Electric vehicle charging infrastructure:

Location guidance for London

MAYOR OF LONDON

TRANSPORT FOR LONDON

EVERY JOURNEY MATTERS

Contents

1. Background and purpose

1.1 Background

The Mayor is consulting on a range of bold new proposals to accelerate the uptake of cleaner vehicles on London's roads, including bringing forward and expanding the Ultra Low Emission Zone (ULEZ), alongside a suite of measures designed to reduce total emissions from vehicles in London.

This is part of the Mayor's ambition to make London's transport network zero carbon by 2050, which will also deliver necessary improvements in air quality, by transforming London's streets and transport infrastructure so as to enable zero emission operation, and by supporting and accelerating the uptake of ultra low and zero emission technologies.

It will only be possible to bring about a zero carbon city by 2050 if all vehicles have zero exhaust emissions by that date. Significant steps are required to achieve zero emission transport by accelerating the switch from fossil fuel vehicles to the cleanest vehicles – ultra low emission vehicles (ULEVs) – which emit no air pollutants from the tailpipe when driven in zero emission mode.

An ultra low emission vehicle, or ULEV, is the collective term for vehicles that can operate with zero exhaust emissions, including battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), range-extended electric vehicles (RE-EVs) and hydrogen fuel cell electric vehicles (FCEVs).

1.2 Aim of this document

This guidance addresses the needs of electric vehicles, which are simply referred to as electric vehicles (EVs) throughout.

London needs a coherent network of electric charging infrastructure that serves the needs of all types of EV users, from residents to commercial fleets.

This document aims to inform our understanding of where infrastructure is best placed to meet the needs of EV users by collating the latest evidence in one place. Each of the detailed research reports is also available for further information.

At Transport for London (TfL) we aim to help boroughs and charge point network operators to deliver charging infrastructure in the right locations for both current and future usage, supporting the implementation of the Mayor's Transport Strategy (MTS).

Following the publication of the draft MTS, we will work with the Greater London Authority (GLA), boroughs, industry and other stakeholders to develop new longer term and ambitious actions to take us beyond the ULEV Delivery Plan. This will ensure we achieve zero emission transport to deliver a net zero carbon city by 2050.

For more information, please see ‘Improving air quality and the environment’ in the draft MTS, available at www.tfl.gov.uk/mayors-transport-strategy.

The MTS also includes proposals to use pricing and regulatory incentives and to work with Government, boroughs and stakeholders across London to ensure the right charging and refuelling infrastructure is put in place to support the transition to ULEVs.

1.3 Core themes

Four core themes have emerged from the research we have undertaken on the current and future use of EVs in London. Examining each of these will ensure the best service for current and future EV users.

1. Identify current demand: Respond to requests for charge points from residents and businesses to balance competing demands for space and maximise charge point usage (and therefore viability of the charge point) from time of installation.

2. Provide for future uptake: Provide a certain amount of infrastructure based on predicted future demand, including for residents, while prioritising demand from essential commercial vehicles, zero emission capable (ZEC) taxis and private hire vehicles (PHVs). This will ensure current public funding will also support Londoners who cannot currently afford to switch to an EV but would like to do so in the future, for example, when the second hand market is more developed.

3. The right charge point in the right place: Use different types of charge points according to the type of user to ensure the most appropriate infrastructure.

4. A good geographical spread: Help to build a network of charge points across London to encourage the switch to EVs equitably across the city. This will also reduce the risk of drivers having to drive unnecessary mileage to top-up.

1.4 Document scope

This document provides a summary of the key findings from our research regarding:

- Strategic advice for boroughs and the charge point industry
- Three distinct categories of publicly accessible charging infrastructure:
    1. On-street charging for residents without off-street parking facilities and car clubs (page 22)
    2. Rapid charging (page 27)

3. Destination/top-up charging offered by commercial partners (page 31)

- ‘Standard’, ‘Fast’ and ‘Rapid’ charging (see Table 1)
- The specific needs of London’s key EV user groups:
  1. Residents, especially those without off-street parking (page 22)
  2. Taxis and private hire vehicles (page 10)
  3. Freight and fleet (commercial users) (page 17)
  4. Car clubs (page 18)

While recognising that these will play a useful role in the uptake of ULEVs and reduction of emissions, this document **does not** cover:

- Off-street/private residential, workplace or depot charging

More information on the Office for Low Emission Vehicles (OLEV) EV Homecharge, Workplace and On-street Residential Charge point grant schemes are available at www.gov.uk/government/collections/government-grants-for-low-emission-vehicles

- Hydrogen refuelling:

There are currently five publicly-accessible hydrogen refuelling stations (HRS) in London. These are located in Hendon, Heathrow, Teddington, Cobham and Rainham.

As a member of the Hydrogen London consortium, TfL is working with the GLA and the hydrogen energy industry to secure funding and deliver a further five HRSs in and around London. These include sites at Gatwick and Beaconsfield services on the M40. This will bring the total number of publicly accessible stations in the London area to at least 10 within the next two years. Further information can be found at the following link www.hydrogenlondon.org

1.5 Electric vehicle charge point definitions

Within this document, we will refer to ‘Standard’, ‘Fast’ and ‘Rapid’ charging. This is simplified terminology, covering the variety of electricity supply and power outputs, as set out in Table 1.

Table 1: Charge point definitions

Charge point type	Maximum current delivered	Supply type	Maximum power output
Slow (3-pin plug)	13A	Single phase	2.4kW or 3kW
Standard	16A or 32A	Single phase	3kW or 7kW
Fast	32A	Three phase	22kW
AC Rapid	63A	Three phase	43kW AC
DC Rapid	120A	Three phase	Up to 50kW DC

The definitions in Table 1 are adapted from the UK EV Supply Equipment Association (EVSE). 'The General Procurement Guidance for Electric Vehicle Charge Points' is recommended as essential technical reading for anyone looking to procure and install charging infrastructure; please see www.ukevse.org.uk/resources/procurement-guidance

1.6 Evidence-based advice

This document brings together the findings of independent technical studies undertaken on behalf of TfL by a number of consultancies with input from relevant stakeholders. We have summarised the main findings of some of the key studies throughout the guidance in our 'Research spotlight' boxes.

We also include insights from conversations and informal consultation with stakeholders.

It is recommended that this document is used as a gateway into the more detailed studies, which are published on our website at tfl.gov.uk/ulev-research

The following studies have been used in the production of this guidance:

- Plug-in electric vehicle uptake and infrastructure impacts study, Element Energy and WSP Parsons Brinckerhoff (2016)
- Electric vehicle charging study: A review of options for charging at homes without off-street parking, WSP Parsons Brinckerhoff (2015)
- A feasibility study into a rapid charge network for taxis, Energy Saving Trust (2015, updated 2016)
- Mapping rapid charge point locations for commercial vehicles in London, Energy Saving Trust (2015)
- Rapid Charging Network Study, Element Energy (2015)

- ULEV car club Study, WSP Parsons Brinckerhoff and Frost & Sullivan (2016)
- Understanding electric vehicles – research findings, Future Thinking (2014)
- Mapping rapid charge point locations for private hire vehicles in London, Energy Saving Trust (2017)
- Private hire vehicle rapid charging points: Research findings, Future Thinking (2016)
- The road to reducing commercial vehicle emissions: Exploring the technical barriers to uptake of alternatively fuelled commercial vehicles (2016)
- How can LoCITY increase operator uptake of ultra low emission vehicles? (2016)
- Electric vehicles: Gauging interest amongst disabled and elderly drivers, 2CV (2016)

This is not the end of the story. Our research is ongoing – as more vehicles become available and more people switch from fossil fuelled vehicles to EVs, we will learn more about what different users need and want from charging infrastructure.

2. Identify current demand

We need to identify current demand to enable a coherent and cost-effective network of charging infrastructure across London. This is where our research can help, providing evidence-based guidance to give boroughs insight into where the most appropriate charge point infrastructure should be located.

Theme 1: Identify current demand

Respond to requests for charge points from residents and businesses to balance competing demands for space and maximise charge point usage (and therefore viability of the charge point) from the time of installation.

2.1 Current electric vehicle infrastructure

In the absence of a ready market of EV users, to date the approach to supplying charging infrastructure in London has been largely opportunistic, making use of available space and host locations.

This has led to a number of charge point network providers operating in London including BluePointLondon (a subsidiary of the Bolloré Group), which operates the Source London network and Chargemaster (POLAR network). These charging networks are covered in more detail in Chapter 4 under 'Destination/top-up charging'.

More recently, many boroughs are receiving more requests for charge points from residents and businesses who want to invest in EVs but do not have suitable charging points. Providing charge points to serve these individual requests can be challenging and expensive, making a strong business case difficult, especially when it involves dedicating an on-street bay in an area of high parking demand.

To help accelerate the provision of charging infrastructure in London, TfL, London Councils and the GLA successfully bid for the OLEV Go Ultra Low City Scheme (GULCS) funding, with the support of London boroughs. In January 2016, London was awarded £13m to help support the switch to ULEVs. By 2020, the GULCS project will aim to deliver over 2,000 additional on-street charging points for London's residents and for car club operators. It will also be used to support our Rapid Charge Point Network and deliver six Neighbourhoods of the Future schemes, which will demonstrate innovative charging infrastructure, policies and initiatives across London. More information on GULCS can be found on the London Councils website at www.londoncouncils.gov.uk/node/28321. Further papers are also available on the London Councils Transport and Environment Committee webpage at www.londoncouncils.gov.uk/node/31435

2.2 Current electric vehicle ownership

The Department for Transport (DfT) publishes quarterly data on vehicle registrations. At the time of writing, the latest data (Q4 2016) reported more than 10,800 ULEVs in

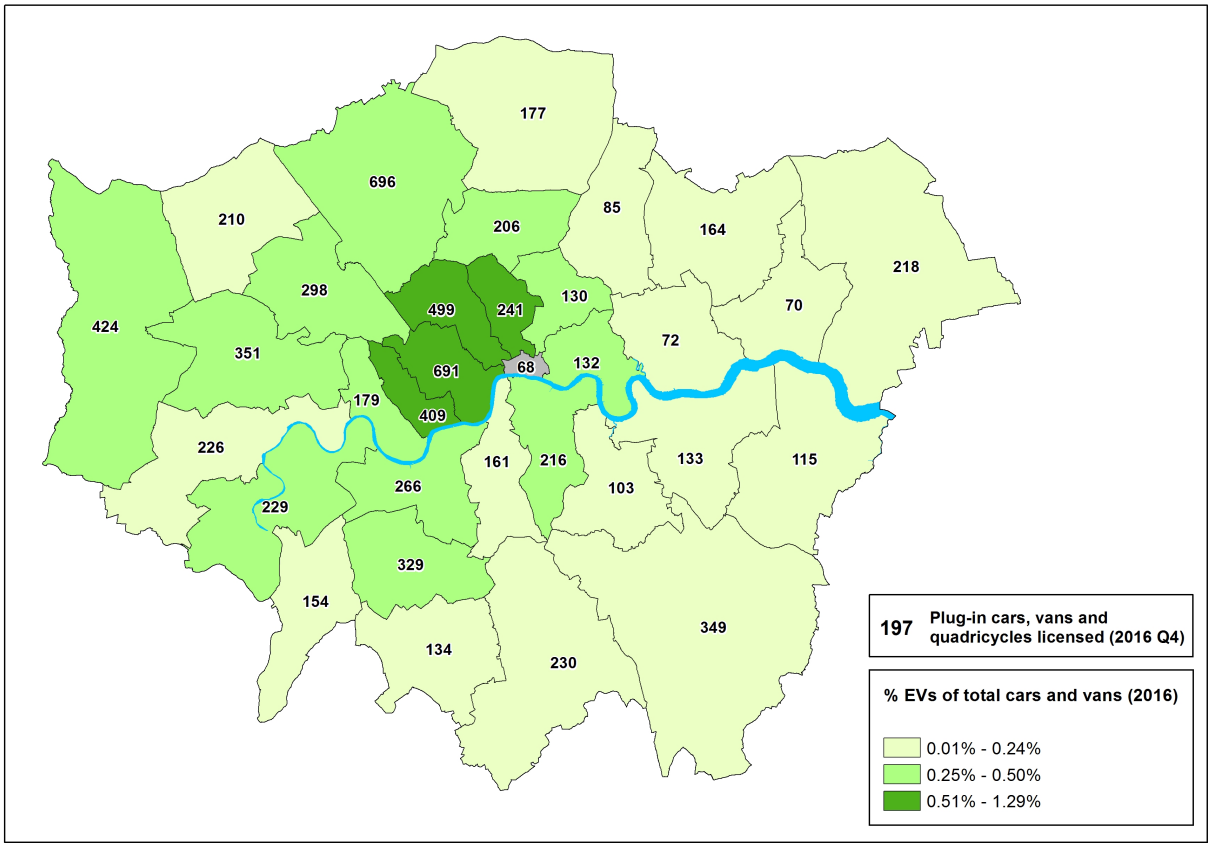
London, of which more than 9,900 were cars and vans.

