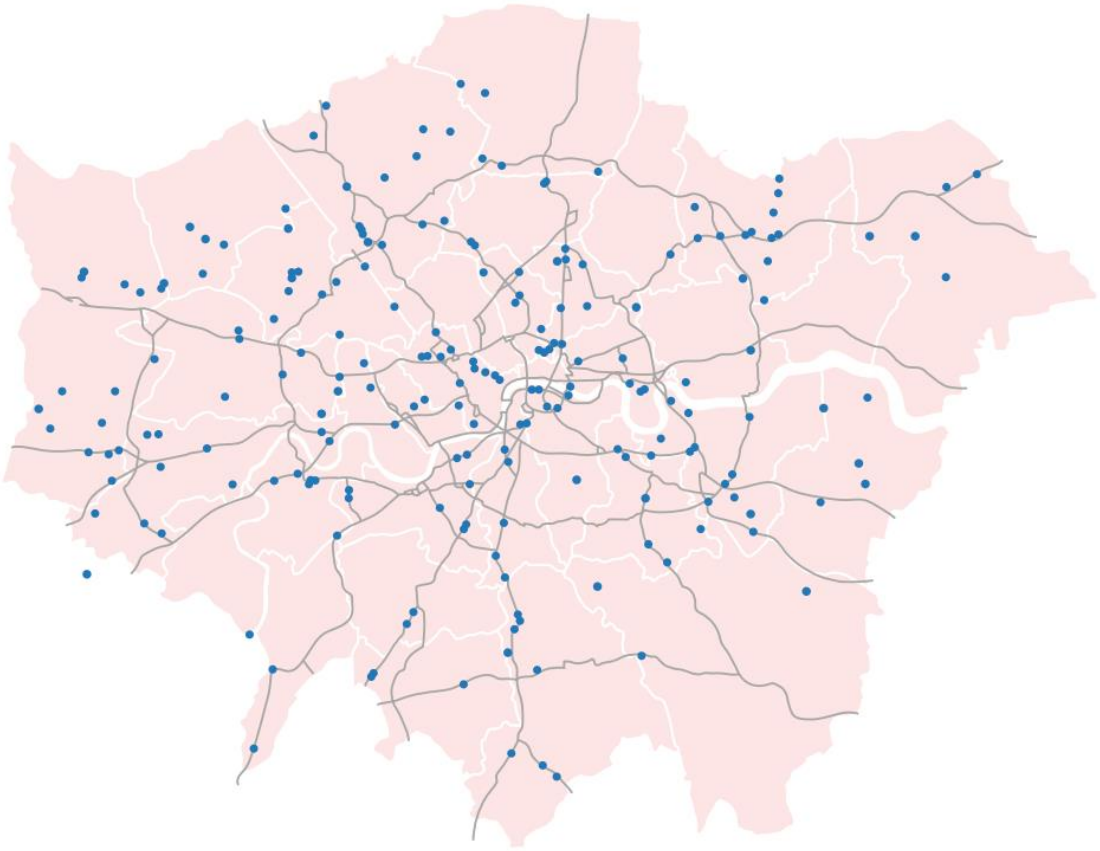


Figure 25: Rapid charge points in London as shown in the 2019 Delivery Plan[87]

[87] Original data source: Zap-Map database, 2019

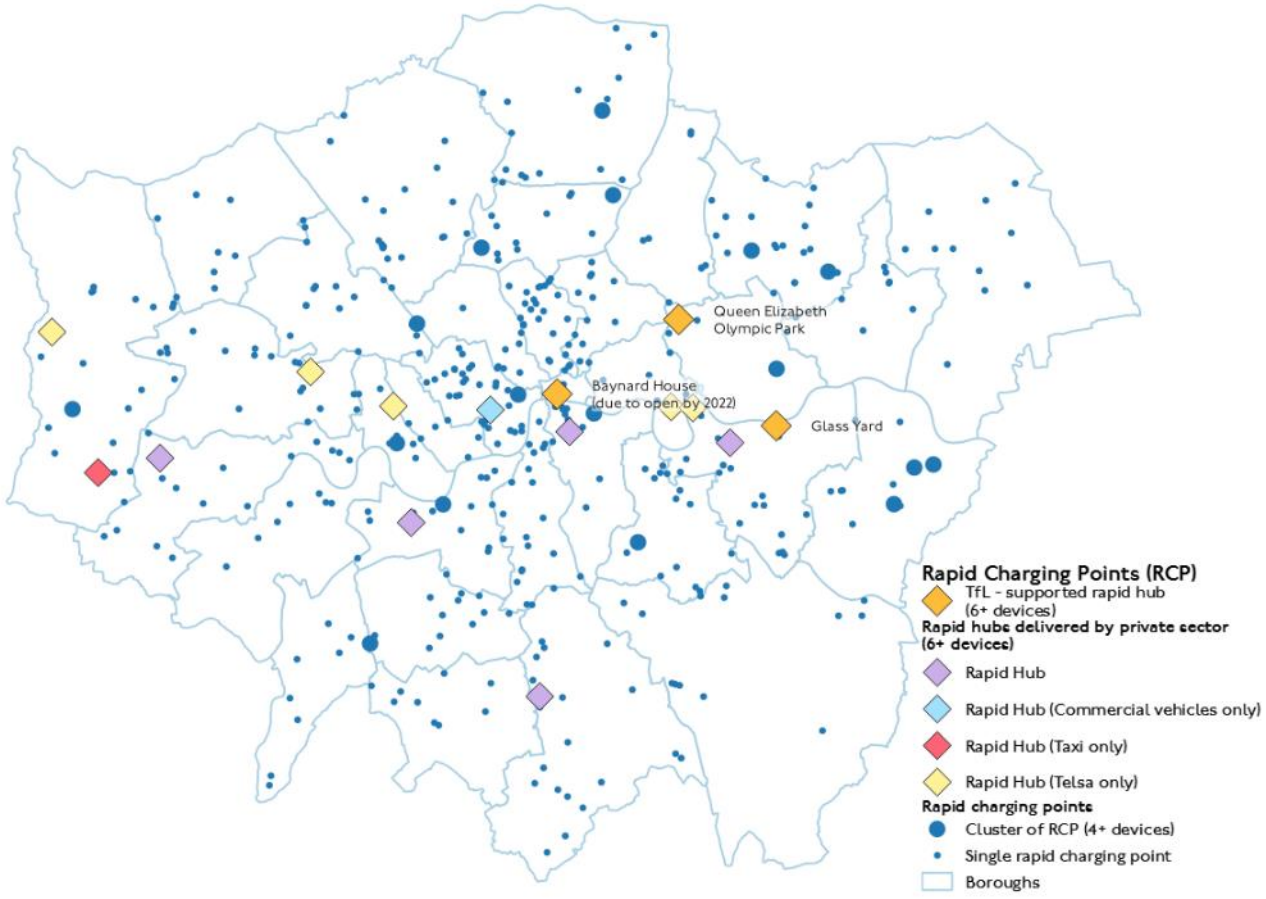


Figure 26: Total rapid charging infrastructure, including hub sites, and clusters of charging infrastructure across London in 2021. Source: Zap-Map, 2021: www.zap-map.com

However, following engagement with private sector delivery partners, as well as our own experience of delivering rapid charging hubs in particular, we have identified that key commercial challenges to the delivery of rapid charging infrastructure remain which may require public support, over and above funding. These are:

- **Availability and affordability of land:** a key barrier to commercial operators is the availability and affordability of land. London is considered a saturated market in which all the 'quick win' sites have already been identified and developed. To overcome this barrier, the private and public sector must work together and innovate
- **Utilisation risk:** rapid sites are expensive to develop and therefore need to be well utilised to cover costs and, even more so, to generate an income. The projection and spatial EV infrastructure data contained in this Strategy can help operators select commercially viable sites that would minimise commercial risks
- **Complexity of the planning process:** the private sector finds the planning process slow, inefficient, and complex, which creates additional commercial risks. Further support and guidance could be provided to both commercial partners and

borough officers by the public sector to raise awareness of the planning process and to encourage best practice

- **Cost and complexity of energy grid upgrades:** the cost of the enabling work to upgrade grid capacity remains a key barrier, continuing to make many sites commercially unviable. Ongoing engagement with the government and DNOs is required to consider ways to overcome this significant barrier. In TfL and GLA's response to OZEV's Future of Transport regulatory review[88] on the subject of Zero Emission vehicles, we have raised the issue of grid connections and associated uncertain and unfair upgrade costs. We have suggested that landowners are incentivised to work with their DNO to plan for future capacity increases, but this requires changes to regulation and appropriate funding. We are also aware that Ofgem is looking to support grid upgrades by allowing DNOs to pass the upgrade cost to energy customers. We urge the government to find a solution for grid upgrades which does not pass the cost on to the consumer.

These challenges are particularly relevant to the delivery of rapid charging hubs, which the Strategy recognises as a continued priority focus, as recognised in the 2019 Delivery Plan. Although recently the private sector has delivered publicly accessible hubs near to Heathrow on the M4[89] , in Croydon, and at New Kent Road[90], with a number of dedicated hubs also delivered to serve key user groups such as taxis around Heathrow[91]. We are pleased to see more commitments from the private sector to deliver rapid charging hubs in London; BP Pulse launched the first dedicated rapid charging hub for fleet vehicles in Westminster in June 2021 and plans to develop a network of rapid charging hubs across London[92]; Shell is due to deliver its first EV charging forecourt in west London in 2022[93]. However, we acknowledge, from our own experience of delivering two rapid hubs to date, that many hubs are complex and costly to deliver due to the costs of grid upgrades and the complexities of developing sites in urban areas.

Through stakeholder engagement with boroughs and private sector partners, we have identified that pre-engagement with local planning teams is an important process which is sometimes overlooked. We encourage private partners to engage with the relevant planning team as early as possible to seek advice from the outset. Further lessons learnt from private sector delivery of rapids, and in particular rapid hubs, is covered in Table in Appendix B.

[88] Future of transport regulatory review: zero emission vehicles, OZEV, September 2021
[89] Cars GT. Moto Motorway Heston Services
[90] New Kent Road Electric Charging Site, 2021
[91] Cars GT, Electric Vehicle Charging Point, Heathrow Airport
[92] BP Pulse's Dedicated Rapid Charging Hub for fleet vehicles.
[93] Shell UK's First EV Hub

How the public sector can support delivery

Having identified that barriers to delivery and commercial viability remain, we have considered the role of stakeholders in influencing, addressing and unblocking these barriers. Key stakeholders include TfL, GLA and the London boroughs, private sector delivery partners and Government.

We have identified four mechanisms through which TfL, the GLA (including the functional bodies) and the London boroughs can continue to help influence and unblock the barriers identified. These are explained below and set out in Section 6.3.

- **Access to land**:
    - The boroughs will remain the key delivery agents of both slow-to-fast and rapid charging infrastructure, given they own and manage 95 per cent of London's roads. CPOs will continue to remain dependent on access to on and off-street borough land
    - TfL is looking to unlock land owned by the GLA functional bodies to enable quick and flexible commissioning of charging infrastructure to meet London's charging requirements to 2030. This would support delivery of a network of rapid charge points and hubs across London, specifically targeting high mileage, essential road users, maximising emissions savings and supporting other Mayor's Transport Strategy goals. This will be covered in more detail in the next section

- **Facilitation:** TfL, London Councils and the GLA can continue to play a pivotal role in facilitating and co-ordinating delivery of charging infrastructure through bringing together delivery partners to share information and identifying key challenges and opportunities.

- **Strategic oversight:** through the development of strategies, delivery plans and guidance documents TfL and the Mayor can continue to provide a clear vision for the future, supported by delivery plans to enable action. Expanding the evidence base and building on existing data (particularly projections and spatial maps) also remains key to being successful in securing further funding from both the public and private sector and to inform delivery.

- **Financing and funding:** TfL has played a critical role in securing financing and funding for charging infrastructure from both Government and private sector partners. Securing ongoing funding and financing to enable more infrastructure delivery in London remains critical, particularly in terms of slow-to-fast charging infrastructure which remains heavily dependent on public sector delivery

It is also clear that further funding will be needed from the Government whose funding has been instrumental in enabling London to meet current demand for charging infrastructure.

It will continue to be needed to maintain consumer confidence and accelerate the pace at which Londoners transition to zero-emission vehicles.

Chapter 5 – London's public EV infrastructure needs

Within this chapter, we examine what additional charging infrastructure London is likely to require to 2030. We begin by looking at what infrastructure is already available, how this is currently utilised and how it has changed in recent years.