Figure 1 shows that the boroughs with the highest **numbers** of EVs registered in Q4 2016 are Westminster (691), Barnet (696) and Camden (499).

The boroughs currently with the highest **proportions** of EVs in their vehicle stock are Camden, Westminster, Islington and the Royal Borough of Kensington and Chelsea, where EVs are more than 0.6 per cent of total vehicle stock (compared to the UK average of 0.24 per cent). The proportion is calculated using the latest available total vehicle stock data from the DfT (end of 2016).

Many of these EV owners will have access to off-street parking, but a number of EV owners are already using on-street infrastructure.

Figure 1: Number of registered electric vehicles per borough (Q4 2016) and as a proportion of total stock (end 2016) (Source: DfT Table VEH0130 and VEH01051)[1]



2.3 New licensing requirements for taxis and private hire vehicles

TfL has confirmed new 'zero emission capable' (ZEC) licensing requirements for taxis and private hire vehicles (PHVs) to facilitate a switch to EVs. The requirements will come into force from 1 January 2018 for newly licenced taxis and from 1 January 2020 for newly licensed PHVs. For more information on the new licensing requirements, visit tfl.gov.uk/ultra-low-emission-zone

[1] The data on EVs includes all types of vehicles with fully electric powertrains, and cars and vans with tailpipe emissions below 75 g/km of carbon dioxide (CO_2).

Even before these requirements come into force, a number of private hire firms are already deploying, or are keen to deploy, EVs in their fleets and the first ZEC taxis will be coming to market in 2017. EVs (including plug-in and range-extended EVs) can be a good option for taxis and PHVs because:

- They are driven predominantly in an urban, stop-start environment, where EVs operate most effectively
- Plug-in hybrids or range-extended EVs can meet the needs of drivers who carry out a mixture of predominantly urban driving with occasional longer journeys
- Taxi and private hire duty cycles already include periods of downtime, for example, waiting for a passenger or during breaks
- EVs can reduce expenditure on motoring for drivers and operators, costing as little as three pence per mile in electricity depending on the price paid per kWh (for example, if charged overnight at home)

The ZEC vehicles require access to charging at home (on-street residential charging) and many will need to charge during working hours (mostly using rapid charging to minimise downtime).

Initial research undertaken by the Energy Saving Trust (EST) (see Chapter 4) identified an immediate requirement for 150 rapid charge points in London by the end of 2018 to support the initial rollout of ZEC taxis, PHVs and other commercial vehicles. This is discussed in more detail in the section on rapid charging in Chapter 4.

2.4 Charging needs of zero emission capable taxis

The first ZEC taxis coming to market in 2017 will be range-extended EVs. The electric mileage of these first vehicles is anticipated to be in the range of 30 to 100 miles and they will also have a petrol engine to provide a back-up source of fuel beyond this range. Our target is for 9,000 of these vehicles to enter the taxi fleet by 2020.

Our research (carried out by EST, see Research spotlight 5 on page 28) has found that the average daily working mileage of a taxi is around 70 miles (or approximately 100 miles when including the commute). Therefore, to operate as much of their working day in electric mode as possible and maximise the air quality and fuel efficiency benefits from the range-extended vehicle, taxi drivers will want to rapidly charge their vehicles. Information on our research and guidance for the best locations for rapid charge points for taxis is provided in Chapter 4.

Many taxi drivers will also be customers for on-street residential charging to charge their vehicles between shifts (our survey shows 30 per cent of taxi drivers park on-street). To help London boroughs understand the potential demand from taxi drivers, residential postcodes have been plotted at a suitably aggregated level on page 26 in

section 4.4 on residential charging.

2.5 Charging needs of zero emission capable private hire vehicles

Research spotlight 1:

‘Private hire vehicle rapid charging points: Research findings', Future Thinking (2016)

We commissioned Future Thinking to carry out a PHV driver and operator survey to understand driver working patterns, potential charging needs of PHV drivers and attitudes towards ZEC PHVs. A total of 1,803 responses were achieved.

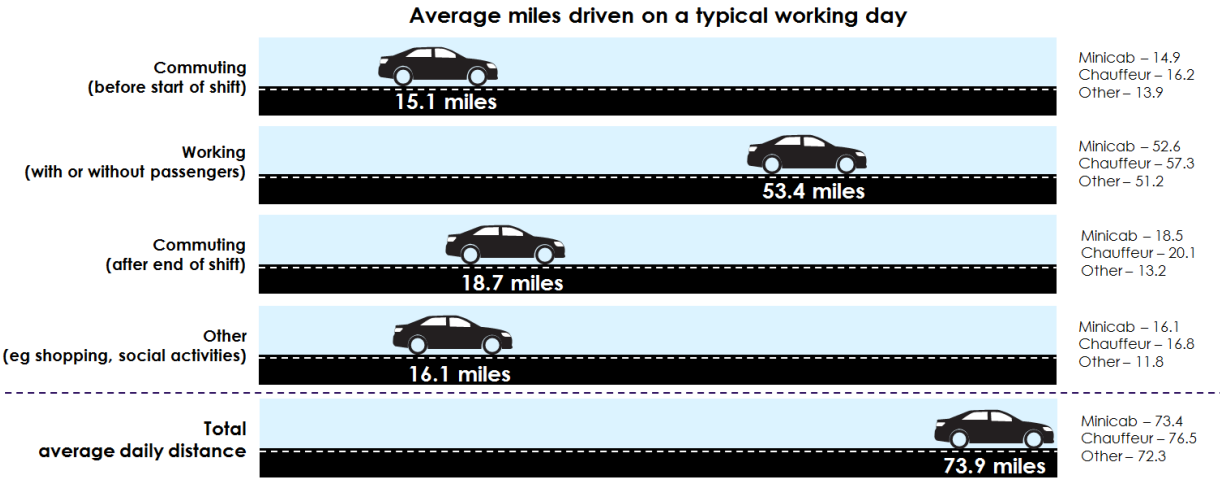
The findings showed that many drivers would consider purchasing a plug-in hybrid EV or EV (65 per cent and 55 per cent of respondents, respectively), assuming there was sufficient charging infrastructure available. The most popular reasons for this were environmental concerns and to save on fuel costs. Alongside concerns about the cost of EVs, the main perceived barriers to operating an EV are range anxiety and the impact that charging a vehicle will have on daily work. Ensuring that a robust, reliable and functioning rapid charging infrastructure network is in place is vital to address these concerns.

The private hire drivers and operators survey found that the average daily working mileage of a PHV is around 50 miles (or approximately 70 miles when including the commute). Given that an eligible ZEC PHV will have a minimum zero emission range of 10 miles, if we want PHV drivers to choose vehicles with larger electric ranges and to operate as much as possible in electric mode, they will need to be able to rapidly charge their vehicles as well as charge at home between shifts. This will maximise both the air quality and fuel efficiency benefits from the range-extended and plug-in hybrid vehicles.

PHVs are generally left close to home at the end of a shift; our survey reported 44 per cent of PHV drivers park on-street. PHV driver home postcodes are plotted at a suitably aggregated level on page 26. Where they are able to use rapid charging (most saloon PHEVs are not currently capable of rapid charging), PHVs could potentially be charged fully at home between shifts then topped-up by rapid charging points and destination charge points during working hours.

An important difference between taxis and PHVs is that PHV journeys must be pre-booked (either via an operator or through an app) rather than hailed on-street. This provides more opportunity for operators to direct the most suitable car to a booking, which could include how much charge a vehicle has left. This has already enabled the growth of some EV-only fleets in London.

Figure 2: Average mileage of PHVs during a typical working day (Source: Private hire drivers and operators survey, 2016)[2]



Theme 1: Guidance for implementation

Boroughs and charge point operators must respond to demand for EVs by installing infrastructure, especially for residents. Boroughs can access funding through the Go Ultra Low City Scheme (delivered by London Councils, TfL and the GLA) and are able to liaise directly with private charge point network operators where appropriate.

To maximise economies of scale, we recommend that boroughs collect and map out requests and carefully plan the locations of charge points to serve as many residents as possible. They should proactively engage with local residents and businesses in areas where requests have been received to encourage more people to switch to EVs to help make charge points commercially viable.

We are seeking sites for London's rapid charge point network, so we need all boroughs to actively identify potential sites for inclusion in the network; this will be vital to ensure that the pan-London network can grow at the rate needed to support commercial vehicles, including ZEC taxis and PHVs. We are aiming to deliver 150 rapid charge points by 2018.

[2] Each driver was assigned a midpoint in the average mileage range for each journey type and the four midpoints were added together to give a total average daily distance (e.g. if they drove 0-5 miles per day for all four journey types, their total average daily distance would be 2.5 + 2.5 + 2.5 + 2.5 = 10 miles). Each of the 1,803 drivers' total average daily distance was then used in the same way to calculate the overall total average daily mileage e.g. the driver in the example above would have been categorised as driving a total of 6-10 miles per day on average and assigned a midpoint value of 8 miles.

3. Provide for future uptake

Although it is important to provide for current demand, as discussed in Chapter 2, we also need to install charge points now that will serve future demand. This will be vital in ensuring that London residents and businesses can eventually make the switch to EVs when prices come down and more models are available.

Theme 2: Provide for future uptake

Provide a certain amount of infrastructure based on predicted future demand, including for residents, while prioritising demand from essential commercial vehicles, ZEC taxis and private hire vehicles. This will ensure current public funding will also support Londoners who cannot currently afford to switch to an EV but would like to do so in the future, for example, when the second hand market is more developed.

3.1 Future uptake scenarios

We have undertaken a number of studies to explore where future demand is likely to be and what type of charge points will be needed.

Research spotlight 2:

‘Plug-in electric vehicle uptake and infrastructure impacts study’, Element Energy and WSP Parsons Brinckerhoff (2016)

TfL and the GLA commissioned a study to understand how quickly and where ULEV uptake is likely to happen across London and the potential infrastructure and energy demands associated with this uptake. The first part of the study projected and mapped the spatial distribution of EVs in the next 10 years.

The second part of the study assessed what charging infrastructure will be needed to support that uptake and what the impact of this could be on demand for parking and energy. The results include ranges of projected numbers of EVs, but it should be noted that the main aim of the study was to show the **spatial** distribution rather than predict exact numbers, in recognition that the speed of uptake will depend on many factors and therefore is difficult to predict. This should be kept in mind when using the data from this study.

The ‘EV Uptake and Infrastructure Impacts’ Study (Element Energy and WSP Parsons Brinkerhoff, 2016) developed two uptake scenarios: ‘Baseline’ and ‘High BEV’. Uptake refers to projected numbers of car/van owners switching to EVs from conventional fuels, rather than additional EVs being purchased.

Both scenarios are ambitious and assume that the speed of EV uptake to 2025 accelerates, which will require strong policy from both central and London government. This is necessary if we are to achieve a zero emission transport network

by 2050, for which we will need all new cars and vans driven in London to be ULEVs by 2040 at the latest.

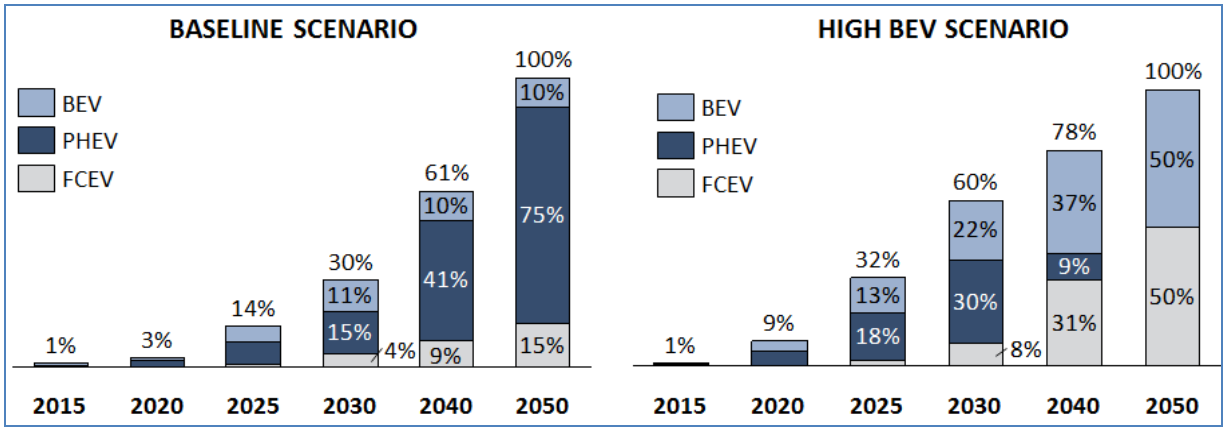
Both the Baseline and High BEV scenarios are therefore dependent on the following supporting conditions:

- Continued incentives, such as the Ultra Low Emission Discount for the Congestion Charge and the government's plug-in car, van and motorcycle grant
- Rapid charging and residential charging infrastructure
- Improved choice of vehicles at a comparable cost
- An increase in customer acceptance of EVs

The Baseline scenario developed for the study (effectively a 'medium' rate of uptake scenario) projects that the number of EVs in London could surpass 40,000 in 2020 and reach approximately 150,000 EVs by 2025.

The High BEV scenario is a policy-led scenario. It sets out what is needed in terms of new vehicle sales to meet the Committee on Climate Change's carbon dioxide (CO_2) reduction targets for 2050. It therefore has a steeper trajectory and greater proportion of fully electric vehicles to meet the challenging CO_2 reduction goals.

Figure 3: Baseline and High BEV scenarios for ULEV uptake to 2050 (new car sales) (Source: EV Uptake and Infrastructure Impacts Study, 2016)



If this higher rate of uptake is achieved, London could see more than 70,000 EVs in 2020 and more than 250,000 EVs by 2025. Increasingly, more drivers will rely on on-street and publicly accessible charging if they are to switch to EVs, particularly in the High BEV scenario.

These figures include our target of 9,000 ZEC taxis by 2020.

3.2 Future uptake by household (sales of ultra low emission vehicles)

The EV Uptake and Infrastructure Impacts Study (Element Energy and WSP Parsons Brinkerhoff, 2016) identified several key characteristics that correlate with the current

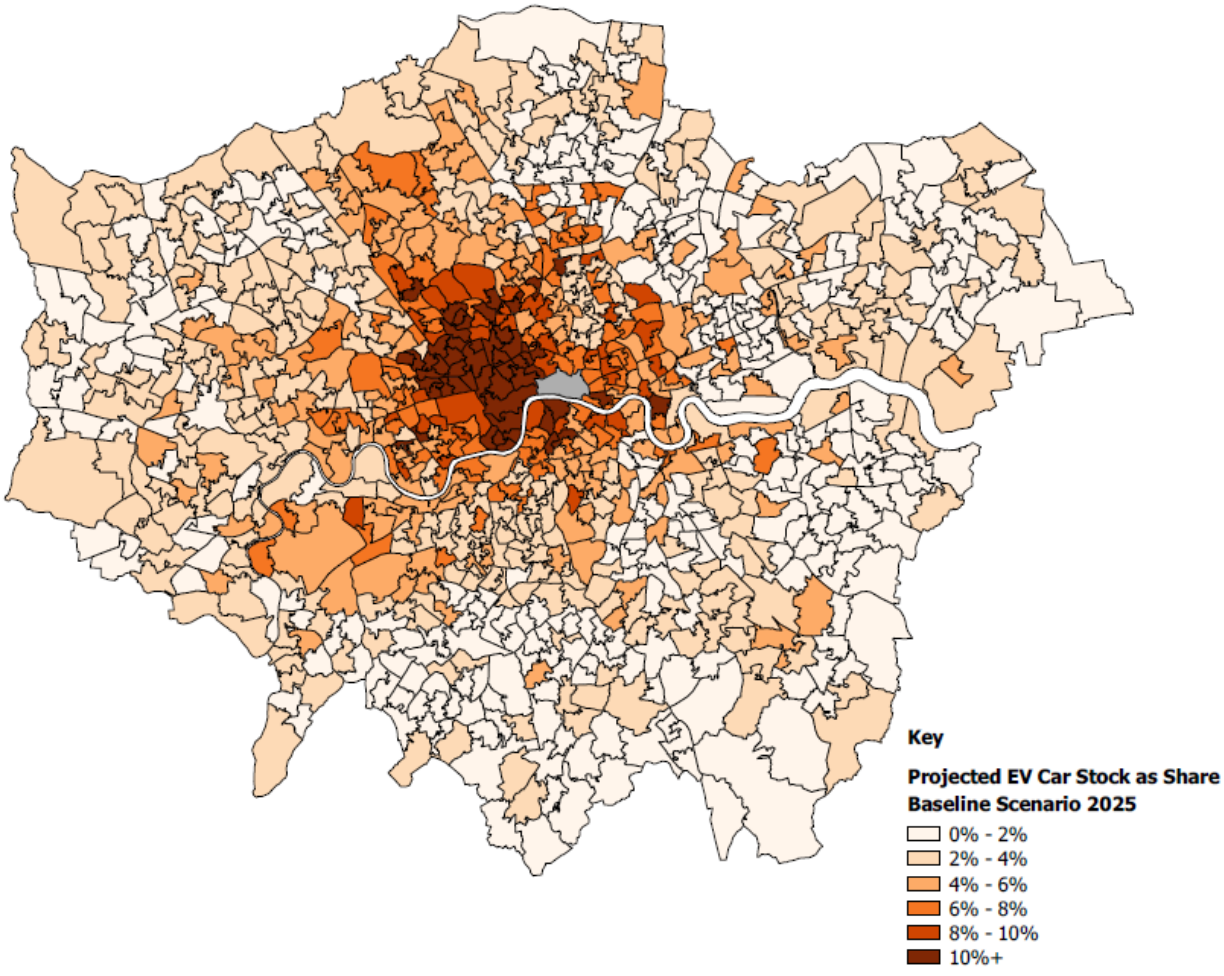
distribution of EV sales in London. This can help boroughs and charge point network providers to identify where future EV uptake is likely to be in the short-medium term.

The key identifying characteristics were found to be, in order of correlation:

- Employment – persons employed per household
- High earning households – percentage of households with income above £75,000
- Local EV policy – presence of supportive policy, for example, free parking for EVs
- Hybrid sales share – identifying where potential early adopters of new vehicle technology live

Uptake in future years was predicted by applying these characteristics to projected population and car sales in 2020 and 2025. The results for 2025 are shown in Figure 4.

Figure 4: Predicted uptake of electric vehicles in 2025 in the Baseline scenario (medium uptake) (share of total vehicles in Middle Layer Super Output Area, MSOA) (Source: Electric Vehicle Uptake and Infrastructure Impacts Study, 2016)



The highest uptake of EVs in 2025 is predicted in western parts of central and inner London. This uptake includes EVs parked off-street and on driveways, so not all of these will require on-street charging.

3.3 Future uptake of commercial vehicles

Reducing transport-related emissions of delivery and servicing vehicles and local businesses is a key focus for many boroughs looking to reduce emissions at the local level.

EST's charge point mapping for commercial fleets study ('Mapping rapid charge point locations for commercial vehicles in London', Energy Saving Trust, 2015) advises that the duty cycles of many commercial vehicles in London mean that they could be ideal for switching to plug-in technology:

- When serving customers in London's busiest and most congested areas (such as central London, inner London and town centres), they are driving in a stop-start environment, which provides the optimum operating conditions for EVs
- Longer journeys (more than 80 miles) within Greater London are not very common, therefore many trips can be carried out on a single charge
- EVs can be used for the last mile of deliveries in conjunction with neighbourhood pick-up centres
- Many commercial vehicle duty cycles include periods of downtime for rapid charging, for example, during a delivery or collection window, or during breaks

The term 'commercial vehicles' refers to a wide range of vehicle types with varied usage patterns.

Many operators will keep vehicles in depots so will need to install their own charge points for charging overnight or between shifts. Other vehicles will be kept at workers' homes overnight. If that worker does not have access to a driveway, they will need access to on-street residential charging.

Both depot-based and home-based vehicles are likely to need access to rapid charging to ensure that they can charge up quickly during their working day without losing valuable working time. This was raised as a key technical barrier in recent research carried out for LoCITY, TfL's industry-led collaborative programme designed to improve air quality by lowering emissions from commercial vehicles. For more informationon LoCITY, please visit www.LoCITY.org.uk

Vehicles used by servicing and maintenance companies, such as utilities, that park for a few hours would also benefit from a wide network of destination-based charge points and visitor access to on-street residential charging facilities.

Vehicles owned by staff and used for business travel (the 'grey fleet') will also need access to charging infrastructure at home, at/near their workplace and rapid charging when out and about.

Commercial operator case study:

Z-Tech Control Systems

Control system and maintenance services in London, Cambridge and Scotland are provided by Z-Tech. In 2009, after an Energy Saving Trust review, it rationalised its fleet and set a 15 per cent carbon reduction target which it had beaten by 2013. Building on its success in reducing emissions, it bought two Nissan e-NV200s to serve a TfL contract for London Underground pumping systems. Z-Tech is keen to embrace new technology, is happy with the performance of the e-NV200s and wants to build on this and invest in more EVs, but sees current battery range as limiting. However, a widespread rapid charge network in London, where drivers can see charge point availability in real-time, could unlock this barrier.