Next, we present estimates of London's charge point needs in 2025 and 2030 updating the modelling undertaken for the 2019 Delivery Plan. This includes a more in-depth look at the needs of the key EV user groups outlined in Chapter 0 including where in London they will most likely need charging up to 2030.

5.1. Our modelling approach

In 2019, as part of the EV Infrastructure Taskforce, we developed an innovative model to give us a sense of scale for the EV charging infrastructure London may need to 2025, based on a range of different demand scenarios.

This modelling has now been updated, building on our improved understanding of how the market is likely to grow (informed by extensive stakeholder engagement) and the likely impacts of the policy changes covered in Chapter 0 that are likely to affect the rate of uptake. We present here our estimate of the ranges of charge points needed within Greater London for 2025, as well as an indicative outlook of what may be needed by 2030.

Modelling with this level of uncertainty means we need to provide forecasts using high and low ranges, rather than exact numbers. EVs currently represent around two per cent of vehicles in London, so insight into how drivers choose to charge is still limited. The long-term impacts of the pandemic on travel behaviour, and availability and uptake of EVs is also uncertain. The further we look ahead, the greater this level of uncertainty becomes due to factors such as technological advances and behavioural changes. A key part of our strategy is therefore to ensure that modelling is regularly updated as new trends emerge.

We have used a scenario-led approach to estimate likely charging infrastructure needs. This presents alternative scenarios for:

- Future EV sales – accounting for both scenarios of high and low rates of uptake to 2025 and 2030; and
- Preferred charging behaviour – including scenarios with a higher driver preference for 'on-the-move' rapid charging (and where public charging is predominantly on-street using slow-to-fast charging (typically in residential areas)

The model is built on a series of assumptions with the key topics summarised in Table 6. More details on the specific assumptions used and our modelling methodology are provided in Appendix C.

Table 6: Key modelling assumptions

Theme	Assumption topic
EV sales	• How quickly different consumers will switch from buying petrol or diesel cars to buying EVs • Whether they will choose battery electric or plug-in hybrid vehicles
Vehicle technology	• How long vehicles can travel before needing to be charged • How quickly a battery can be charged
Travel behaviour	• How overall demand for car travel will change over time • Consumer preferences for different types of charging (based on where they live, how they travel and when will be most convenient)
Charging infrastructure	• The types of charging technology that will be on offer in future • How many vehicles can be charged by each charge point in a day • The power needed to deliver each charge
Charger utilisation	• How regularly charging infrastructure will be in use throughout the day

5.2. Future EV sales

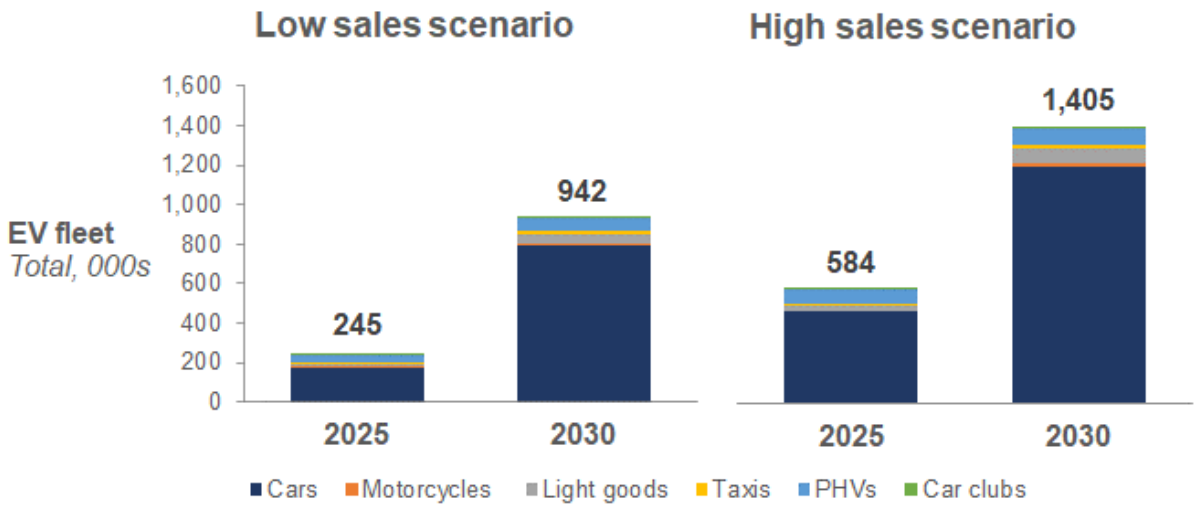
With reducing purchase costs, a rapidly expanding range of models and improving battery range, the volume of EVs registered within London is expected to increase dramatically in the near future.

While we are confident of continued growth, the pace of this will be determined by many factors we cannot accurately forecast, including how many vehicles will be available for sale in the UK, whether these vehicles are suitable different types of drivers' needs and how quickly private car owners will choose to switch. Reflecting this, we have developed two scenarios for new registrations, which are intended to show the extremes. These relate to:

- A 'low sales' scenario, where EV sales are initially slow (growing from around five per cent of new vehicle registrations in 2020 to around 30 per cent by 2025), then increasing to the point where more than 90 per cent of the total number of new cars and vans registered in 2030 are EVs; and
- A 'high sales' scenario, where EV uptake accelerates faster to 2025 (to around 80 per cent of new car and van registrations by this point), and then increases to more than 95 per cent of all car and van sales by 2030.

This leads to a projection of between 0.3 and 0.6 million EVs in London by 2025 (between 9 per cent and 21 per cent of London's total car and van fleet). By 2030, our projections estimate between 946,000 and 1.4 million EVs (between 34 per cent and 49 percent of London's total car and van fleet), shown in Figure 27. Compared to our previous 'high sales' scenario of 335,000 EVs by 2025 (11 per cent of all cars and vans) estimated in the 2019 Delivery Plan, this represents a significant uplift, with that figure now much closer to

our updated ‘low sales’ scenario. This reflects signs of increasing consumer acceptance of EVs and expected growth in EV manufacturing.



NOTE: Based on vehicles registered in London only (for instance does not include any taxis or PHVs which are licenced to operate in London, but which are registered outside). Both scenarios are informed by Element Energy’s Electric Car Consumer Model.

Figure 27: Low and high estimates of potential future EV registrations in London

It should be noted here that these estimates are only of the vehicles that are registered in London, while a significant proportion of London’s traffic (including taxis and PHVs) is made up of drivers travelling into the capital from beyond the Greater London boundary. This has been factored into the analysis of our charging estimates (with detail on how provided in Appendix C).

5.3. Charging infrastructure estimates to 2030

The next level in our modelling is to look at the infrastructure required to charge these vehicles and how this would be impacted by differences in driver preferences of how to charge. This is used to estimate how many of each of the different types of charger described in Table 4 (slow-fast residential, slow-fast destination and rapid/ultra-rapid) could be required depending on how trends in charging behaviour develop.

Our modelling for this strategy has focussed on two behavioural scenarios:

The first (Scenario A) assumes that there is **a preference for faster public charging**, with more on-the-go, top-up charging taking place, as well as a continued mix of speeds, with most still wanting slow to fast chargers near their home. For those using faster charging, such as rapids and ultra-rapids, there will be more similarities to current petrol station refuelling behaviour.

The second (Scenario B) assumes that, although there will be some faster charging, there will be **a strong preference for more on-street slower, residential-based charging**, as well as a slightly higher proportion of private, at home charging on driveways.

Under both scenarios, we assume that where drivers have access to a driveway, or where vehicles are part of a company fleet and parked at a depot when not in use, private charging will be the preference for most of their charging needs.

The outputs of our modelling using these scenarios (summarised in Table 7) suggest that, in a lower uptake scenario where rapid charging was the preference, London could need as few as 43,000 charging devices by 2030. However, in a higher EV uptake scenario, with a preference for slow-to-fast chargers, this could rise to 92,100 by 2030. The full breakdown of chargers by scenario is provided in **Appendix C.**

Table 7: London's EV infrastructure projections to 2025 and 2030

	A) Higher rapid charging preference scenario				**B) Residential charging preference scenario**			
	2019 Delivery Plan forecast		**2021 new forecast**		2019 Delivery Plan forecast		**2021 new forecast**	
	Slow-to-fast	Rapid (50kW)	**Slow-to-fast**	**Rapid** (100kW average)	Slow-to-fast	Rapid (50kW)	**Slow-to-fast**	**Rapid** (100kW average)
2025	20,000-34,000	2,500-4,100	18,500 – 34,500	1,600 – 2,600	28,000-49,000	1,400-2,300	26,000-49,500	1,100-1,600
2030	N/A	N/A	40,000 – 55,000	3,000 – 3,900	N/A	N/A	60,000-90,000	1,700-2,100

The 2025 estimates for slow-fast charge point requirements in Table 7 show broad consistency between the figures generated through current modelling and those from the 2019 Delivery Plan. The notable difference in rapid charger estimates reflects how technology has already evolved since 2019. Most vehicles now able to be charged at speeds above 50kW/hour, with most new rapid infrastructure delivery comprising chargers offering speeds of 150kW or above. For the purposes of our analysis we have therefore assumed a theoretical average charger speed of 100kW, rather than the 50kW used for previous estimates. Charging at this speed enables more vehicles to be served by a single charger.

The consistency with previous estimates reflects the continued expectation that much of the near-term growth in EV uptake (and accordingly demand for charging) will be from higher-mileage drivers – and particularly by the taxi and PHV sectors. Even in 2019, there were ambitious commitments set by PHV operators, with most committing to operate a fully ZEC fleet from 2025, some even from 2023. These commitments remain in place so, although the phase-out of petrol and diesel vehicles has the biggest impact on uptake from 2025.

The first scenario is more desirable and aligned with our vision and principles. The focus of this strategy is to support key user groups who typically do higher mileage, and who are more likely to need top-up, on-the go charging. Faster charging is more convenient and efficient. Technology is developing at pace and users can be offered a similar level of convenience to refuelling a petrol or diesel vehicle today. This scenario still includes a sizeable proportion of slower charging to accommodate the needs of lower mileage users or those who are more price sensitive. The forecasts projected to 2030 in the second scenario would not deliver so well against our vision and principles, owing to the implications of having so many devices along our streets on streetscape, as well as the competing demands on the kerbside. In addition, this scenario would require higher levels of public sector funding given the business case for slower chargers tends to be considerably lower.

Although Figure 27 shows the forecast number of EV registrations in London in 2030 could be two to three times our estimates for 2025, the overall number of charge points needed is not expected to increase by the same rate. Within our modelling this is down to most of the later adopters of EVs being private car owners who typically travel fewer miles each year than commercial drivers. Another consideration is how advances in battery technology and range by 2030 will reduce how frequently drivers need to charge. This will likely further increase how many vehicles can be served by a single charge point.

Our modelling forecasts are projections and should not be treated as targets. They give a sense of scale of what could be needed and are based on many variables. While these estimates are based on in-depth modelling, incorporating up-to-date industry data and insights, there is still a high degree of uncertainty. As such, we have used scenarios to cater for different trajectories of EV sales and charging behaviours. We will continue to update our forecasting to account for the greater level of uncertainty that emerges as we look further ahead and to account for new trends.

Borough-level estimates of charging demand

In 2020, the International Council on Clean Transportation (ICCT) published a working paper setting out its estimates of the charging needs for each London borough to 2030 and 2035[94]. This analysis built on the 2019 Delivery Plan methodology and offers a useful starting reference for boroughs in planning their infrastructure needs. This highlights the current uneven distribution of charging infrastructure across London and offers a useful reference in particular for those boroughs which currently have few chargers on what will likely be needed in the future.

With EV uptake likely to grow unevenly across London reflecting the diversity of our city, a better local level understanding of EV charging needs will be vital to improve planning – especially of slow-fast charging. For the purposes of this strategy, however, our modelling is based on London-wide estimates of needs. Carrying out more insightful borough-level analysis than that already provided by the ICCT will require a richer understanding of how the local context is likely to impact on charging demand (including demographics and

[94] ICCT (2020) ‘Fulfilling electric vehicle charging infrastructure needs in Greater London and its boroughs’.

household characteristics, on-street and off-street parking provision, local travel behaviour and daily travel into and out of boroughs). This is an area we are keen to support London's boroughs further and, as such, we will be working with London Councils and boroughs to improve insight at a more local level, with particular focus on how to plan for the priority user groups identified in this Strategy.