Luke Stanbridge, Head of Marketing and Communications, advised that 'a good geographical spread of rapid charge points is crucial' if fleets like Z-Tech's are to have the confidence to invest in EV deployment on a large scale.

3.4 Car clubs and electric vehicles

We support car clubs as an alternative to private car ownership as they enable car users to share a vehicle instead of owning one, help to reduce unnecessary car use, reduce pressure on kerbside space, and encourage use of public transport, walking and cycling. 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 more Londoners to give up their cars while allowing for infrequent car travel in inner and outer London.

London's car club industry has an ambition to serve one million members annually in 10,000 car club vehicles by 2025, with EVs comprising 50 per cent of the fleet. This would result in car clubs deploying 5,000 EVs in London by 2025. This will reduce emissions, help to normalise EVs by increasing their visibility and enable Londoners to drive EVs without having to purchase them, replacing the use of private vehicles.

The models currently operating in London are:

- Round-trip – a car club member books a specific car, located in a dedicated parking bay, for a period of time and then returns the car to the same dedicated parking bay before the end of the reserved time
- Fixed one-way – a member starts a reservation in an available car at a designated parking bay and drives to another designated parking bay, where the reservation ends
- Floating/flexible one-way – a member spontaneously reserves an available nearby car and drives it to their destination, wherever that may be. To end their reservation they must park the car within a specified geographical operating area

Research spotlight 3:

‘ULEV car club study’, WSP Parsons Brinckerhoff and Frost & Sullivan (2016)

We commissioned research to better understand the complex operational needs of the various car club models and their charging infrastructure requirements. Operators, boroughs and key stakeholders, such as Carplus and the British Vehicle Rental and Leasing Association (BVRLA) were consulted via workshops and interviews. The research found that operators plan to increase the proportion of EVs within their London car club fleet, from four per cent in 2015 to 50-72 per cent in 2025.

Differences were highlighted between car club operators and boroughs in their aspirations for car clubs in 2025, as well as a range of challenges to the delivery and installation of charge points across London to serve the various car club models. The study uses three scenarios of car club growth to estimate the number of charge points that may be needed to enable car clubs to grow and achieve 50 per cent EV fleets by 2025 in a typical central, inner or outer London borough – subject to the borough’s policy on car clubs.

This section summarises the research and provides insight into how the three models of car club/car sharing are likely to adopt EVs and the charging infrastructure they may need to support this.

- **Type of EV** – Encouragingly, all of the London operators (of all car club models) see EVs as suitable for their operations, now or in the near future. Some thought BEVs were the most viable vehicle option, whilst others were more cautious about EVs in general and thought PHEVs would be more suitable to provide customers with a petrol back-up for longer journeys. This will impact the need for charging infrastructure, so boroughs should liaise with the car clubs operating in their borough to understand their individual future vehicle strategy

- **Charge point to EV ratio** – Operators’ preferred ratios vary depending on the car club operating model. Back-to-base models work best with a single dedicated charge point per bay (1:1 ratio). The point-to-point and floating one-way models require access to more charge points per vehicle to accommodate their more flexible movements, but these bays can be shared with other car clubs and user groups rather than requiring dedicated provision

- **Charge point type** – Operators voiced a clear preference for fast chargers (7kW or 22kW). Rapid charging hubs will also be important, particularly for floating one-way operators. However, it was felt by some that slow chargers (3kW) could be used overnight if widely available

Theme 2: Guidance for implementation

Boroughs must use a combination of sources – including our research, their own local knowledge and discussions with local stakeholders such as businesses – to build an evidence-based picture of where residents and commercial EV users are likely to need different types of charging infrastructure in future, particularly the next five to 10 years. This should inform current charge point investment as well as planning policy, securing charge points in new developments.

Boroughs can access funding for residential and car club charge points to serve future users through the GULCS project, helping to stimulate a switch to EVs in new areas where a lack of charging infrastructure has previously been a barrier to uptake. The EV Uptake and Infrastructure Impacts Study (Research spotlight 2 on page 14) and ULEV Car Club Study (Research spotlight 3 on page 19) will be particularly useful for planning deployment of this infrastructure.

As well as providing sites for rapid charge points and installing their own infrastructure, boroughs should use this research to inform discussions with charge point network operators to make sure new infrastructure is targeted where it will provide for future uptake, especially in areas where car use will continue to be necessary (such as outer London) and where high demand is predicted in the future.

4. The right charge point in the right place

As the previous chapter made clear, there is no ‘one size fits all’ solution to providing for EV users without access to their own charge points. Boroughs will need to decide how best to meet the needs of their EV users while balancing the needs of other residents and road users. Boroughs and charge point network operators will need to consider the most appropriate type of infrastructure for any given location.

Theme 3: The right charge point in the right place

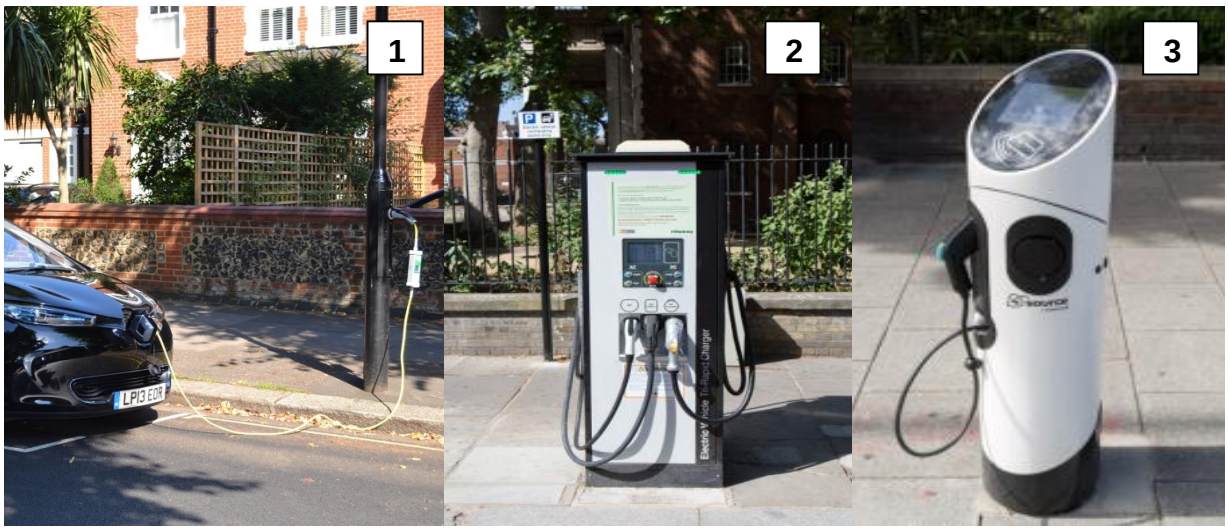
Use different types of charge points according to the type of user to ensure the most appropriate infrastructure.

4.1 Charge point solutions

The three types of charging infrastructure covered in this chapter are:

1. On-street residential charging
2. Rapid charging
3. Destination/top-up charging

Figure 5: Images of charging infrastructure



4.2 Technical note

To ensure their charge points are open for use to as many customers as possible, all charge point network operators should ensure they:

- Use standard plugs (Type 2 connectors)
- Use the latest Open Charge Point Protocol (OCPP)
- Are interoperable with other networks and/or offer a pay as you go option
- Provide an app and website to help customers locate available charge points
- Have a clear pricing structure

4.3 London's street types

Street Types can be a useful tool to help identify where different infrastructure types could be located. The Street Types for London guidance classifies London's streets according to the functions of 'movement' and 'place'. TfL has since been working with boroughs to classify the entirety of London's road network according to the nine Street Types.

In this document we have suggested which type of charging infrastructure is best suited to each Street Type. For more information on Street Types visit www.tfl.gov.uk/info-for/boroughs/street-types

Table 2: Which Street Type?

Type of charging infrastructure	Street Type(s)
Residential on-street charging	**Local streets** – these streets make up 80 per cent of London's road network and are where the majority of people live.
Rapid charging	Rather than aiming for a particular Street Type, rapid charge points will mostly be located in **off-street 'hubs'** or in dedicated locations. Streets with a high 'movement' or high 'place' function could provide a high demand for rapid charging, particularly areas where EVs are incentivised, for example, Neighbourhoods of the Future or Low Emission Neighbourhoods.
Destination/top-up	**High streets and city streets**, because destination and top-up charge points will be most needed in areas that attract car trips and where short-medium term parking is available. They will also be suited to off-street car parks of any type of street.

4.4 On-street residential charging

Residential on-street charge points are needed for regular charging, usually when vehicles are parked overnight. Standard (3kW or 7kW) charging is sufficient for overnight charging as it provides a full charge in four to eight hours.

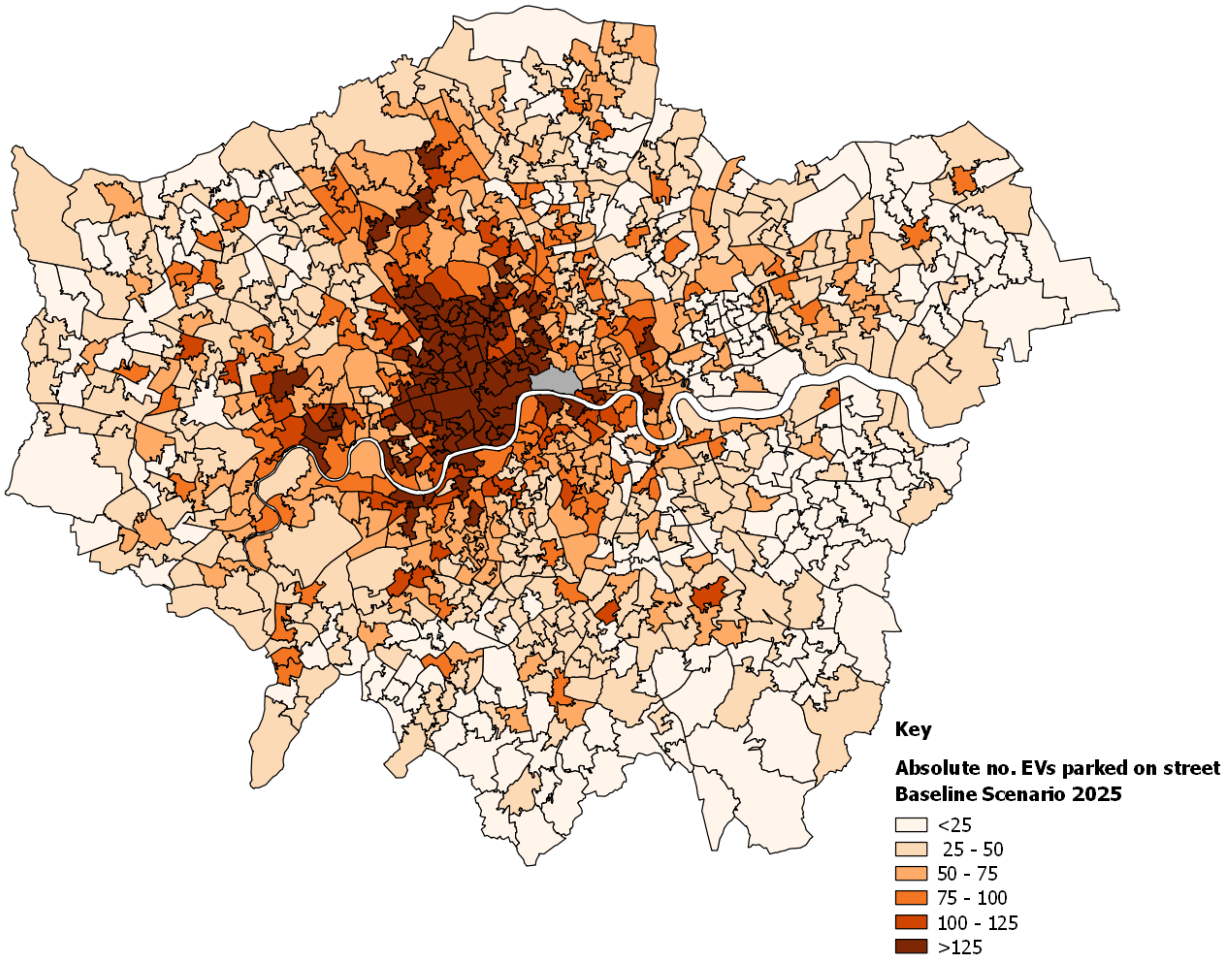
The key customers for residential charge points are:

- Residents without access to off-street parking
- Visitors of residents, including servicing and deliveries
- Local businesses
- Car clubs

About two thirds of Londoners do not have access to driveways or off-street parking, so will be reliant on on-street parking to switch to an EV. Our research (carried out by Element Energy and WSP Parsons Brinckerhoff, see Research spotlight 2) found that this rises to 85 per cent in inner and central London.

Figure 6, taken from this study, shows the projected reliance on on-street EV charging in 2025. It was made by combining the EV uptake projections with assumptions on reliance on on-street parking.

Figure 6: Predicted uptake of electric vehicles needing to charge on-street in 2025 in the Baseline scenario (medium uptake) (per MSOA) (Source: Electric vehicles uptake and infrastructure impacts study, 2016)



The boroughs predicted to have the highest demand for on-street EV charging in 2025 include west inner London boroughs such as Kensington and Chelsea and Wandsworth, but a number of other inner and some outer London boroughs also

have pockets of high demand.

To date, provision on residential streets has been mostly ad hoc and in response to requests but if we are to achieve a major expansion in EVs, more strategic planning of charge points is needed. Boroughs will have to weigh up future and current levels of demand when planning where to install new charge points, such as those funded through the Go Ultra Low City Scheme.

Boroughs will also have to weigh up conflicting demands for limited street space. Converting parking bays to EV bays could cause conflict with other non-EV car owners if EV owners are seen to have a 'dedicated' bay. However, prospective EV owners need to have confidence that they will be able to charge their vehicle near their home when they need to, in order to make the choice to invest in an EV. Enabling any Londoner who needs to drive to be able to switch to an EV (or other ULEV) will be vital in achieving the Mayor's priorities for tackling air quality and reducing CO_2 emissions. Therefore we need boroughs to allocate more space for EV charging in residential areas.

Research spotlight 4:

'Electric vehicle charging study: A review of options for charging at homes without off-street parking', WSP Parsons Brinckerhoff (2015)

On behalf of a consortium of boroughs and TfL, led by Hackney Council, WSP Parsons Brinckerhoff has undertaken a technical study into residential charging options for residents without off-street parking. The aim was to examine the options, then assess the different solutions. The need for the study came from concerns raised by a number of boroughs that, without feasible alternatives, more residents may trail cables from windows to charge their cars parked on-street, which could be a safety hazard.

The study looked at the legal concerns with trailing cables, then assessed the feasibility of a range of other on-street charging options that could enable charging for residents without off-street parking, assessing their potential effectiveness and deliverability. It then used case studies to test options in various types of streets. Scenarios were developed to provide an indication of what the future charging infrastructure mix might look like for residents without off-street parking.

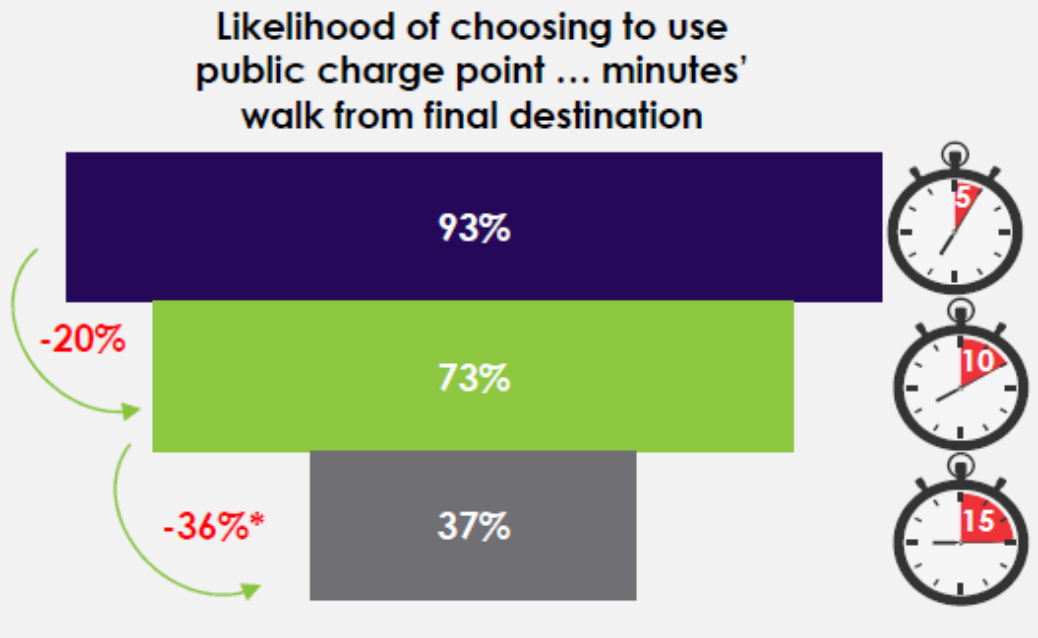
Research conducted by WSP Parsons Brinckerhoff (2015) (Research spotlight 4) showed that, in the short term, residential EV charging is likely to be provided by 'traditional' standard charge points in designated bays. This could be via third party charging providers, such as Chargemaster and Source London, or a dedicated local residential charge point network.

To help overcome the challenge of finding space for EV charging, innovative charging technologies, for example, lamp post charging should be considered as well

as more traditional charge points. Charging solutions nearer people's homes are likely to become cheaper and more readily available as new models and technologies emerge. To further make the best use of the limited space in residential streets, boroughs could explore options for residents to share bays (for example, charging every other day) especially if they do not cover enough miles to need to fully charge every night. As battery technology improves, the range of EVs will increase which may make daily charging less important. Rapid charging could also supplement less frequent access to residential charge points.

Charge points should be close to EV owners' houses but not necessarily directly outside or on their street – our customer research (conducted by Future Thinking, see Research spotlight 8) shows that most EV users are willing to walk five minutes to a charge point and three quarters will walk up to 10 minutes. This can help to make charge point provision cost-effective through shared use between residents, businesses and visitors. Charge points should cater for all types of residents, including those with disabilities who may rely on their car.

Figure 7: How long electric vehicle drivers will walk to a charge point (Source: Understanding Electric Vehicles (customer research), 2014)



Car clubs could also enable residents who need to use a car but can't afford an EV to share a vehicle rather than invest in their own, or try one before they buy. However, there are a variety of models and operators for boroughs to consider, with different challenges and potential benefits. Whatever model(s) a borough supports, they should refer to Section 3.4 of this guidance to ensure that any charging infrastructure aiming to support car clubs to switch to EVs is fit for purpose.

Many taxi and private hire drivers taking up ZEC vehicles will need access to on-street parking near their homes. The maps in Figures 8 and 9 show where PHV drivers and taxi drivers respectively live across London. The keys show the number of drivers living in each postcode.

Figure 8: PHV driver home postcodes (Source: TfL, licensing database)

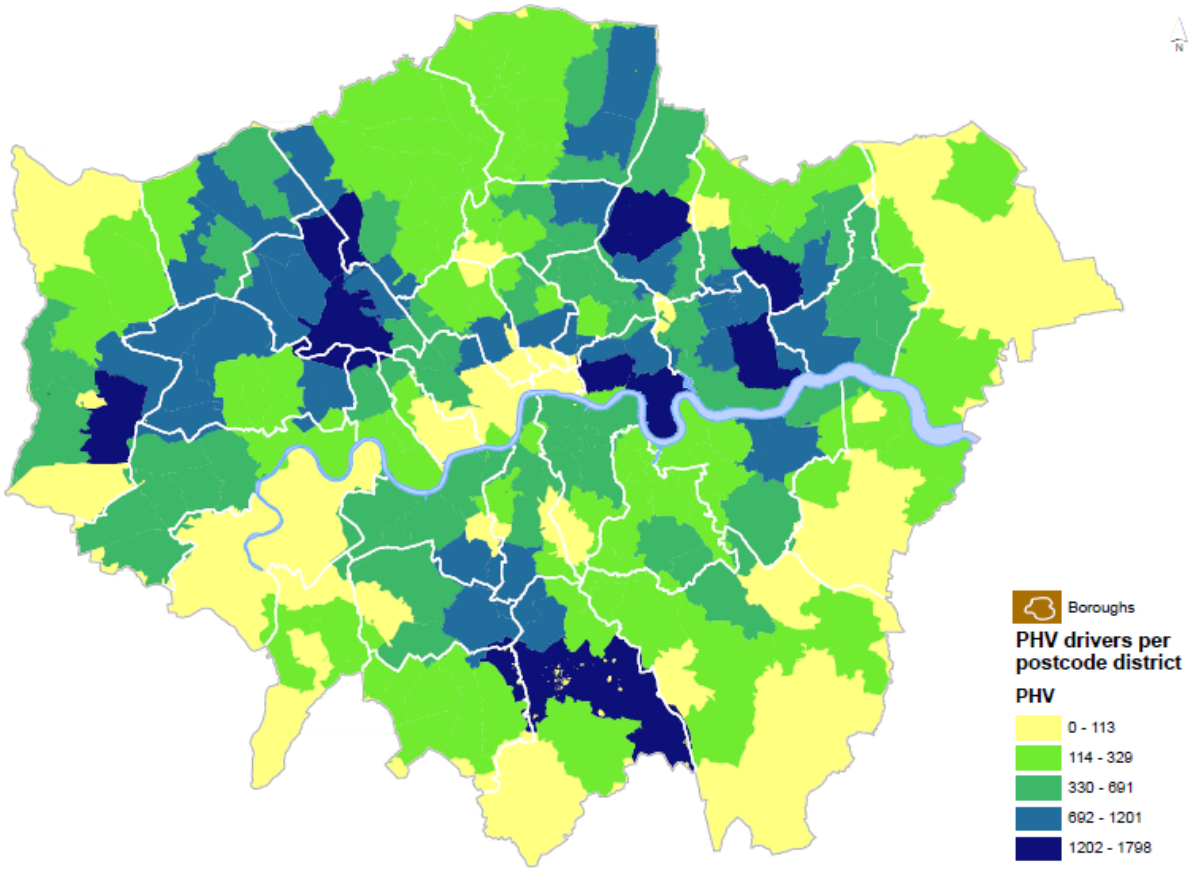
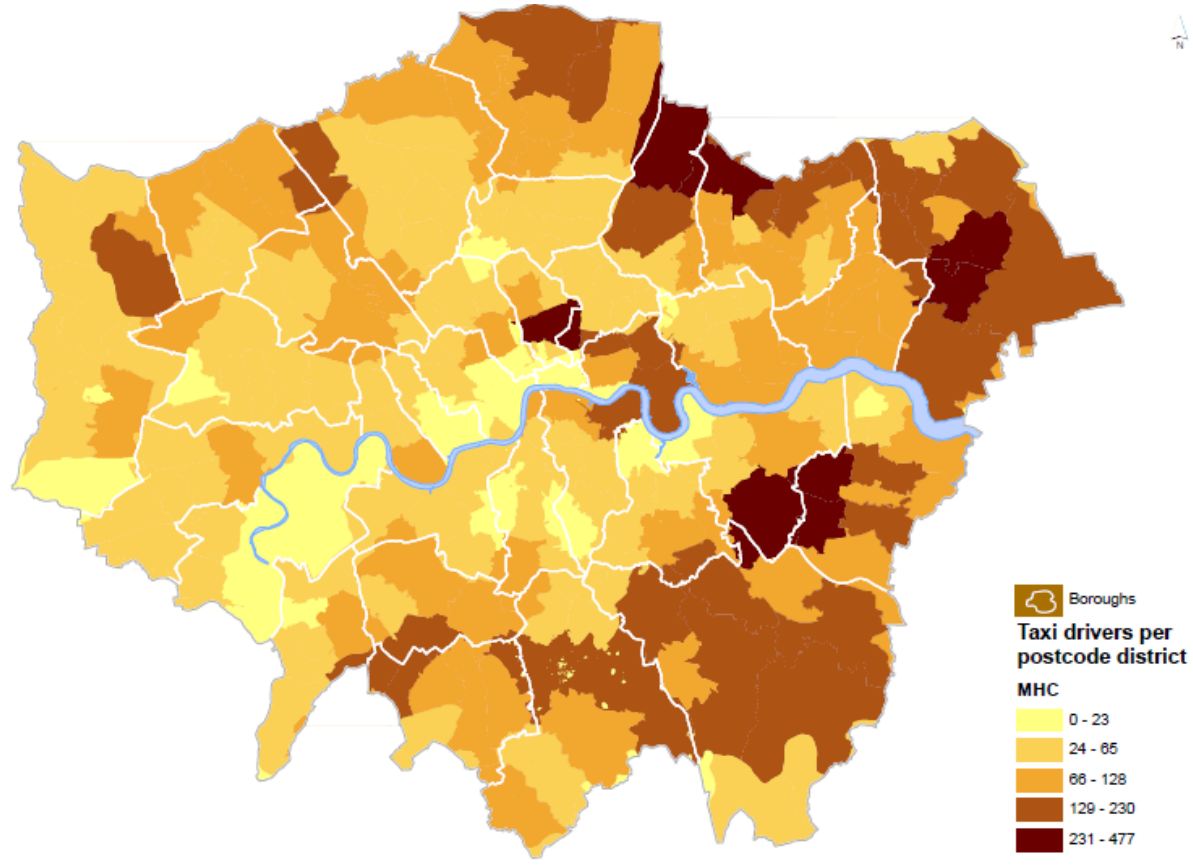