5.4. Carbon impacts of EV uptake

To better understand what impact London's EV uptake may have on carbon dioxide emissions, we have undertaken some provisional analysis using a comparison between the emissions of typical petrol or diesel vehicles and EVs of the same category. This has looked at the carbon impacts of the 'low' and 'high' sales scenarios for 2030 and compared them to a 2020 baseline.

The delivery of infrastructure to support the scale of EV usage set out above could result in around 46 per cent of the overall distance travelled by cars in London being by electric car. The proportion of EVs in the vehicle stock could reduce carbon dioxide emissions by between 1.5 million and 2.6 million tonnes per year by 2030 (Figure 28). With much of the early shift to EVs expected to come from London's highest mileage drivers, this could represent between 40 and 84 per cent of London's total transport carbon emissions from cars

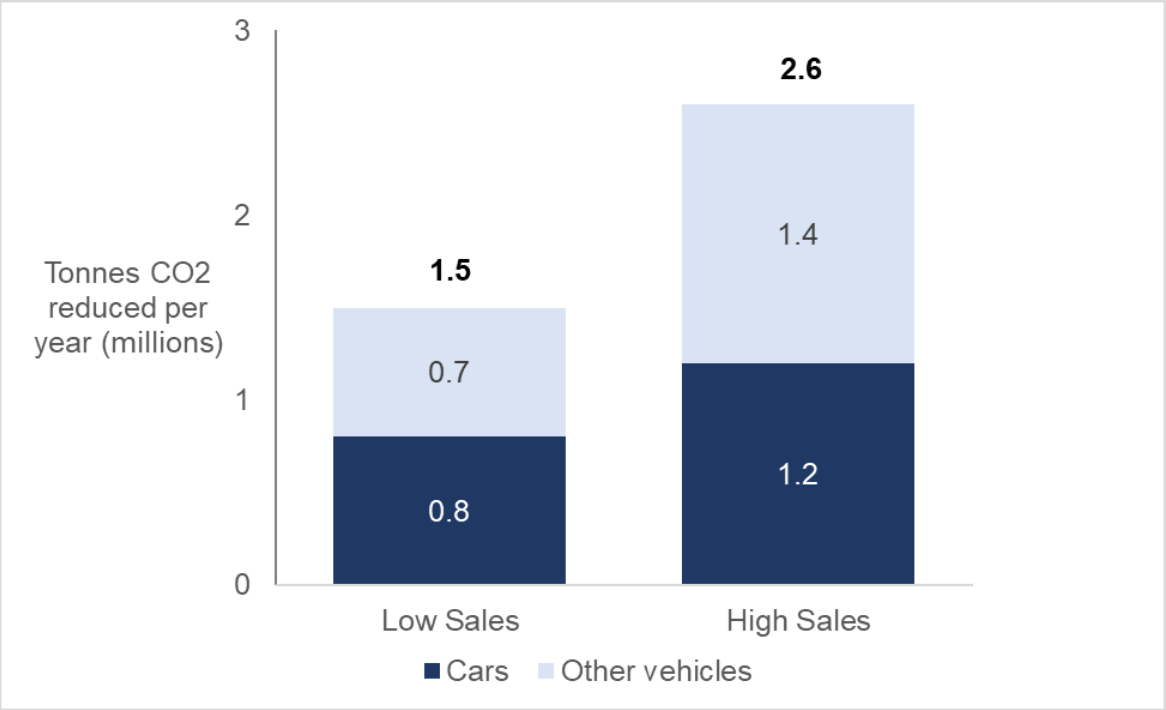


Figure 28: Tailpipe annual CO_2 emission reductions in 2030 from a low and high EV sales scenario in London

Chapter 6 – Key findings and commitments

6.1. What do we need to do to deliver our aspirations and goal?

Just over two years on from the publication of the 2019 Delivery Plan, London has seen the successful delivery of EV infrastructure in line with its demand estimates. As the publication of the Delivery Plan: One Year On[95] report documented, progress has been made to achieve almost all of the enablers identified.

The EV market has continued to develop at pace and, with recent policy announcements such as the national phase-out of petrol and diesel sales by 2030, the switch to EVs is set to proceed even faster than previously considered, with implications for the level of infrastructure required.

We have set out the overarching vision and supporting principles, as outlined in section , by which we intend to deliver the infrastructure London needs in line with the Mayor's Transport Strategy. We encourage all sectors of the industry to acknowledge these principles and vision.

The EV revolution will be key to a green and fair recovery for London, both in terms of supporting people and businesses to switch to EVs as well as green skills and job creation. London has an integral role to play in achieving national-level policy objectives of transport decarbonisation given the scale and density of the transport network and the number of daily trips contributing harmful emissions.

As we move forward, we will continue to seek the expertise of the EV infrastructure taskforce as well as other key stakeholders engaged in the production of this Strategy (**Appendix A)** to ensure that opportunities are sought to deliver the infrastructure London needs.

6.2. Headline findings

Our analysis of key user requirements and the subsequent forecasts of infrastructure required to 2030 has built on the findings of the 2019 Delivery Plan and provided new insight in terms of prime locations for the delivery of infrastructure in London. This is presented below, looking at rapid charge points, then slow-to-fast.

Rapid charge points:

- The advantages of rapid charge point hubs were strongly advocated by the 2019 Delivery Plan and remain valid. The Delivery Plan set out an ambition for a rapid hub in every sub region of London by 2025. The public sector has led on hubs opening in south London (Glass Yard, Woolwich) and east London (Stratford), and will be opening one at Baynard House, central London in early 2022. The private sector has delivered publicly accessible hubs near Heathrow on the M4, Croydon

[95] Electric Vehicle Infrastructure Delivery Plan: One-Year-On Report, TfL, 2020

and New Kent Road, with a number of dedicated hubs also delivered to serve key user groups such as taxis and commercial trips. North London remains a sub region without a hub, although rapid charge point coverage, including a growing number of rapid clusters (locations with between two to four rapid charge points), is increasing. A hub in North London will remain a priority for future site consideration

- Additional rapid chargers will continue to be required to meet London's needs. These should continue to be delivered in central London, with the majority of any further taxi-dedicated charge points in this vicinity, and a focus on town centres including in outer London. Charge points should also be on strategic routes such as A-roads across the capital to serve the diverse trip patterns of other users.

- The criteria for site selection set out in the 2019 Delivery Plan remains current, namely:
  - population of the town or urban area
  - geographical size of the area
  - existing nearby rapid charger provision
  - relative number of high-mileage users
  - through traffic
  - available energy capacity

- User-specific location recommendations are given in Chapter 0 of this Strategy

- Although we have previously installed rapid chargers of 50kWh, as technology advances, higher speeds are becoming more common. In the future, although it may depend on energy supply and other factors, increasing numbers of 150kW chargers are likely to be more suitable.

- Currently, the public sector has delivered around 45 per cent of London's rapid chargers, although private sector delivery is now accelerating. Of the overall numbers of rapid chargers forecast to be required in London by 2025, it is anticipated that approximately 20-30 per cent (180 to 570) rapid chargers depending on the scenario) could be delivered with support from the public sector. This percentage has been derived from current understanding of the market and stakeholder engagement. Support could be in the form of direct delivery or by facilitating others to deliver, such as providing land or supporting energy upgrades. By 2030, little or no further public sector funding is expected to be required as higher usage will enable high viability for commercial operators

Slow-to-fast charge points:

- A good geographic spread of slow-to-fast charge points will be required in London in the future, with a focus on locations where priority user groups will need them. They will be required particularly for the large numbers of private hire EVs, where ambitious commitments have been made, but for others too
- Our analysis has identified large spatial gaps in the current slow-to-fast public infrastructure network in residential areas for each of the priority user groups. Efforts should be made to focus infrastructure investment to support these groups. These are explored in detail in Chapter 3

- The need to reduce streetscape impact continues, to address accessibility concerns as well as to avoid street clutter and redundant apparatus. Discreet solutions, such as lamppost chargers and pop-up low-profile devices, are helping to achieve this, while considering accessibility concerns
- Delivery of slow-to-fast charging infrastructure to date has been predominantly public sector funded (currently approximately 60 per cent). Towards 2025, as usage increases and slow-to-fast infrastructure becomes more viable, we would expect increased delivery by the private sector, so that by 2025 there to be a more even distribution, with at least 50 per cent from the private sector. Public delivery will depend on funding available and contracts with operators that give boroughs a fair deal. By 2030, we anticipate the majority would be funded by the private sector, but that certain locations may still require public sector support, and all those that are placed on borough land will continue to require public involvement

6.3. The role of TfL and the public sector

Following on from the review in Chapter 4 of delivery mechanisms used to date, and the challenges faced by the private sector, which led to an assessment of future delivery options, four key mechanisms have been identified through which TfL can continue to help influence and unblock the barriers to delivery identified through extensive stakeholder engagement:

Land access

The availability and affordability of land was identified as one of the key challenges for the private sector to deliver further EV rapid charging or hub facilities.

By unlocking land owned by the GLA functional bodies, and potentially boroughs, it could be possible to enable quick and flexible commissioning of charging infrastructure to help support London's charging requirements. This would support delivery of a network of rapid charge points and hubs across London, specifically targeting key user groups, as guided by this Strategy.

The GLA is also investigating the viability for shared charging infrastructure across GLA Group fleets, which includes TfL, the London Fire Brigade and the Metropolitan Police Service. The challenges of electrifying these fleets were described in Chapter 3 which highlighted access to land as a major barrier. This would also support the Mayor's commitments to transition the GLA Group's fleet to zero-emission vehicles.

Facilitation

London boroughs have been central to the roll-out of mass slow-to-fast EV infrastructure in London, with more than 4,800 charge points installed using funding from the GULCS and ORCS Government-funded programmes. As EV uptake accelerates, delivery of infrastructure will need to proceed at pace and volume to meet users' EV needs. With boroughs under significant resource and financial constraints, it will be more important than ever that tools, guidance and templates are available to ensure a clear, consistent and simplified process for boroughs to identify suitable sites and deliver infrastructure. The

planning process has been highlighted as one such issue by the private sector where we see benefit, working with London boroughs, helping to navigate planning policy relevant to the installation of EV infrastructure. TfL, with London Councils, will seek to establish a borough EV infrastructure working group to develop and influence this content to ensure it meets boroughs' needs.

Following on from the extensive engagement carried out to produce this Strategy, TfL will continue to work with stakeholders from across the industry, and utilise the expertise of the EV infrastructure taskforce to build a better understanding of EV user requirements so that delivery of infrastructure to 2030 continues to meet user needs.

Opportunities will also continue to be sought for shared access to infrastructure by public and commercial fleets and agreed partners or for public access where feasible, as recommended in the 2019 Delivery Plan.

Strategic oversight

Through the development of strategies, delivery plans, guidance documents and data, TfL and the Mayor will continue to provide a clear vision for the future.

TfL is uniquely positioned as the strategic transport authority in London to provide data to help the private sector, third-party delivery partners and boroughs to identify future forecast demand. This data can provide certainty to funders of the commercial viability of sites to take forward. This will also support the development of a consistent, equitable and balanced network of EV infrastructure across the whole of London.

For example, charge point utilisation data can be used to inform future delivery of infrastructure. As discussed in section 4.1, the London Datastore dashboard provides a useful heat map showing locations and utilisation of each charge point, and graphs to display analysis of the trends and patterns of usage at a pan-London and individual borough level.

While the dashboard has provided a valuable source of charge point data for analysis and planning purposes, much of the analysis related to key user requirements presented in this Strategy has been heavily caveated due to discrepancies in, and the quality of, the data available to date. This is due to the relatively new coordination of delivery of mass EV infrastructure between multiple partners. TfL is keen to improve current datasets to enable better planning of infrastructure to support users' requirements. In order to do this, we need to better understand how user segments are using the infrastructure available today to answer key questions such as how often users charge and how far they typically travel to get to a charge point. We will work with operators and specialist data teams to access this type of information[96]. We will also continue to update our forecasting of EV infrastructure requirements across London as a whole, to ensure assumptions used reflect the reality of EV industry development, looking to refine projections to the borough level.

[96] Ensuring compliance with the Data Charter recommendations expected from the EV Energy Taskforce to ensure users know how and when their information is being used and accessed: https://www.zemo.org.uk/work-with-us/energy-infrastructure/projects/EVP20-1-EV-Energy-Taskforce.htm

We are also a key stakeholder in the London Data Commission[97] pilot project that seeks to demonstrate the impact of insights from public-private data-sharing on unlocking EV charging market constraints. The public sector organisations and businesses involved in the pilot project will progress towards a proof of concept, and deliver key data insights that will help to develop the London Data Charter and London Data Board spearheaded by the Chief Digital Officer for London.