Figure 9: Taxi driver home postcodes (Source: TfL, licensing database)



4.5 Rapid charging

Rapid charge points provide charging for high mileage users such as ZEC taxi and PHV drivers and freight and fleet operators. These points could also be used by residents and visitors if slower standard charging is not available.

TfL is investing millions of pounds to open London up to private sector investment to provide a reliable and sustainable solution for rapid charging. We will use funding we have secured from government to find and enable suitable sites, including upgrading electricity supply and ground works. We will then appoint charge point operators via a procurement framework. The operators will be responsible for the costs of installing, operating and maintaining rapid charging infrastructure on these sites. Through engaging with public and private sector landowners, and looking at our own property estate and the TfL Road Network (TLRN), we are identifying a long list of potential sites suitable for the network. For more information regarding the rapid charge point project, please contact us at electricvehicles@tfl.gov.uk

We plan to deliver 150 rapid charge points by the end of 2018, and have funding to support the delivery of at least 300 by 2020. Our research suggests that London will need 150 rapid charge points by 2018, but in the region of 700 by 2020. This is made up of 560 rapid charge points to support 9,000 ZEC taxis and 140 to support electric PHVs. We will keep this figure under review based on vehicle uptake and charge point usage. We will also be working with government, industry and stakeholders to examine possible funding routes and delivery models to support the delivery or rapid charging infrastructure in London.

The following paragraphs provide highlights from three key studies conducted by the Energy Saving Trust which have helped us develop our strategy for rapid charge points and provide advice on the best locations for their installation:

- Feasibility study into a rapid charge network for taxis
- EV charging requirements for PHVs
- Mapping rapid charge point locations for commercial vehicles in London

Research spotlight 5:

‘A feasibility study into a rapid charge network for taxis’, Energy Saving Trust (2015, updated 2016)

The EST carried out a feasibility study which analysed existing TfL data on taxis and undertook a new survey of taxi drivers to understand their working patterns, breaks and attitudes to EVs. The survey was distributed to 6,000 drivers directly with more receiving the survey indirectly, for example, via their trade association. Responses were received from 672 drivers.

EST’s analysis found that rapid charging would be necessary and feasible in central London, but highlighted that many potential charge point locations may require significant investment to upgrade the electricity grid.

Taxi drivers’ working patterns are highly variable. They have autonomy to choose their hours. The trips they do and the areas of London they cover are, to a large extent, determined by their passengers’ journey destinations. Therefore it is quite difficult to predict exactly where rapid charging will be needed.

However, a significant majority of drivers do have preferred working patterns, regular ranks and commonly visited break locations, which were captured in our taxi drivers’ survey (Research spotlight 5). Popular break locations include petrol stations, rest ranks and other ranks, supermarkets/retail/fast food vendors and on-street bays. The most commonly used ranks are at central London stations, hotels in the W1 area and Heathrow and London City Airport.

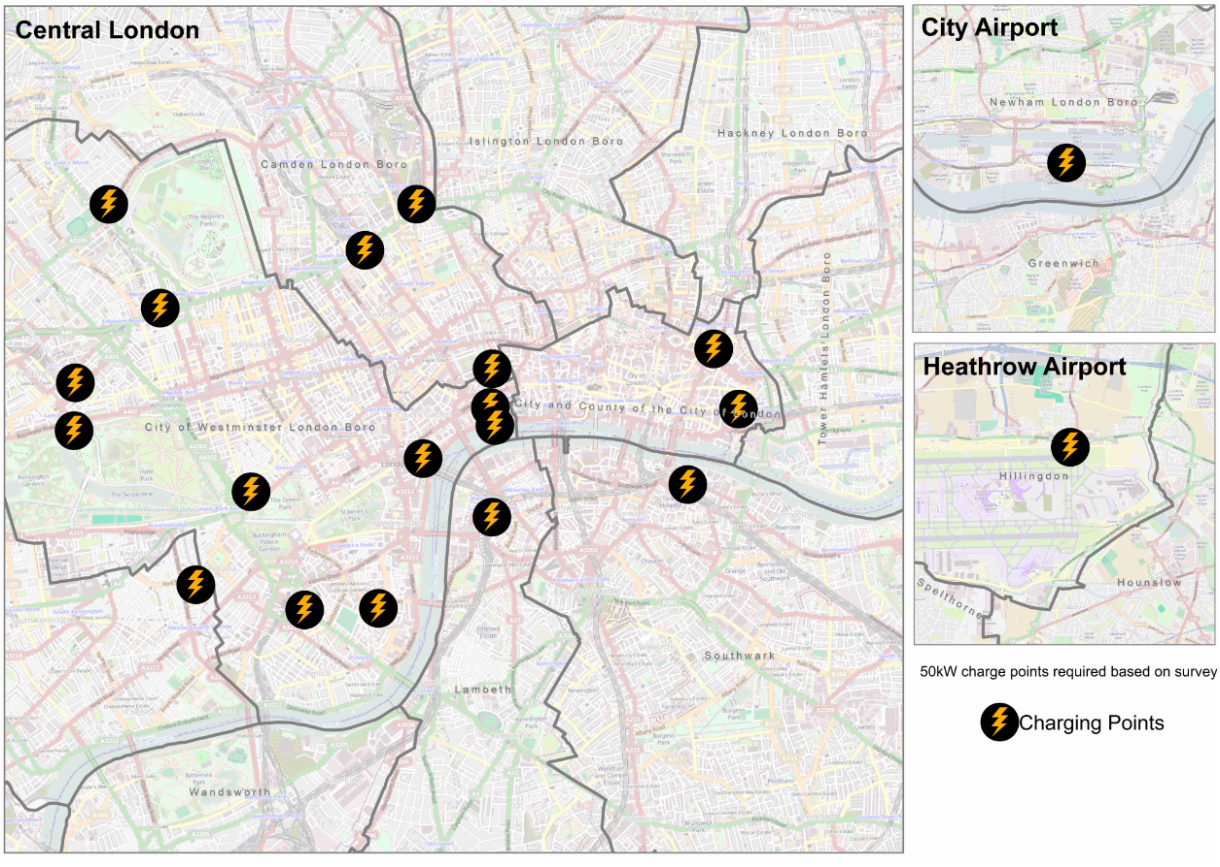
This information was used by EST to assess the number of rapid charge points needed by taxis and to develop a map of indicative locations. This analysis recommended that 150 rapid charge points would be needed to support the anticipated uptake of ZEC taxis in 2018. The report also suggests that around 560 could be needed to support 9,000 taxis in 2020, though this is an estimate which will need to be reviewed as ZEC taxis are adopted and begin to use the charge points.

Alongside the EST study undertaken for PHVs (see next section) and extensive stakeholder engagement of the taxi and PHV trades, as well as landowners, this has allowed us to develop our plans for the deployment of rapid charging.

Taxis are most likely to require rapid charge points near their regular pick-up and drop-off locations (central London and transport hubs) as well as near popular break locations in central London, including taxi rest ranks. Rapid charge points on strategic routes into the centre of London will also support commuting and longer fares, particularly out to London’s airports.

The map in Figure 10 illustrates potential locations in central London that would theoretically suit the charging needs of ZEC taxis.

Figure 10: Illustrative rapid charge point locations for taxis (Source: Feasibility study into a rapid charge network for taxis, 2016)



Research spotlight 6:

'Mapping rapid charge point locations for private hire vehicles in London (Energy Saving Trust, 2017)

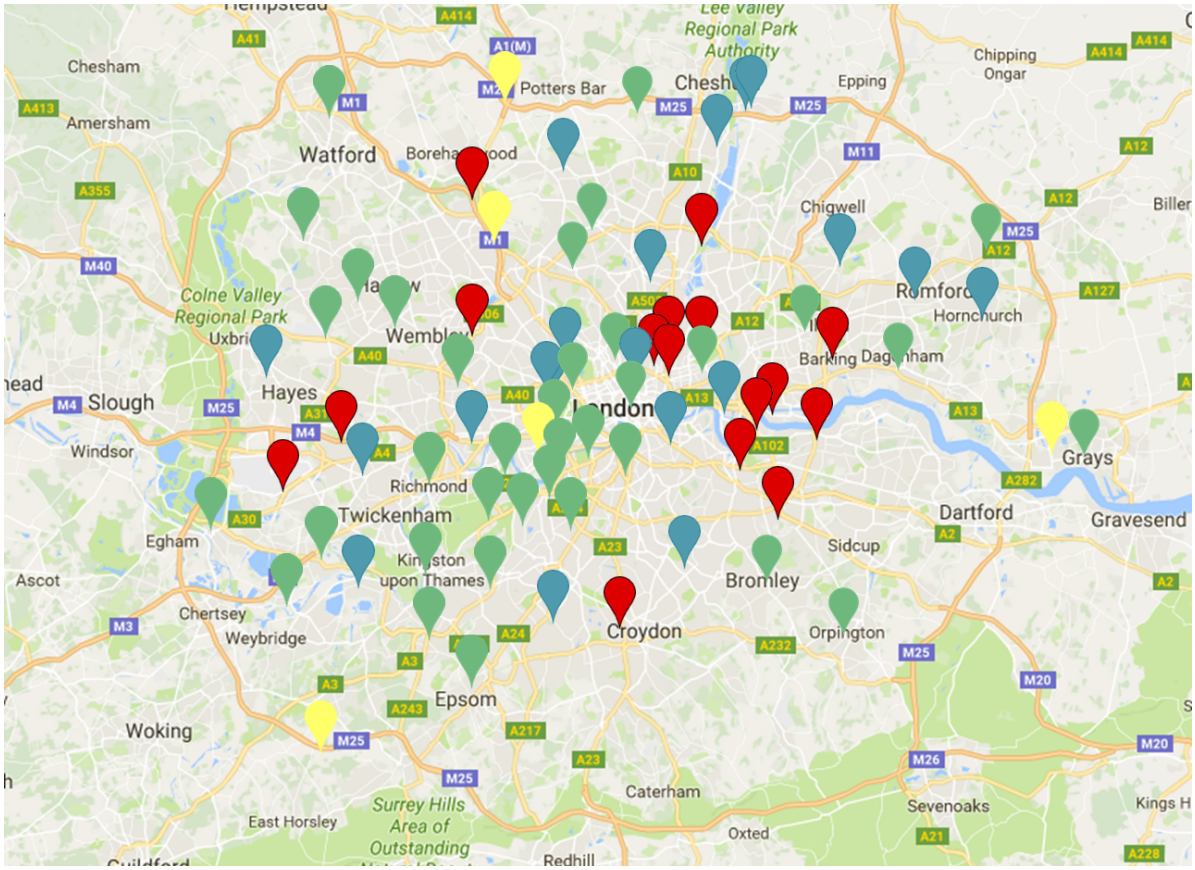
This study investigated the rapid charging requirements of the private hire trade. Six private hire operators contributed to the study, representing a cross-section of the private hire industry in London in 2016 in terms of fleet composition, operational model and geographical coverage. The contributors were: Addison Lee, eConnect cars, GLH, Karhoo, Tristar and Uber.

The study analysed telematics data of four of these fleets (a total of 1,748 cars) to understand the movement and distribution of the vehicles. The study made assumptions on the turnover of the vehicles and likely proportion of the new ZEC PHVs that will be battery EVs (as there are not currently any PHEVs suitable for use as a PHV that can rapid charge). EST then developed a map of suggested rapid charge point locations needed in 2020 to serve the theoretical EVs in these four fleets. The analysis was supplemented with interviews from all six fleets to determine the most appropriate locations and appetite of operators to adopt EVs.

PHV drivers operate across the London boroughs, but the EV customer research survey (Research spotlight 1) showed they were most likely to work in central London, with key drop-off and pick-up points in the W1, SW1 and EC1 areas as well as Heathrow Airport (TW6). PHV drivers would therefore like to see rapid charging points available in these areas of central London, as well as in supermarkets and airports, especially Heathrow.

The 2017 EST PHV mapping study estimates that 140 rapid charge points will be needed to serve the electric PHV fleet in 2020. It suggests 78 illustrative locations which are shown in Figure 11. The estimated number of charge events per week is indicated by the colour of the dot.

Figure 11: Map of illustrative rapid charge point locations for private hire fleets and expected utilisation levels (Source: Electric vehicle charging requirements for private hire vehicles, 2017)



Charge events per week (30 minutes duration)	
High	**30+ charges**
Medium	**10-29 charges**
Low	**3-9 charges**
Rare	**1-2 charges**

The map produced through the telematics analysis indicates that:

- PHVs will need a denser rapid charge point network in inner and, particularly, central London, reflecting the higher number of journeys in this area
- Proximity to strategic roads is important. A number of the suggested locations fall on or near to major arterial routes into London as well as the North and South Circular roads

These outputs are backed up by the stakeholder interviews. Many of the operators agreed that rapid charging will be needed on the arterial and other strategic roads to support commuting and longer distance fares. While working patterns varied significantly across the operators, there is a concentration of activity in the West End, City of London, northwest London and to and from Heathrow.

While for taxis, typical break locations in central London could be used to help identify suitable rapid charge point locations, the private hire operators did not identify any specific regular/popular break locations, with the exception of the recently commissioned Authorised Vehicle Area for drivers awaiting incoming flights at Heathrow. Private hire drivers tend to take breaks during quiet morning and afternoon periods, but many would need to be available should a job come in, making the availability of rapid charge points for a quick top-up very important.

4.6 Destination/top-up charge points

Private EV users will normally use residential charging to regularly charge their vehicles fully overnight. However, they are also likely to occasionally use top-up facilities away from their homes. These can be used in an ad hoc manner, either through signing up to a membership scheme or by pay as you go.

We refer to this type of infrastructure as ‘destination/top-up charging’ to differentiate between regular overnight charging by residents and more occasional use by EV users when out and about and/or when parking at a destination. However, in many cases the providers for residential and destination/top-up charging are likely to be the same. Other key customers for destination/top-up charge points are visitors/shoppers and freight and fleet operators parking for a few hours.

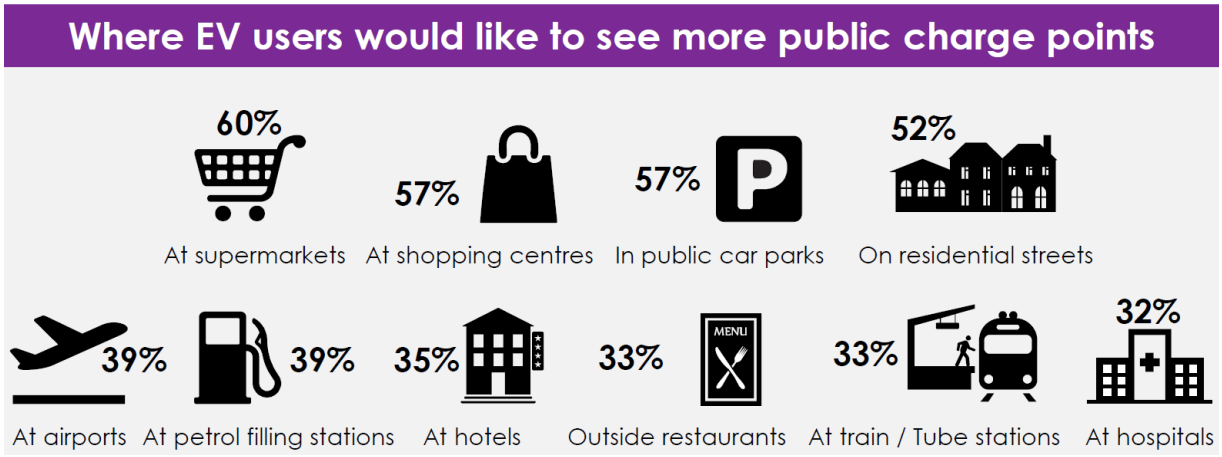
Research spotlight 7:

Understanding electric vehicles – research findings, Future Thinking (2014)

Alongside collecting data on charging patterns and reasons for purchasing EVs, our survey of EV owners investigated views on public charging infrastructure. In this survey, EV owners were asked what they would campaign for if they were part of a committee responsible for expanding the public charge point network in London. Thirty-three per cent said 'additional charge points'.

The survey found that proximity to their final destination is a key requirement for public charge point users and they are unlikely to walk more than 10-15 minutes to/from a charge point. The most popular locations for more charge points are shown in Figure 12 below.

Figure 12: Demand for more destination-based/top-up charge points (Source: Understanding Electric Vehicles (customer research), 2014)



Destination/top-up charging will be most viable where there is a steady turnover of vehicles that stay for a few hours, such as in retail or leisure parks or town centre car parks. These charge points can also be used to enable EVs to be used as part of a longer multi-modal journey, for example, providing EV charging in station car parks.

To be part of a successful and coherent network of charge points across London, destination/top-up charge point network operators should aim to:

- Provide a spread of charge points across London, focusing on popular car-based travel destinations to enable more existing car users to switch to EVs
- Work with boroughs to understand where they want to promote EVs (for example, in air quality hotspots and Neighbourhoods of the Future)
- Work with car clubs to understand local opportunities to work together to offer EVs to more customers

Destination/top-up charge points are generally operated by commercial operators, such as BluePointLondon (a subsidiary of the Bolloré Group), which operates the Source London network and Chargemaster (POLAR network). London's public access charge points and the full range of providers operating here can be found at www.zap-map.com

Between them, BluePointLondon and Chargemaster have made public commitments to deliver more than 7,000 publicly accessible charge points across London by 2018.

Theme 3: Guidance for implementation

Boroughs and charge point operators should consider which type of charging infrastructure is needed in their boroughs in different locations, providing a mix of residential, rapid and destination/top-up charging to serve all types of users. When planning the locations and types of charge point needed, boroughs should take into account: Street Types; housing types; potential future uptake; likely target markets; and local priorities such as air quality hotspots.

For residential charging, charge points should ideally be available within a five minute walk of owners' houses, but not necessarily directly outside if this causes conflict with other residents. There are a number of different technology options that could be suitable – see the WSP Parsons Brinckerhoff study for more information and ideas. This can be delivered through GULCS or directly through the commercial charge point operators. Designating bays with charge points for car clubs in residential streets can also help with wider strategies to reduce car use, by enabling residents to give up their cars and share (electric) vehicles.

For rapid charging, we need help from the boroughs and private sector to find more sites across London. These should be close to strategic routes where off-street hub locations can provide a number of charge points to reduce queuing anxiety. Taxis will need rapid charge points particularly in and around central London and transport hubs to be near popular pick-up, drop-off and break locations. PHVs will need rapid charge points in inner as well as central London.

Boroughs should work with commercial charge point operators to provide more charge points at destinations where short-medium parking is available, particularly in outer London. The provision of destination charge points should enable those Londoners who have to use a car to switch to an EV, but should not encourage additional car use. Charge points should be provided in the most convenient and visible bays in a car park to help incentivise more people to switch their vehicle. Destination/top-up charging will be especially valuable in areas of poor local air quality and where the borough is promoting EVs, such as Neighbourhoods of the Future and Low Emission Neighbourhoods.

5. A good geographical spread

The following sections provide some overarching guidance for the key considerations in the different areas of London. This should be read in conjunction with the advice for the different types of charging infrastructure in Chapter 4.

All parties should work with TfL, London Councils and the charge point network operators who will deliver the charge points on those sites. This partnership working will enable London's charge point infrastructure to grow sufficiently to provide for EV users all across the Capital.

Theme 4: A good geographical spread

Help to build a network of charge points across London to encourage the switch to EVs equitably across the city. This will also reduce the risk of drivers having to drive unnecessary mileage to top-up.