We will also work closely with Government through the DfT on its data discovery programme of work to open EV charge point data[98]. We believe charge point data should be openly available to enable the consumer to locate charge points. The DfT is looking to explore the best way to make the data available to support stakeholder needs and understand the feasibility and application of data standards to support the outcomes.

Finally, we will continue and enhance our efforts to educate, myth bust and guide both those installing and those using the infrastructure, aiming to bring the community with us. Sufficient information is needed to ensure infrastructure installed is the right type, in the right place, and being used in the best way. Where charge points may be provided on our land, we will look to set standards for ensuring simple and effective usage, alongside those to achieve fair pricing and operational reliability.

Financing

TfL has played a critical role in securing funding for charging infrastructure from both Government and private sector partners to date. Making the case for continued investment in London will be crucial to the continued success of EV uptake in London and supporting key user groups infrastructure requirements.

Our assessment of delivery mechanisms has revealed there are sectors of the commercial market, predominantly slow-to-fast CPOs, that will require ongoing funding support from the public sector due to the poor commercial viability of this type of infrastructure. We recognise the crucial role the infrastructure will play in supporting the needs of the majority of EV users in the short to medium term to 2030, as it provides a low-cost solution to fulfilling charging requirements. That is why in our forecast projections of the slow-to-fast chargers London will need to support EV users by 2025, we have anticipated at least 50 per cent of the infrastructure (up to 13,250 slow-to-fast charge points) to continue to be delivered by the public sector, which would cost approximately £66m.

We remain committed to increasing funding contributions from the private sector where the commercial viability of rapid charging points has evolved significantly. To this end, we have proposed that the public sector should support the delivery of 20-30 per cent of the anticipated rapid charging requirements to 2025 (between 180 and 570 rapids), which would cost between £15m and £48m. Even where a charge point is privately delivered, if it is on public land, the public sector would continue to be a key stakeholder.

As well as seeking further public funds, we will support further financial contribution from the private sector and create a self-sustaining charging market through the provision of data, leveraging our strategic oversight role, to help operators identify commercially viable sites and plug gaps in the charging network. TfL will work with government, the private sector and other stakeholders, such as the UK Cities Climate Investment Commission, to

[97] London First, London Data Commission – Data Sharing Pilots
[98] https://www.digitalmarketplace.service.gov.uk/digital-outcomes-and-specialists/opportunities/15132

explore innovative financing models, including blended cross-sector place-based financing facilities to transition regions to net-zero holistically.

Table *8* highlights the proposed role TfL, the public sector, the GLA, London Councils, Government and the private sector can play in the future delivery of infrastructure to meet the requirements forecast to 2030 and support key users to switch to EVs.

Table 8: Proposed role of public sector in delivery of EV Infrastructure

TfL / GLA / London Boroughs	
Role	Key activities/examples
Facilitation	Share best practice (TfL, LC, Gov)
	Engagement with key EV actors/groups (TfL, LC, Gov)
	Develop innovation/best practice trials (TfL, Gov)
	Continue to lobby Govt to support a national framework (TfL, LC)
	Continue Charge Point Operator Forum (GLA)
	Improved tools to assist delivery partners (private)
	Public and private sector troubleshoot rapid hub delivery (TfL, LC, private)
	Work together to address cost of grid upgrades (Gov, private)
	Provide data standards (including Open date) (Gov)
Strategic Oversight	Set strategic direction (via strategies, policies such as for parking, zero emission zones, guidance docs etc) (TfL, LC, Gov)
	Leverage policy levers & planning powers to accelerate EV uptake (TfL, Gov)
	Build evidence base to support site selection (LC, TfL)
	Maintain Data Dashboard for all GULCs charge points (LC, GLA)
Land Access	Sharing upgraded grid capacity (e.g. at TfL bus garages) (TfL)
	Developing rapid hubs on TfL / borough/ third party land, including those which provide a number of amenities/ services
	Enable further charging infrastructure on GLA, TfL and borough land (TfL, GLA, boroughs)
	Continue to explore commercial partnerships with landholders (GLA)
	Explore peer to peer sharing of charging infrastructure (private)
	Enforcement (TfL, boroughs)
Financing	Continue to make the case for private sector investment (TfL, LC, GLA)
	Continue to cover staff time but seek to recoup through share of revenue (TfL/ boroughs)
	Continue to bid for funding for TfL and London Boroughs (TfL, LC)
	Public and private sector to work together to reduce cost of rapid hubs (private)
	Increased funding contributions for charge point delivery from private sector (private)
	Fund commercially unviable sites in the short term to avoid gaps in the network (TfL, boroughs)

6.4. The Mayor and TfL's commitments to achieve the strategy's vision

The keystone Mayoral commitment, which will support and enable both private and public sector delivery of new EV infrastructure, is:

> **From 2022, unlock GLA Group land to repurpose it for EV charging – addressing one of the biggest barriers to infrastructure roll out in London. Leading the way for London boroughs to unlock their land, ensuring sufficient levels of charging can be achieved.**

By addressing one of the biggest barriers to infrastructure roll out in London, this commitment will boost private sector delivery as well as public. It will support CPOs by making land available and support all users by enabling many more charge points across the capital. By doing this we will support access for all users especially those without off-street home charging, essential travel, and for high mileage users, levelling infrastructure access across inner and outer London.

This will involve:

- Assessing all available GLA group land, looking for suitable locations to support the delivery of a network of rapid charge points and hubs across London. Initial estimates indicate up to 1,000 rapids could be accommodated on GLA Group land
- Focusing initially on high-mileage, essential road users, maximising emissions savings and supporting the goals of the Mayor's transport and environment strategies, while considering the need to encourage all road users to switch to zero-emission vehicles
- Encouraging London's boroughs to continue and enhance delivery of residential slow-to-fast charge points on their land, where users can access lower cost energy for residential slow-to-fast charging, even if they don't have access to home charging. This will help make the procurement and delivery process more streamlined and efficient
- Implementing high-quality operational standards, looking at the procurement process to improve the user experience, fair pricing, sustainability and longevity of the charging infrastructure
- Working with the private sector to support, in the form of technical, commercial, and financial where possible, the delivery of public infrastructure
- Our Commercial Development team is pursuing opportunities to roll out our own rapid charging hubs, using available land. These hubs will have environmental, social and economic benefits, providing significant ongoing revenue while supporting the transition to electrification. Planning, legal and technical due diligence is being done to assess ten initial sites, owned by us and the boroughs, for their suitability. It is intended that several hubs will come forward for development in 2022

All users will be supported by the following:

- Developing a real-time and open Application Platform Interface (API) of all charge points across London to improve user experience and provide more reliable

information on individual charge points. We will improve the user experience and provide more reliable information on individual charge points. Subject to an initial feasibility study and Government funding, this will be initiated in 2022

- Supporting the delivery of shared access charging facilities between third parties, benefiting key user groups. We will pioneer the first bus garage shared infrastructure, which, subject to Government funding, will get under way in 2022

The **EV Industry** will be supported by:

- Seeking a partner to set up an EV Ethics and Sustainability Committee that will engage with others, such as international cities, governments, trade bodies and non-government organisations to identify collective international action to address the ethics and sustainability of the supply chain for EVs. TfL will also seek to tackle through its own procurement standards
- Providing demand data and evidence base to support private sector investment in rapid charging infrastructure, via the CPOs Forum, and potentially to wider audiences depending on the sensitivity of the data
- Work with energy distributors (DNOs) to identify localised grid constraints, so that DNOs can get government support to fund this grid upgrades, as required
- Exploring green financing opportunities with the private sector to find the best financing solutions to support the roll out of EV infrastructure
- Supporting CPOs who want to streamline the verification of driver licence status, improving efficiencies when applying preferential charging rates to key users
- Updating London level EV infrastructure forecasts every two to three years and supporting boroughs with granular level forecasts, starting in 2022

Commitments and actions in support of specific key user groups, addressing barriers of concern to each, are set out below.

Taxis
Key Barriers: • Price premium of EVs and slow uptake due to the coronavirus pandemic impact and recovery • More rapid chargers required in the Congestion Charging Zone where many taxi trips originate and end • Lack of close-to-home slow-to-fast charging for Taxi drivers who don't have access to off-street parking • Expense of public charging infrastructure

Taxis

Commitments in support of taxis:

- Working with CPOs to find technical solutions to enforce taxi-dedicated bays – This work has already begun
- Continuing delivery (subject to funding) of taxi-dedicated bays in locations where taxi drivers frequently work. As demand grows from other key sectors, we will also explore dynamic solutions to maximise utilisation
- Continuing to explore innovative charging options including wireless charging on taxi ranks

PHVs

Key barriers:

- Lack of off-street parking for a large majority of PHV drivers yet to switch to EVs
- Lack of rapid chargers at strategic locations outside central London where PHV trips take place

Commitments in support of PHVs:

- Encourage delivery of slow-to-fast charge points focusing in areas with a high proportion of private hire drivers
- Supporting the delivery of rapid charging where drivers live and work such as town centres across the city
- Instigating a regular forum, from the end of 2021, between CPOs and PHV representatives which will help solve specific issues.

Light goods vehicles (LGVs)

Key barriers:

- Limited data available on travel behaviours, location and size of fleets to establish specific public infrastructure requirements
- Lack of access to some charging facilities 24/7
- Limited geographic spread and volume of charging hub sites, affecting commercial users' confidence in availability and reliability
- Complex payment and subscription services for charge points
- Lack of close-to-home slow-to-fast charging for drivers who don't have access to off-street parking

Light goods vehicles (LGVs)

Commitments in support of LGVs:

- Establishing a commercial fleet database for future planning and investment in infrastructure to support commercial fleet users to switch to EVs, by 2023. This could be built on the Energy Saving Trust study in 2015[99]. By developing a pilot database in London, it would set the context for a scalable national version to be developed, recognising the inter-region trip patterns of commercial fleets.

- Set up the London EV Business Leader's forum working with private and commercial fleet operators to address specific issues, including their transition to EVs and how they support the delivery of London's charging needs. This will be achieved from 2022.

Car Clubs

Key barriers:

- Limited geographic spread and volume of rapid charging facilities across London
- Government funding restrictions for installation of charge points at on-street car club bays
- Different approaches by London boroughs to supporting car clubs EV infrastructure provision

Commitments in support of car clubs:

- Support the electrification of car clubs by encouraging infrastructure in locations where active car clubs operate

- Working with operators and car clubs to explore dynamic solutions, looking at how car clubs can make optimal use of the infrastructure, such as prioritised overnight rapid charging

[99] A study conducted by Energy Saving Trust, on behalf of Transport for London, in 2015 worked with organisations operating a total of 2,250 vehicles in London to identify illustrative locations for rapid charge points to support uptake of plug-in commercial vehicles and highlight where strong businesses cases for rapid charging infrastructure exist and could be used by multiple fleets. The study recommended the outputs and map of optimum locations be reported publicly with a greater sample of real-word fleet movements as it provides valuable information on the likely optimum locations for installing rapid charge points, provides confidence for potential financial investors on utilisation and facilities the adoption of electric vehicles by commercial fleets.

Emergency services and public sector fleet vehicles
Key barriers: • Lack of depot space to support on-site EV charging for all fleet vehicles • 24-hour use of vehicles with limited opportunities to charge at depot • Public infrastructure required for resilience plans • Physical constraints of public charge point bays to charge specialised, and large, vehicles
Commitments in support of emergency services and public sector fleet vehicles: ➢ Work with emergency services and public fleets (eg boroughs) via the GLA fleet forum to support their transition to electric vehicles. Building on joint EV infrastructure study, coordinate further EV charge point procurement, market engagement and explore joint funding opportunities ➢ Looking at the feasibility of a dedicated bay for emergency services at one of our rapid charging points, with feasibility work starting in 2022.

6.5. Funding requirements

The Government's Transport Decarbonisation Plan[100] and subsequent Net Zero Strategy[101] commitment to phase out the sale of new petrol and diesel cars from 2030 will require an accelerated roll out of EV infrastructure in London and across the UK. More than one third of all charge points in the UK are currently located in London[102]. EV sales are beginning to accelerate at pace, and this will result in increased demand for EV charging infrastructure, as our modelling has forecast. Furthermore, London has implemented strict emissions-based policies that are encouraging Londoner's to transition away from petrol and diesel vehicles to zero-emission vehicles more quickly.