5.1 Central London

Central London is where the ULEZ will be first implemented and the Mayor has an ambition to rollout a zero emission zone in the location by 2025. It is also known as the Central Activities Zone (CAZ), owing to the level of commercial and tourist activity here. Congestion leads to stop/start traffic conditions and idling.

Central London is a key hotspot for poor air quality and high levels of exposure, affecting the health of those who live, work and visit this area.

Provision of charging infrastructure in central London therefore should not encourage new drivers or vehicle trips into the area, but instead convince those who already rely on a vehicle, for example taxi drivers, to switch to an EV. Space is at a premium here so EV charging needs to be weighed up with space requirements of other sustainable transport modes, such as walking, cycling and public transport. On-street charging in areas of high economic activity such as the City of London will mainly need to cater for the non-resident daytime users, such local businesses, taxis, private hire and commercial drivers.

ZEC taxis and PHVs will require rapid charging near to popular central London pick-up and drop-off locations such as the City, the W1 postcode and near rail termini.

5.2 Inner London

The Mayor has proposed to expand the ULEZ to include inner London and will be consulting on this in autumn 2017. Charging infrastructure will be vital to help encourage those inner London drivers looking to replace their cars as a result of ULEZ to take up EVs.

Our research (conducted by WSP Parsons Brinckerhoff, see Research spotlight 4) has shown that on-street charging will be in high demand in much of inner London

owing to the combination of the demographics of the residents, high population density and low parking availability. In areas of inner London where there is a mix of residential and commercial activity, third party commercial charging providers may be a good short-term solution. On-street charge points shared by residents, businesses and visitors would help balance competing demands for space.

Innovative shared on-street charging solutions such as charging from lamp columns could ensure high utilisation rates of charge points in inner London residential streets, especially where high conversion to EVs is forecast.

Local businesses that rely on on-street parking could benefit from access to on-street standard charge points to use when parked for a number of hours and rapid charge points for quick top-up charges when needed.

Rapid charge points near strategic routes in the eastern part of inner London (for example, the Inner Ring Road, A11 and A13) would allow the many taxi and PHV drivers who live to the east and north of London to charge their vehicles on their way to work.

Many PHV drivers live in boroughs to the northeast of inner London such as Tower Hamlets, Newham and Waltham Forest with other pockets also found in Croydon, Hillingdon and Brent. Without access to off-street parking many PHV drivers will need on-street charge points if they are to convert to ZEC vehicles (see map on page 26).

High density population, good public transport access and low access to parking make inner London favourable to car club operators. Car clubs can be a useful transport option for residents who occasionally need to use a car, helping Londoners to give up their private cars and reduce pressure on parking. By providing charge points for car clubs, boroughs can help ensure these customers can choose an EV.

5.3 Outer London

Outer London is generally less densely populated than inner London, but with pockets of dense population that share the characteristics of inner London (such as town centres, for example, Croydon). In these areas, the advice for inner London should be followed.

Car ownership is higher and public transport services more limited in outer London, which can lead to more short trips needing to be undertaken by car, particularly orbital trips. These journeys could be switched to EVs if charging infrastructure is provided at key destinations, such as town centres and rail stations.

In general, outer London residents are more likely to have access to private off-street parking so in many areas there is also a lower demand for on-street parking. Our research (carried out by Element Energy and WSP Parsons Brinckerhoff, see Research spotlight 2) indicates that even in areas of low population density and high availability of off-street parking, approximately 30 per cent of EVs will rely on on-street charge points, with pockets of high demand for on-street residential charging forecast in north and northeastern outer London boroughs.

To support EV uptake in commercial fleets, hubs of rapid charge points are encouraged where there is more space in outer London. These could be near town centres, strategic routes, air quality hotspots and where high EV uptake is forecast.

High concentrations of taxi drivers live in northeastern, eastern and southeastern parts of outer London such as Chingford in Waltham Forest, Hornchurch in Havering and Eltham in Greenwich. These drivers may need on-street charging when parked between shifts. Hubs of rapid charge points along the Strategic Road Network in the east and north are likely to be in increasing demand as drivers switch to ZEC taxis.

Car club operators should be encouraged to develop in outer London as there are the greatest benefits to be realised here given this is the area of highest car dependency. Car clubs can help cater for journeys that are too far to walk or cycle and have limited public transport options. Providing dedicated charging infrastructure for car clubs in residential areas and public access charge points at destinations can help facilitate this switch.

5.4 Growth areas and new developments

New developments and Growth Areas are an opportunity to influence sustainable, emission-free travel choices when new residents and businesses are moving into an area and forming new travel habits.

EV uptake should be encouraged through planning requirements for new developments, using the London Plan standards for EV charge point provision as a minimum. This has the added benefit of securing electricity capacity for charge points at the time of building, saving the costs of retrofitting later on. Boroughs could consider requiring developers to provide land for rapid charge point ‘hubs’ within mixed use developments, such as in customer parking areas for retail developments.

The current London Plan requires a minimum percentage of active (live) and passive (with an electricity supply ready for a charge point to be installed) charge points to be installed where car parking is provided in new developments. Meeting these requirements will ensure that the current and future charging needs of residents, businesses and visitors are met. A new draft London Plan is due to be consulted on in 2017 and will contain more detailed requirements for EV charging. Even more stretching standards for each land use type could also be set through Growth Area transport strategies and parking policies.

Car users moving into a new area will be reassessing their travel behaviour. Growth Areas and new developments should therefore capitalise on this opportunity to encourage residents who rely on cars to choose an EV or, even better, sell their car and join an EV car club. Some boroughs use car clubs as a tool to reduce the need for private car parking provision and enable car-free developments. By requiring developers to provide charging for EVs at the time the car parks are being built, new developments can be a great opportunity to support the growth of EV car clubs by providing investment for charge points through developer contributions.

Charge point installation can be complemented by other low emission measures in Growth Areas and new developments, such as using procurement mechanisms to incentivise construction vehicles to be electric and setting up freight consolidation centres served by EVs.

Theme 4: Guidance for implementation

The overall recommendations for central, inner, outer London and Growth Areas are summarised in Table 3.

Boroughs and charge point operators should use our London-wide research in conjunction with local knowledge to plan the right type of infrastructure across the city, helping to develop a pan-London network that serves local priorities.

Neighbouring boroughs should work together to ensure London has a coherent network of publicly accessible charging infrastructure, so that EV users do not have to drive out of their way to find a charge point they can use.

Table 3: Guidance for charging needed in the different spatial zones across London

Charging infrastructure type	Central (Central ULEZ and fringes)	Inner	Outer	Growth Areas and new developments
On-street residential	All cars contribute to congestion, no matter what their emissions, so charge points should be aimed at converting existing drivers who have to drive (eg taxis and freight), not to encourage non-drivers to purchase a new vehicle. Central London street space is at a premium, so innovative and shared solutions could be very important here.	The highest projected demand for on-street charging is found here, owing to demographic characteristics (such as household income) coupled with low levels of off-street parking. Different solutions will apply to different housing types, as discussed in the WSP Parsons Brinckerhoff study.	Where parking pressure is less intense, residential streets here are more likely to easily accommodate charge points. However, demand may be lower which could make commercial viability an issue. Providing EV bays for car clubs could help to reduce emissions by reducing car ownership and introducing cleaner vehicles.	Charge points should be provided in line with London Plan parking standards at a minimum. This requires a mixture of active (ready to use) charge points and passive (with an electricity connection for set up when demand is there). The new London Plan will be consulted on in late 2017.
Rapid	Rapid charge points should be deployed near areas of commercial activity to support the use of EVs for servicing and deliveries as well as ZEC taxis and PHVs.	Rapid charging hubs would be best located close to strategic routes such as the North/South Circular and A roads. They should also be considered at transport hubs and close to	Rapid charging hubs would be best located close to strategic routes and in/around major town centres, transport hubs and industrial areas.	Mixed use and retail developments with open access car parks could be an opportunity to develop rapid charge point ‘hubs’ to support the uptake of ULEVs in areas where users

	Single rapid charge points may be more viable than hubs (eg taxi rest ranks).	busy high streets, particularly in air quality hotspots.		are forming new travel habits.
Destination-based /top-up	Charge point network operators should work with boroughs to convert parking spaces to charging bays in areas of existing car-based activity. This will support the use of EVs for existing car trips that can't be switched to other modes, including servicing and deliveries.	Boroughs and charge point network operators should work together to identify existing parking bays in which to install this type of charge point, particularly in mixed use areas and destinations such as near high streets and transport hubs, especially in air quality hotspots.	Charge points should be provided at key destinations such as shopping centres, retail parks, town centre car parks and transport hubs to encourage car owners to undertake local trips by EV.	Developers should provide this type of charge point in mixed use and retail developments with open access car parks to provide 'active' charge points in line with the London Plan minimum requirements.

6. Further reading

6.1 Using our research for future planning

To date, EV charging has been mostly ad hoc and in response to requests from those who already own EVs. To achieve a major expansion in EVs, more strategic and evidence-based planning and investment is required, guided by both research and local consultation.

Following the advice in this guidance will help ensure that London has the charge point infrastructure to support any driver to switch to an EV. Adhering to the four themes and following the guidance for implementation as set out in Chapters 2-5 of this guidance will help ensure this is the case:

Four themes

1. Identify current demand: Respond to requests for charge points from residents and businesses to balance competing demands for space and maximise charge point usage (and therefore viability of the charge point) from time of installation.

2. Provide for future uptake: Provide a certain amount of infrastructure based on predicted future demand, including for residents, while prioritising demand from essential commercial vehicles, ZEC taxis and PHVs. This will ensure current public funding will also support Londoners who cannot currently afford to switch to an EV but would like to do so in the future, for example, when the second hand market is more developed.

3. The right charge point in the right place: Use different types of charge points according to the type of user to ensure the most appropriate infrastructure.

4. A good geographical spread: Help to build a network of charge points across London to encourage the switch to EVs equitably across the city. This will also reduce the risk of drivers having to drive unnecessary mileage to top-up.

We recommend that boroughs and charge point operators also refer to the studies themselves as they provide much more detailed insight into the various EV user groups in London – namely taxis, private hire, residents, the freight industry and car clubs.

6.2 List of studies

The following studies have been used in the production of this guidance:

- Plug-in electric vehicle uptake and infrastructure impacts study, Element Energy and WSP Parsons Brinckerhoff (2016)
- Electric vehicle charging study: A review of options for charging at homes without off-street parking, WSP Parsons Brinckerhoff (2015)
- A feasibility study into a rapid charge network for taxis, Energy Saving Trust (2015, updated 2016)
- Mapping rapid charge point locations for commercial vehicles in London, Energy Saving Trust (2015)
- Rapid Charging Network Study, Element Energy (2015)
- ULEV car club Study, WSP Parsons Brinckerhoff and Frost & Sullivan (2016)
- Understanding electric vehicles – research findings, Future Thinking (2014)
- Mapping rapid charge point locations for private hire vehicles in London, Energy Saving Trust (2017)
- Private hire vehicle rapid charging points: Research findings, Future Thinking (2016)
- The road to reducing commercial vehicle emissions: Exploring the technical barriers to uptake of alternatively fuelled commercial vehicles (2016)
- How can LoCITY increase operator uptake of ultra low emission vehicles? (2016)
- Electric vehicles: Gauging interest amongst disabled and elderly drivers, 2CV (2016)

The studies can be found on our website at: tfl.gov.uk/ulev-research

For more details on any of this research, please contact TfL at electricvehicles@tfl.gov.uk