While we urge the private sector to respond to meet this demand, with continued support from TfL providing strategic oversight and facilitation, it is clear that London will require ongoing funding from Government to help maintain consumer confidence and accelerate the pace at which Londoners are transitioning to zero-emission vehicles. It is promising to see additional Government support pledged in the Net Zero Strategy for the continued delivery of slow-to-fast on-street residential charging infrastructure, which has limited commercial viability due to the nature of the business model and present utilisation.

However, we would also like to see **a national fund to support the roll-out of on-street and rapid charge points**, which London is eligible to bid for, following on from the success of GULCS and ORCS. We estimate that an investment of between £15m and £48m would deliver between 180 and 570 rapid charge points, which is 20 to 30 per cent of London's likely rapid charging need by 2025. Investment of between £26m and £66m would deliver between 5,250 and 13,250 slow-to-fast charge points, which is around half of

[100] Decarbonising Transport, DfT. 2021
[101] Net Zero Strategy: Build Back Greener, UK Government, October 2021
[102] www.zap-map.com/statistics/

London's likely needs by 2025[103]. The percentages we expect to be delivered by the public sector have been estimated from our current understanding of the market and from stakeholder engagement, enabling us to set a clear vision for the future.

While we remain committed to increasing funding contributions from the private sector, we acknowledge that the slow-to-fast market is not yet mature enough to provide fully funded proposals to London boroughs that offer a fair and just deal. In the short term, Government funding remains key to support the two-thirds of Londoners without access to off-street parking. Without this funding, a large proportion of Londoners could be left behind in the move towards fleet electrification, which risks reinforcing existing social inequalities and prolonging the use of more polluting vehicles.

We will also be evaluating a variety of more flexible procurement models while exploring the use of GLA land, to help accelerate the installation of vital infrastructure, alongside private CPOs. Some of these models would continue to require upfront investment from the public sector, as per the on-street residential charge points delivered by London Boroughs and funded through GULCS and ORCS.

As a result of our success to date in delivering EV charging infrastructure in London, we are uniquely placed to pilot innovative solutions in response to the challenges of electrifying the vehicle fleet.

As outlined in this Strategy, the scale of the challenge and uncertainty of how commercial fleets will get to zero emission is crucial to action, and we would like to put forward proposals specifically to support their transition. Initially, we are seeking Government funding of up to £1m to develop a **database of commercial fleet activity**.

Through the assessment of delivery mechanisms and role that public sector institutions can play, we have also identified the opportunity to maximise the use of refuelling infrastructure by creating **shared access to infrastructure for public and commercial fleets** where feasible, potentially between public fleets, commercial fleets and through public access. We are seeking £20m to deliver shared infrastructure at bus garages in London, and so pioneer this new business model.

We are also seeking up to £1m to pioneer a new data platform to develop a world-leading **real-time information system for EV charge points,** which could be scaled up to operate at a national level.

The GLA/ TfL has demonstrated competence in delivering pilots to test and develop solutions that can then be scaled up to the rest of the country. Our experience in developing open data systems, with their unified API for real-time and high-volume transport data, has stimulated innovation and new business, for example CityMapper.

We would welcome a collaboration with OZEV to address the pain points for EV drivers – with £1m funding support from Government, we can work with CPOs to develop a unified and real-time data feed of all EV charge points in London, stimulating innovation, improving outcomes for EV drivers and helping set the standard for the rest of the country.

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[103] An estimate of £5,000 is used to calculate the cost of an individual slow-fast charge point and £85,000 to deliver 50kW rapid charge points or 150kW ultra rapid charge points.

6.6. Next steps

The Strategy has highlighted how the EV market is developing at pace, even within the five-year timeframe of the 2019 Delivery Plan and in the context of the pandemic, which continues to cast uncertainty on how people will travel and the use of EV infrastructure in London. We saw a record number of EV registrations in the last year and Government acceleration of ICE vehicle phase-out in a bid to maximise progress towards air quality and climate change targets. The COP26, the UN Climate Change conference hosted in Glasgow in 2021[104] provided an opportunity to redouble efforts, action and commitment to tackle climate change by cities, businesses and individuals and build on this momentum to achieve a carbon-neutral London by 2030.

It is essential that TfL, local authorities, London Councils and the private sector continue to work together to make progress in growing a future-proof charging network, in a cost-effective way, embedding the vision outlined in this Strategy and acknowledging London's significant role in achieving national and international climate targets as a leading global city. Through the collaboration demonstrated by the EV Infrastructure Taskforce, and through stakeholders engaged in the production of this Strategy, we have together started to unlock the barriers around the practical delivery of charging infrastructure. As we consider the next phase of EV infrastructure installation, we must consider too how it can contribute to London's recovery, supporting green jobs and a sustainable economy, and unlocking social benefits as the switch to EVs accelerates.

The number of public charging points we expect to need by 2030 is challenging, and we call all those who can help achieve it to take action. Though the commitments in this strategy, including putting forward public sector land, we expect, although challenging, it will be achievable.

We welcome the imminent publication of a National EV infrastructure Strategy to ensure the UK's charging infrastructure network meets the demands of its users and setting out the vision for infrastructure rollout across the UK, recognising the inherent nature of car journeys across boundaries and regions.

Data is pivotal to understanding EV users' charging behaviour to enable better planning of infrastructure. We will continue to work with stakeholders, including through the London Data Commission pilot project supporting plans for EV charging infrastructure[105] to explore how sharing insights from public-private partnerships can unlock EV market constraints.

The conclusion of the E-Flex project[106], which looks at how vehicle-to-grid technology, EVs and energy services can be used by fleet owners and operators to cut energy bills and reduce energy use, will also be fundamental to the installation of infrastructure and the impact on the electricity grid in the future. The outputs of another demonstration project, Wireless Charging of Electric Taxis (WiCET)[107], will also provide long-awaited findings on the potential for inductive charging technology to provide for EV charging requirements. We continue to seek further engagement with city partners, in the UK and beyond, to

[104] COP26, UN Climate Change Conference UK 2021
[105] Data Sharing Pilots, London Data Commission
[106] https://www.e-flex.co.uk/
[107] WiCET, Wireless Charging of Electric Taxis

understand the implications of emerging technology and roll-out of EV infrastructure at scale.

Many questions have been raised around the source and end-of-life sustainability of materials. Further research is required to build the evidence base for this and ensure responsible ethics of the whole supply chain. We will continue to collaborate with partners such as Electronics Watch, to improve the transparency of the socio-economic and environmental impacts of the EV supply chain.

The purpose of this Strategy is to reassess what might be needed and what more can be done to further facilitate the transition to zero emission vehicles by supporting the necessary provision of infrastructure across London, focusing on essential road users. However, we recognise that electrification of transport will not solve all our problems and that a focus on sustainable mode shift remains a key priority with efforts targeted at achieving an overall reduction in private car use across the road network.

In order to ensure that our work continues to have maximum impact and we make progress towards Mayoral targets, we will continue to work closely within TfL, the GLA, London boroughs, London Councils and across the industry to achieve our key principles and the vision for 2030 outcomes. An overview of this ongoing activity is also set out in Table 9 below.

Table 9: Ongoing and future activity to support the London EV Infrastructure related to the desired 2030 outcomes

Theme	Ongoing and future activity
Environment	Supporting infrastructure delivery, enabling switch to EVs, reducing carbon emissions and improving air quality. Addressing battery supply chain transparency, working with partner organisations, such as Electronics Watch. Setting specifications that all EV infrastructure delivered through TfL frameworks are required to operate using renewable electricity, (which can also be adopted by boroughs).
Sustainable Mode Shift	Prioritising essential road users' EV charging requirements, whilst also enabling other users who need to make an essential trip by car to access a charge point, providing strategic vision and continued development of forecasting tools to support this.
Healthy Streets	Promoting TfL guidance to ensure the delivery of EV infrastructure aligns to TfL's design principles. We will update the EV charging point installation guidance to reflect updated feedback and emerging accessibility guidance.
Accessibility	Working with Government for a national-level solution for roaming payments and for a switch to pence-per-KwH tariffs to ensure users know what they will be charged and consistent with energy sector pricing for home charging. Mandating the enablement of Pay-as-you-go options on all public EV infrastructure and contactless payment on all rapid charge points that are available to the public, delivered through TfL frameworks and ensure these requirements can be adopted by boroughs.

Social Inclusion	Using available and suitable land to deliver a consistent, fairly priced network of charging infrastructure across London. Making the case for funding of sites which, although less commercially viable, would bridge gaps in London's charge point network. Work with the government for VAT consistency between public charge points and home charging use.
Commercial Viability	Supporting a strategic approach to site selection, providing data and analysis, to improve the business case for private investment. Using a flexible procurement model, TfL will vary the contract lengths delivered on TfL or GLA land reflect the viability of the site whilst also seeking a fair deal for TfL and boroughs.

Appendix A: Stakeholder engagement

In order to develop our evidence base for this Strategy and understand the market failures of public and private EV infrastructure, we consulted with a wide range of stakeholders to understand issues faced. Engagement mainly took place online in 1-1 meetings, attendance at roundtable discussions and hosting of workshops/ forums to share views.

The Mayor's EV Infrastructure Taskforce was also reconvened and aided the development of this Strategy. The stakeholders consulted (see Table A1) provided information and evidence on how they saw the EV market evolving, opinions on current policy changes, the role of TfL and the public sector, and the use of EV infrastructure.

Table A1: Stakeholders consulted for the development of this Strategy (non-exhaustive)

Examples of stakeholders engaged by category	
Logistics / Fleet Operator	
Amazon	Logistics UK
Centrica/ British Gas	Royal Mail
Federation of Small Businesses	
Car and Van Share	
BVRLA	Enterprise Car Club
Como UK	Zipcar
Emergency Services	
London Ambulance Service	Metropolitan Police
London Fire Brigade	
Consultancy/ Research organisation	
Baringa Partners	ICCT
RAC Foundation	Zero Carbon Futures
Element Energy	
Charge point suppliers/ operators	
Allego	Osprey Charging Network Ltd
BP Chargemaster	Shell
Connected Kerb	Trojan Energy
ESB	Ubitricity
Gridserve	UKPN (development) Ltd
Fastned	Electric Miles
Energy	
National Grid	UK Power Networks
SSE Enterprise	Energy UK
Taxi and Private Hire Operators & Representatives	
Addison Lee	LTDA
Bolt	Uber
Industry Representatives	
BEAMA	London First
Citizens Advice	Renewable Energy Association
Energy Saving Trust	Society of Motor Manufacturers and Traders
Government / Local Authorities / Agencies / Other	
London Boroughs	Ofgem
London Councils	Office for Zero Emission Vehicles
Greater London Authority	Cross River Partnership

Appendix B: Lessons learnt in charge point delivery

Lessons learnt – public sector

Table B1: Lessons learnt from public sector delivery of slow-to-fast on-street charge points

Item	Lesson	Opportunities
1. TfL's procurement framework	TfL's public sector procurement framework has provided boroughs with a simple and standardised process for the procurement and delivery of charge points. It is becoming out of date and will expire in July.	If we are to continue providing a public sector framework, then a new and more flexible procurement route is required which provides access to new technology and private finance.
2. TfL's guidance documents	TfL has produced a range of documents including London's EV charge point installation guidance. The best practice documents have been widely welcomed by the boroughs.	TfL guidance documents could be refreshed to include advice on trailing cables, EV signage and futureproofing infrastructure.
3. Borough resource constraints	Resource constraints (funding and staff) are an ongoing challenge for boroughs. Meeting match funding requirements has been difficult, and staff resource has been an ongoing challenge, which has impacted delivery timescales.	Most boroughs are committed to continued delivery of on and off-street residential charge points, however there is a desire for a fully funded charging infrastructure that covers staff costs.
4. Understanding demand	Site locations have largely been led by desire and feasibility rather than being strategically planned.	This Strategy provides pan-London and borough level forecasting of infrastructure demand, supporting a strategic approach to site selection. Our findings and projections can inform borough strategy and help third parties to identify commercially viable sites.

Item	Lesson	Opportunities
5. Site viability	Up to 50 per cent of proposed sites are rejected at site assessment due to site constraints and the suitability of lampposts.	Enhanced mapping could help boroughs eliminate unsuitable locations before site assessment helping to improve efficiencies.
6. Misuse of charge points	In areas of high parking demand and where only one charge point has been delivered, boroughs have reported receiving complaints from residents who can-not access charge points.	Future guidance documents should recommend that in areas of high demand, delivery of multiple charge points is the best way to ensure adequate access. Operators can manage access through technological fixes and flexible tariffs that discourage overstaying for EV drivers plugged in longer than they need to charge.
7. Competing kerbside priorities	Boroughs are concerned at the growing political delivery of EV charging against other priorities such as cycling infrastructure.	In response to borough requests, TfL should consider producing a kerbside strategy that considers the competing demands on the kerbside.
8. Street clutter	Boroughs are keen to minimise street clutter.	Future slow-to-fast delivery options to support discreet technology to help minimise street clutter.

Table B2: Lessons learnt from public sector rapid charge point delivery

Item	Lesson	Opportunities
1. TfL's procurement framework	TfL's Rapids framework has supported boroughs and ensured consistency across London. The procurement framework has been unable to adapt to changing requirements as the market progressed.	If we are to continue providing a public sector framework, then a new and more flexible procurement route is required which provides access to new technology and private finance.

Item	Lesson	Opportunities
2. TfL's guidance documents	TfL has produced a range of best practice guidance documents for key delivery partners. While welcomed by the boroughs, they have not been consistently used by other partners.	If we maintain these documents, we will need to continually update them as new best practices emerge and encourage all delivery partners to use them.
3. Roles, responsibilities and project processes	At times there has been lack of clarity on roles, responsibilities, and processes. For example, boroughs have experienced contract management issues with operators.	To increase transparency, efficiency and contract compliance, we must clearly define the roles, responsibilities and processes at project onset.
4. The role of TfL and the boroughs	Borough resource constraints have been a persistent challenge. The lack of funding to cover staff costs presents a challenge to boroughs.	Define more clearly the future role of TfL and boroughs in the delivery of rapid charging infrastructure
5. Site viability	A large proportion of identified rapid charging sites prove unviable following site assessments. The barriers include the cost of grid upgrades, aesthetics and the length of the lease.	DNO heat maps could be layered with additional information, providing a fuller picture of site viability We expect some of the aesthetic challenges will be overcome as technology and design evolves Longer leases boost the commercial viability of sites
7. Misuse of charge points	Ongoing reports of non-taxi vehicles using taxi-only charge points.	Enhance enforcement at problem sites
8. Street clutter	Rapid chargers are installed alongside other street furniture, which can present a hazard to pedestrians/other footpath users and add to street clutter.	Any refresh of TfL's guidance could consider recommending the use of build-outs, to retain accessibility of the footpath for pedestrians.

Item	Lesson	Opportunities
9. Meeting the needs of different vehicle types	Different vehicle types have different charging needs. Some vehicles cannot be charged at certain locations due to cable length, charger position or vehicle size.	Any technical specifications for charge points should be inclusive of a wide range of vehicles.

Lessons learnt – private sector

Table B3: Lessons learnt from private sector rapid charge point delivery

Item	Lesson	Opportunities
1. Land affordability and availability	The availability and affordability of suitable land in London is a key barrier.	• Sharing of charge point infrastructure between third parties is an area of considerable potential. • The public sector can explore utilising its land to support charging infrastructure. • Private partners could exploit under-utilised assets, including car parks, by forging new partnerships.
2. Utilisation risk	Utilisation risks affect commercial viability.	• The projections and spatial data contained in this Strategy support a strategic approach to site selection, helping to minimise commercial risks. • Some sites will not be deemed commercially viable but will be of strategic importance. The public sector needs to consider its role in supporting delivery of these sites.

Item	Lesson	Opportunities
3.The complexity of the planning process	The planning process is deemed slow, inefficient and complex, and gaining consent can be uncertain. These factors add to commercial risks.	• Not all private operators understand the planning process. TfL could consider developing a planning guidance document, which includes rapid chargers and hubs. • TfL is to consider providing planning consent training to borough officers to encourage best practice and knowledge sharing.
4.The cost and complexity of energy grid upgrades	Cost: The peak demand for electrical networks is at capacity in many locations, resulting in the need for power upgrades. The enabling work tends to be costly, making many sites commercially unviable. Complexity: Engaging with, and accessing information from, UK Power Networks can be complex and lengthy.	• Cost: Ongoing engagement with DNOs and the government is required to consider how to overcome this critical challenge. The public sector could also consider financial models which help the private sector recoup costs. i.e. longer leases. • Complexity: Ongoing engagement with DNOs is in areas such as how to improve the DNO engagement process, and the feasibility of layering heat maps with additional information to capture associated costs and considerations.

Appendix C: Modelling Assumptions

In this appendix, we explain the methodology and key assumptions used to develop the estimates of charging requirements outlined in Chapter 5.

These have been generated by updating the modelling undertaken as part of the EV Infrastructure Taskforce Delivery Plan in 2019, our first attempt to quantify the sense of scale charging infrastructure to 2025 based on feasible demand scenarios. The assumptions and key inputs to this model have been updated to reflect how the EV market in London has since developed. It should be noted that our estimates are presented to show how the market may grow based on our current knowledge (under certain scenarios) and the implications this would have for charging requirements.

In particular, our modelling assumes that there are no changes in policy which impact on the number of overall vehicles in London, or the distances drivers travel. It also does not take into account how future technologies may reduce the frequency that vehicles need to be charged or the time it takes to charge. And as described in the introduction, the potential widespread use of autonomous vehicles in the future is out of scope due to the high degree of market uncertainty associated with this area.

In this appendix we outline the key updates made to our assumptions, which include:

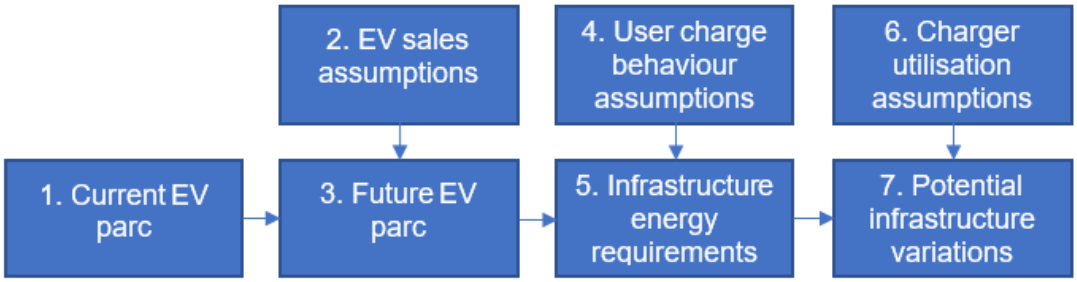
- Rebasing our modelling to 2020 to reflect progress made since 2019
- Extending the time horizon of our modelling to 2030
- Reviewing the forecast growth in EV uptake to 2030

This appendix focuses on the changes made and the rationale for these, rather than provide full detail of all assumptions used. A more detailed explanation of the complete modelling process can be found in Appendix A of the 2019 EV Infrastructure Taskforce Delivery Plan[108].

Modelling overview

The model has seven key components which are outlined in Figure C1. These steps remain unchanged from the previous modelling.

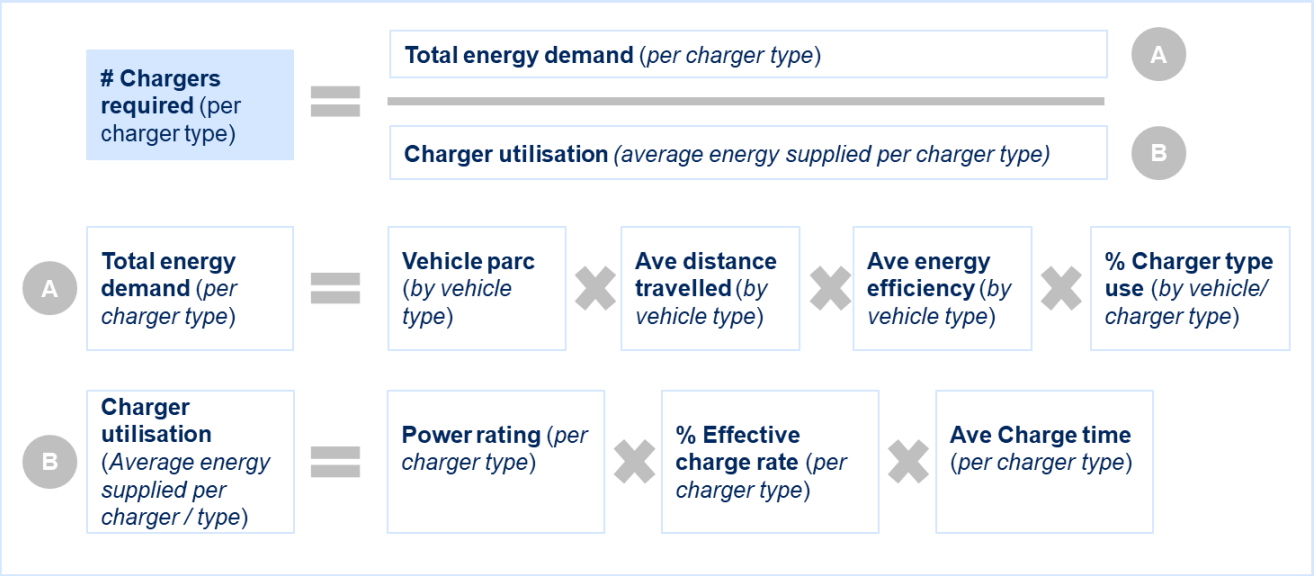
Figure C1: Components of the EV infrastructure model



[108] London Electric Vehicle Infrastructure Delivery Plan, Transport for London, June 2019

The number of chargers required of each type is calculated using a simple formula which is shown in figure C2. Estimates are based on the total energy demand for a given type of charging (e.g. slow-fast, or rapid) divided by the average energy that can be supplied by a charger of that type.

Figure C2: Basic equations used in the model



The following discussion considers each of the seven modelling steps set out in Figure C1 and explains what amendments have been made to our previous 2019 forecasts.

1. Current EV parc

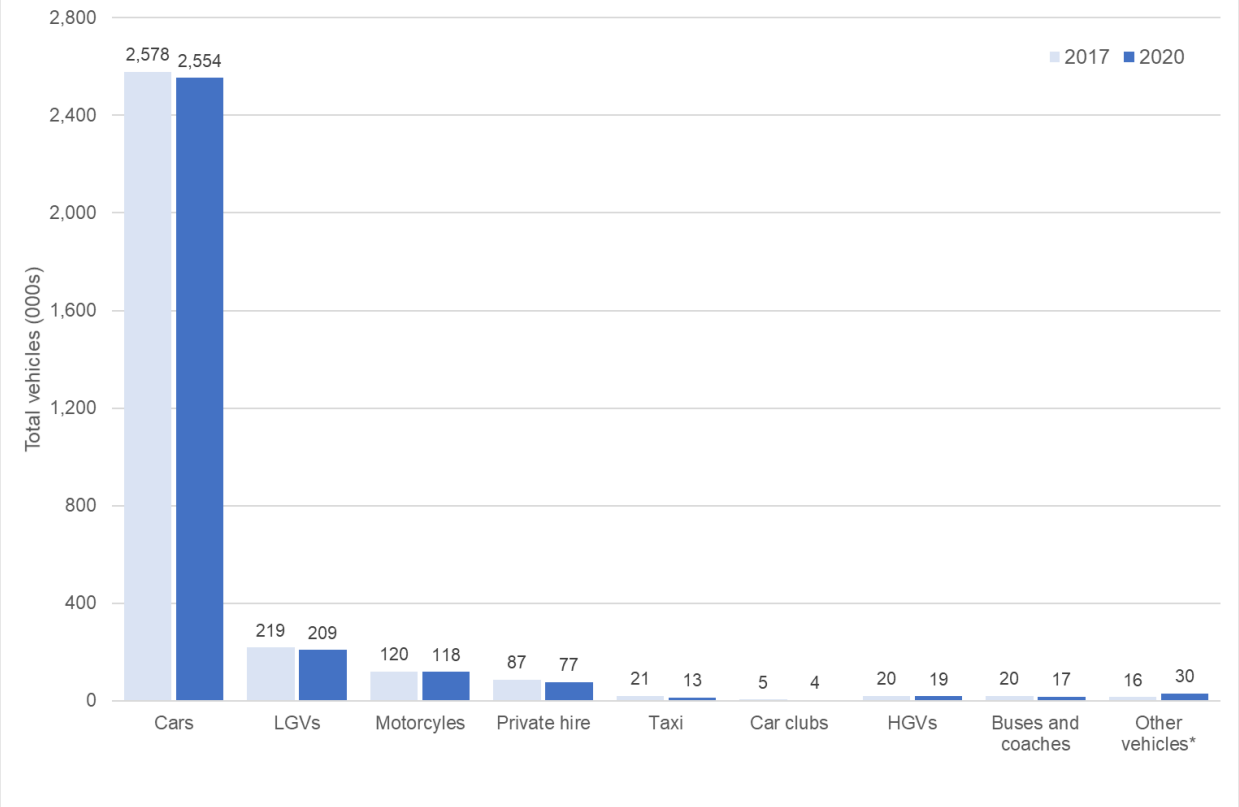
London's EV parc has tripled from the 2017 baseline of 14,000 vehicles which was used for the 2019 EV Taskforce modelling. As of Autumn 2021, when the modelling runs took place, the total nunber of EV's registered in London exceeded 53,000. This included:

- Over 40,000 EV cars and vans
- Over 4,500 ZEC taxis
- 3,700 battery electric private hire vehicles

Despite a signficant decline in the overall number of new vehicles registered in 2020, uptake of EVs has remained strong. The total number of vehicles registered in London (including non-EVs) has fallen very slightly since 2017, but remains at approximately 3 million (Figure C3). For the purposes of the modelling, our overall assumption around the number of vehicles that will need to shift in future remains unchanged. We do assume that any long-term reduction will have signicant impact on our forecasts to 2025 in particular.

The coronavirus pandemic has significantly disrupted both the taxi and private hire sectors, leading to notable reductions in registrations in 2020. It remains unclear how each will recover. However, for modelling purposes, both are assumed to return to pre-pandemic levels.

Figure C3: Total vehicles registered in Greater London in 2020[109]



As previously, the modelling is based only on cars and vans registered in London, but estimates are used to calculate all London charge point needs.

This continues the assumption that when the annual distance travelled by London drivers travelling outside London is factored into the analysis, this approximately offsets the distance travelled within London by non-London registered vehicles.

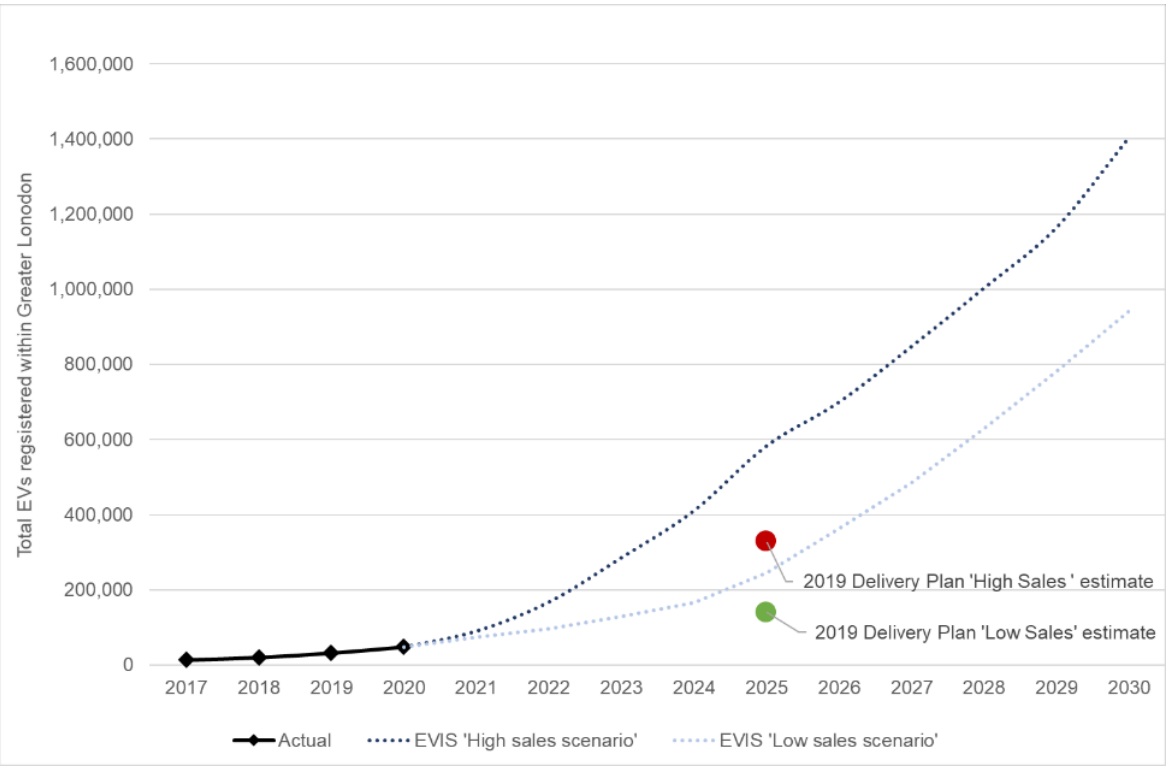
2. EV sales assumptions

Future EV sales assumptions remain a key uncertainty – both in terms of the supply of vehicles (especially in the short-to-medium term) and in the level demand from consumers.

As previously, our modelling has been based around a low and a high scenario for sales. These scenarios have been revised to provide updated assumptions for 2025 and new assumptions for 2030 (see Figure C4).

[109] Data sources: Department for Transport, dataset VEH105, TfL taxi and private hire vehicle licensing and CoMo UK (car club data)

Figure C4: EV sales growth scenarios[110]



For cars, vans, LGVs and motorcycles, the ‘low sales’ scenario represents a relatively slow growth in sales to 2025, followed by quicker growth between 2025 and 2030. In particular, this scenario assumes that growth will be constrained by the availability of new vehicles (for instance through a continuation of the disruption that has occurred during the coronavirus pandemic). It also assumes car drivers will be less willing to switch to an EV due to ongoing concerns around suitability.

Under the ‘high sales’ scenario, these supply constraints are removed quickly, and with an increasing range of vehicles on offer and reducing differences in price and convenience between EVs and ICEs, uptake accelerates fast. By 2030, over 80 per cent of annual registrations cars and vans are made up of BEVs.

Under each scenario, we assume that the annual number of new vehicles (including ICE vehicles) registered in London is the same and remains constant to 2030.

As with our previous modelling, EV uptake by taxis, PHVs and car clubs is calculated differently. Under the ‘high sales’ scenario, pledges by PHV providers to fully electrify their fleets by 2025 (or 2023) are delivered, with other PHV drivers also quick to take advantage of lower EV running costs. The uptake of EV taxis continues at pace, with over 70 per cent of drivers having switched to an EV by 2025.

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[110] Sources: Department for Transport, dataset VEH0131 for actuals to 2020; TfL taxi and private hire vehicle licensing and CoMo UK (car club data); 2019 EV Infrastructure Taskforce Delivery Plan; Element Energy Electric Car Consumer Model (for EVIS scenarios)

The ‘low sales’ scenario assumes a slower rate of EV uptake by the PHV sector, with annual registrations closer to those currently observed than the rate needed to fully electrify by 2025. Under both scenarios, however, over 95 per cent of taxis and PHVs are EVs by 2030.

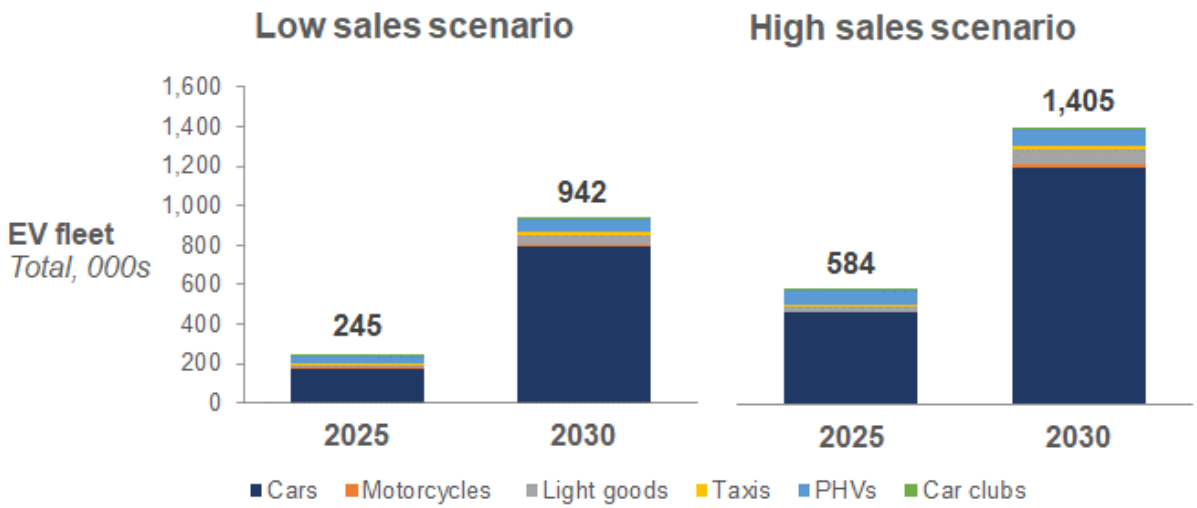
The car club market has evolved significantly since 2019, with several operators no longer operating in London. The largest operator, Zipcar has set a goal of a fully electric fleet by 2025[111] and it is assumed that this will be met under the ‘high sales’ scenario.

It should be noted that our ‘high sale scenario’ leads to a significantly higher projected number of vehicles by 2025 and 2030 than those modelled as part of other analyses, including the recent study on London’s charging needs by the International Council on Clean Transportation[112]. There are two reasons, in particular, why we have done so:

- The growing attractiveness of battery electric vehicles to consumers – with price parity between EVs and ICEs likely within a few years and previous concerns (including battery range and vehicle suitability) beginning to ease as technology advances and a wider range of vehicles is introduced
- The Government’s phase out of the sale of ICE vehicles from 2030 – which may stimulate more drivers to switch earlier than they would previously have considered

This scenario may remain relatively unlikely but is helping in defining what represents a realistic upper estimate of charging requirements for each type. This is especially important in determining how best to accommodate future charging demand in London.

Figure C5: Vehicle totals for high and low sales scenarios[113]



[111] As set out in the Zipcar Vision for 2025
[112] ‘Fulfilling electric vehicle charging infrastructure needs in Greater London and its boroughs’, ICCT (2020).
[113] Source: both scenarios are informed by Element Energy’s Electric Car Consumer Model.

NOTE: Based on vehicles registered in London only (for instance does not include any Taxis or PHVs which are licenced to operate in London, but which are registered outside)

3. Future EV parc

The future EV parc is simply the total number of EVs in 2025 and 2030 under the low and high sales scenarios. This is calculated by adding EV sales for each year to the existing parc. This indicates a range of between 245,000 and 946,000 EVs by 2025 and 584,000 and 1.4 million EVs by 2030 (Figure C5).

4. User charge behaviour assumption

How drivers will charge once EVs become more mainstream remains one of the key uncertainties in our modelling. As with the 2019 EV Taskforce Delivery Plan, our approach has been to use different charging behaviour scenarios to examine how each would impact on the energy demands for each type of charger. Our modelling has examined two scenarios:

The first (Scenario A) assumes that there is **a preference for faster public charging**, with more on-the-go, top-up charging taking place, as well as a continued mix of speeds, but most still wanting slow to fast chargers near their home. For those using faster charging, such as rapids and ultra-rapids, there will be more similarities to current petrol station refuelling behaviour.

The second (Scenario B) assumes that, although there will be some faster charging, there will be **a strong preference for more on-street slower, residential-based charging**, as well as a slightly higher proportion of private, at home charging on driveways. As with our 2019 modelling, access to off-street parking is still considered to be the most significant determinant of how private car, taxi and PHV drivers will charge their vehicle.

For each scenario we have provided a set of assumptions about how this then translates into demand for each charging type. This is broken down by the type of driver, where it is parked, and the type of vehicle (PHEV or BEV).

Our modelling in 2019 also considered a third scenario which assumed a preference for destination slow-to-fast charging. While destination charging way is still expected to be an important part of London's charging mix, we have not repeated this scenario within our modelling update. There are two key reasons for this:

- In the long-term, we consider it unlikely this will to be the preferred method of charging for most drivers

- Using the two charging scenarios enable us to capture the range of each type of charger that is likely to be needed, with the estimates for a 'destination scenario' between the two (for example, a 'destination preference' scenario requires more rapid chargers than the 'residential preference' scenario, but fewer than the 'rapid preference')

With the purpose of our modelling be to provide an estimated range of the chargers needed, we do not consider this to impact on our findings.

Table C1: Proportion of energy attributed to charger category types, by vehicle category and charging scenario

Vehicle category	Basic archetype	Per cent of vehicle category	EV type	A) Higher rapid preference (%)				B) Higher residential slow-fast preference (%)			
				P	Re	D	R	P	Re	D	R
Cars and motorcycles	Off-street parking	60%	PHEV	90	0	10	0	95	0	5	0
			BEV	85	0	5	10	95	0	3	3
	No off-street parking	40%	PHEV	20	50	30	0	20	75	5	0
			BEV	20	45	5	30	20	70	5	5
Taxis and private hire vehicles	Off-street parking	25%	PHEV	80	0	0	20	90	0	0	10
			BEV	80	0	0	20	85	0	0	15
	No off-street parking	75%	PHEV	0	50	0	50	0	70	0	30
			BEV	0	50	0	50	0	70	0	30
Vans	Depot-based fleets	33%	PHEV	90	5	5	0	100	0	0	0
			BEV	80	0	0	20	95	0	0	5
	Private owned delivery	33%	PHEV	55	20	20	5	80	15	5	0
			BEV	45	15	0	40	60	20	5	20
	Private owned trade	33%	PHEV	45	40	10	5	70	25	5	0
			BEV	40	30	10	20	50	30	10	10
Car clubs	-	100%	PHEV	0	40	20	40	0	60	20	0
			BEV	0	40	20	40	0	60	20	0

Key: P= Privately charged, Re = residential slow-fast, D= destination slow-fast, R= rapid

5. Infrastructure energy requirements

Charger energy demand has been modelled by combining the vehicle parc/user charging behaviour scenarios and the assumptions on annual distance travelled and fuel consumption for the different vehicle categories. Our assumptions around the distance travelled (shown in Table C2) remain unchanged from 2019, while energy consumption rates per segment have been updated to reflect more recent guidance (Table C2).

Table C2: Distance travelled per segment (km/year)

Segment	Distance travelled	Comment
Cars	7,500	Calculated by dividing total London fleet vehicle kilometres travelled from Emissions Factor Toolkit (LAQM) by total London fleet (DfT)
Motorcycles	5,000	Calculated by dividing total London fleet vehicle kilometres travelled from Emissions Factor Toolkit (LAQM) by total London fleet (DfT)
Vans	15,000	Calculated by dividing total London fleet vehicle kilometres travelled from Emissions Factor Toolkit (LAQM) by total London fleet (DfT)
Taxis	45,000	Based on taxi survey data that drivers travel an average 70 miles per day (~110km) for an estimated 300 days per year
PHV	60,000	Provided by large PHV operator, includes personal distance travelled for an average full-time driver

Table C3 then provides the modelled output of electricity demand across the two sales scenarios. This is followed by Table C4, which provides the same modelled output data, but split per user subgroup and by the modelled split between publicly accessible and private charging. As in our 2019 modelling, this indicates that, by volume of electricity, the taxi and private hire fleet, particularly those without off-street charging, is the dominant user group in the timeframe between now and 2025, with private cars growing to surpass this by 2030.

Table C3: Energy consumption rates per segment (kWh/km)

Segment	Energy consumption	Rationale
Cars	0.19	Based on average of current EVs on sale in UK as reported by Electric Vehicle Database[114]
Motorcycles	0.06	Consumption ranges from 0.05-0.08 for models of 'Zero Motorcycle' [115]

[114] Electric Vehicle Database, Energy consumption of electric vehicles.

[115] Spiritmonitor.de

Segment	Energy consumption	Rationale
Vans	0.23	Based on typical consumption rates for currently available vehicles.
Taxis	0.22	Calculation estimates for the LEVC ZEC taxi based on quoted EV range and assumptions about total/usable battery capacity. Expected that given size, weight and passenger loading, taxis will be closer to LGVs (vans) than cars
PHV	0.20	Selected as an interim value between private cars and taxis as PHVs are skewed towards Multi-Purpose Vehicles (MPVs)

Table C4: Total electricity demand scenarios by segment (GWh/year)

	2025		2030	
	Low sales	High sales	Low sales	High sales
PHV	453	808	845	1,054
Taxis	69	82	90	90
Cars	188	526	898	1,401
LGVs	22	87	133	232
Motorcycles	1	1	3	7
Car clubs	6	12	12	23
Total	739	1,516	1,981	2,807

6. Charger utilisation

Our assumptions around the effective charge rates of chargers remain largely unchanged from our 2019 modelling.

The key difference we have seen since 2019 has been the increased roll-out of ultra-rapid charging, with chargers of 150kW now commonplace and fewer 50kW chargers being delivered. Additionally, most new EVs are also capable of accepting charging speeds of above 50kW/h. To reflect this, we have adjusted our assumptions of the average charge speed provided by a rapid charger, increasing this from 50kW/h to 100kW/h. This assumption applies to all new charging infrastructure requirements from 2021/22 onwards, with our estimates of overall charging needs adjusted to reflect the number of 50kW chargers currently available.

Table C5: Assumed effective charge rates per charger type and average energy per day

	Rapid (from 2021/22)	Rapid (existing)	Destination slow to fast	Residential slow to fast
Assumed capacity kW	100	50	11	7
Effective charge rate – modelled	75%	75%	50%	50%
Average energy per day – modelled kWh/day	300	150	44	32

7. Potential infrastructure variations

The final component of the model provides potential scale of required infrastructure and builds on all previously developed assumptions within the model. Numbers are highly dependent on actual EV sales, actual user charging behaviour and actual utilisation levels. For this reason, they should not be treated as targets, but rather to provide a sense of scale for a number of 'what if' scenarios.

Figure C6 provides the range of modelled outputs for rapid chargers, Figure C7 for destination slow-to-fast and Figure C8 for residential slow-to-fast. Each of these charts provides modelled number of chargers for the different user behaviour scenarios, for two time periods 2025 and 2030 and for low and high EV adoption scenarios.

For the rapid charging estimates it should be noted that these are based on the assumption current 50kW charging will be retained at this speed (and not upgraded), while new charging will deliver an average 100kW charge (assuming this will be a mix of 50kW, 150kW, 350kW or potentially greater speed chargers).

Figure C6: Modelled number of **rapid chargers** by charge behaviour and sales scenario for 2025 and 2030

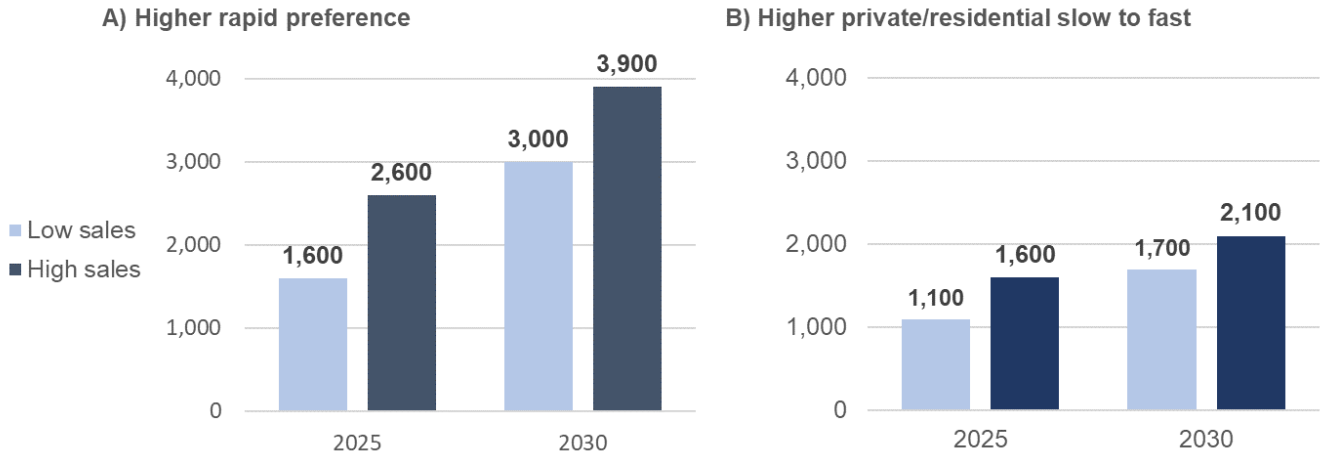


Figure C7: Modelled number of **destination slow-fast chargers** by charge behaviour and sales scenario for 2025 and 2030

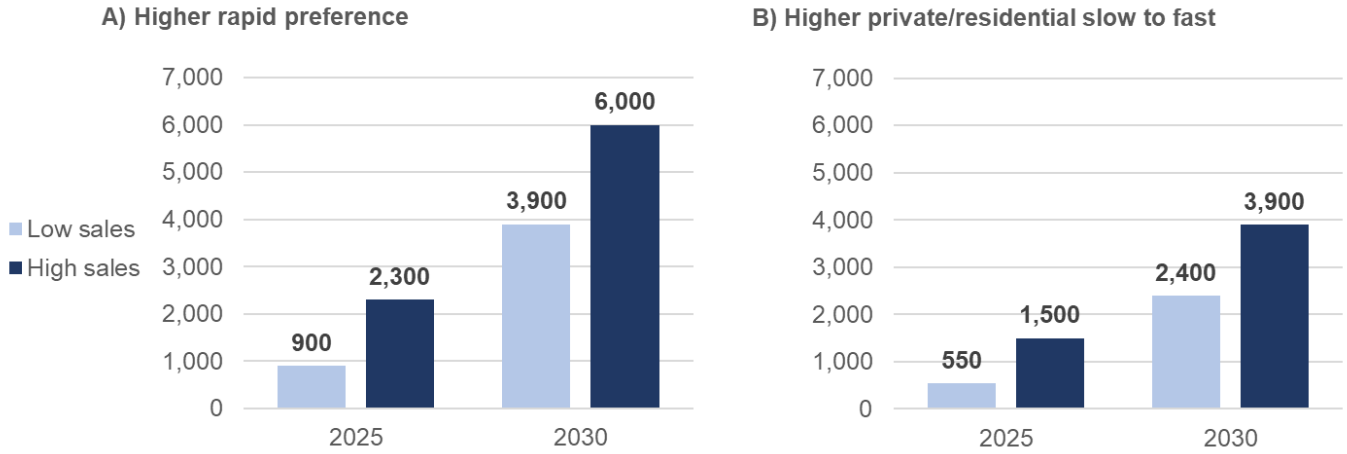
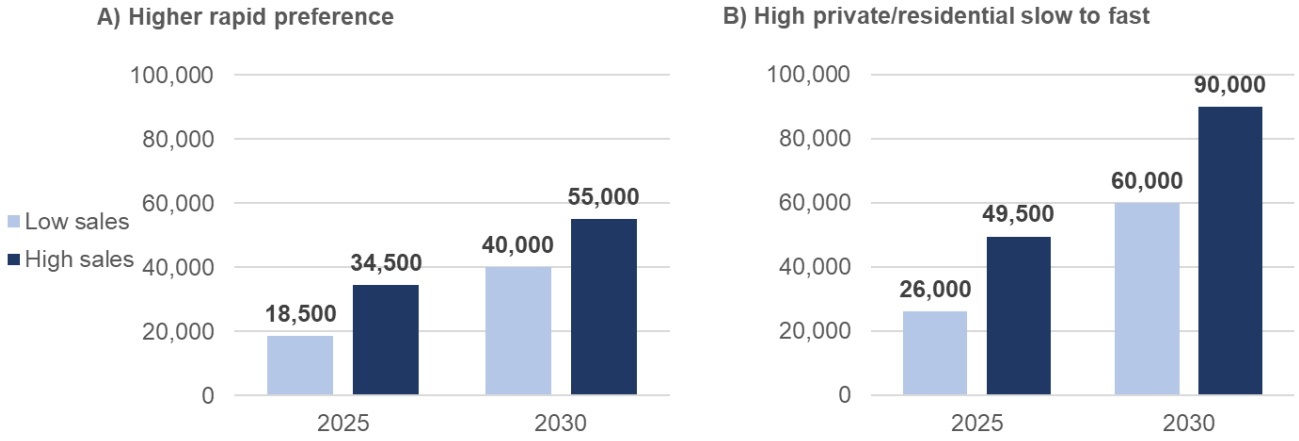


Figure C8: Modelled number of **residential slow-fast chargers** by charge behaviour and sales scenario for 2025 and 2030



Appendix 4 – List of 30 Fire Stations in Phase One

Barking
Battersea
Beckenham
Bexley
Clapham
Croydon - Front
Dowgate - Landlord's consent received
East Ham - Front
Euston
Finchley
Forest Hill
Greenwich
Holloway
Ilford
Lee Green
Lewisham
Norbury
Paddington - Upper
Park Royal

Poplar
Ruislip (Fire Station)
Shoreditch
Soho
Stratford (Fire station)
Sutton
Tottenham
Wandsworth
Wembley
Whitechapel
Wimbledon