Research report

energy saving trust

Electric Vehicle

Infrastructure Forecasts 2025

City of London Corporation February 2020

Introduction

The City of London Corporation have adopted a Transport Strategy that includes planning for and enabling the transition to the use of Electric Vehicles. Mayoral plans for a zero-emission zone in central London will increasingly lead to the electrification of vehicles travelling to and through the Square Mile, raising questions over where these vehicles will refuel. Energy Saving Trust have been commissioned to provide a range of forecasts, which aim to establish how much charging infrastructure will be required by 2025.

In the UK, electric plug-in vehicles (PiVs) accounted for around 3% of new vehicle registrations in 2019, up about 1% on 2018[1]. These levels of uptake might not seem disruptive; however, many established manufacturers are set to release new electric models over the coming years and new EU legislation[2] will progressively incentivise manufacturers to reduce the emissions from their new vehicles, from 2020.

The combination of model availability, emissions legislation and the UK policy environment will certainly create the right conditions for greater proportions of PiVs on the UK's roads but where will these vehicles refuel, and who will provide the charging infrastructure to ensure the vehicles become viable alternatives to petrol and diesel vehicles?

Recent industry statistics from UK Power Networks[3] suggests that 9% of charging sessions will take place at a destination by 2025, with the remaining 91% spread across home, work and en-route charging scenarios. These statistics also identify that 22% of charging sessions will take place at home on street, illustrating that residential areas must be considered in plans, however for the City the limited amount of residential parking is all off-street.

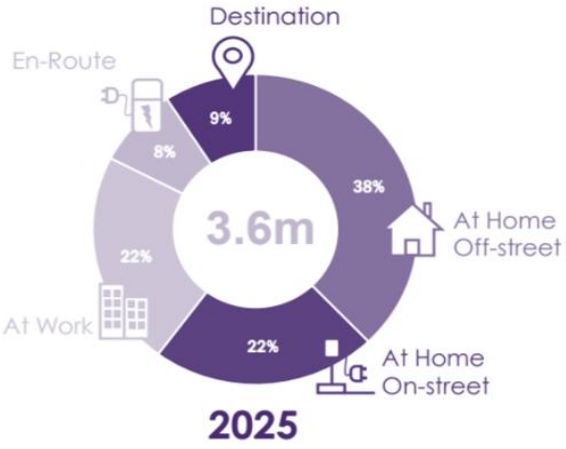


Image courtesy of UKPN

The electric vehicle supply equipment (EVSE) industry has evolved at pace, with established and startup companies alike so far placing strong emphasis on securing a market share. Consequentially, the industry will invest ahead of demand but usually taking a phased approach and often encouraged with investment from UK and local government.

Future market demand should provide the certainty required for market led solutions at scale, but local authorities have and will continue to play a critical role in supporting this transition, by working with industry to install enough infrastructure ahead of consumer demand.

Some charging solutions focus on achieving the fastest rates of charge, and others on on-street solutions; however, it's accepted that a mixture of charging options is required to meet needs.

The City of London Corporation have recently published their transport strategy[4] - 'City Streets, Transport for a Changing Square Mile' which considers measures to reduce the social, economic and environmental impacts of motor traffic and congestion over the next 25 years. Included, are ambitious policies to help reduce all motor vehicle trips in 2030 by 25% and specifically freight/delivery vehicle flow by 15%. Specific measures will include introduction of zero emission zones, helping to disincentivise non-critical journeys and shift others to zero emission technology.

This study explores key issues and provides clear recommendations on the quantity and specification of Plug-in vehicle charging infrastructure that will be needed to meet the anticipated demand from motorcycles, cars, taxis and light commercial vehicles by 2025.

Executive summary

The City of London, Transport for London (TfL) and the UK government have all recently released climate change policy objectives and the current goal is for the UK to be net zero by 2050, meaning that almost every new car and van sold in the UK will be zero emission by 2040, or possibly earlier. There are over 32 million vehicles registerd in the UK, and with electric vehicles currently the preffered zero tailpipe-emission technology, it's clear that new re-charging infrastrcuture will be needed, but how much of this needs to be located inside the The City boundary?

Energy Saving Trust have undertaken in-depth, data led anlysis and have developed this report, forecasting the quantity and specification of charging infrastructure that's anticipated will meet the charging needs of London's taxi, car, light van and motorcycle (light vehicle) drivers inside The City.

Most traffic entering the Square Mile originates from across Greater London, or beyond, so historical uptake of Plug-in vehicles (PiVs) registered within the The City itself is not the best indicator for forecasting future scenarios. Our analysis considers PiV uptake from across the Greater London area as a proxy for predicting the rate of adoption by traffic entering the City - in 2019 around 1% of light vehicles registered in Greater London were plug-in models.

The period up to 2025 will see manufactuers release many new electric models (34 in 2021). Improved choice, new EU vehicle emissions regulations, national incentives and the introduction of zero emission zones will encourage increasing numbers of drivers to switch to PiVs.

Three local uptake scenarios have been modelled to 2025 ranging from 17-30% of traffic flow. The low scenario (17%) is based on historical uptake, accelerated to represent increasing popularity of PiV technology. The high scenario (30%) is a policy based projection, and uses a scaled value for 2025, to represent City of London ambition for 90% of traffic to be zero emission by 2030. The mid scenario (23%) is simply the midpoint between the high and low models and will be useful to measure future progress against.

Applying these uptake scenarios against traffic flows for strategic sites throughout the the City provides an indication of the proportion of vehicles by category that could be electric and require charging inside the Square Mile by 2025. Adjusting for ambitions to cut traffic volumes highlights that by 2025, there could be an around 8,000 light vehicles entering the City of London each day. Increasingly high numbers of these will be plug-in and will at least partly rely on charging infrastructure inside The City to help make electric models a viable.

The City will play a crucial role in enabling zero emission vehicles, but it cannot be considered in isolation. Greater London Authority and TfL have already installed significant quantities of charging infrastructure, with more planned. Charging infrastructure can have long lead in times and installation is normally followed by a period of normalisation before utilisation stabilises. The Corporation have and should continue to work closely with TfL and other boroughs to understand how these wider infrastructure plans could impact their own.

Energy Saving Trust recommend that a network of 26 (50kW) rapid chargers be planned, with a proportion reserved for use by taxis. There could be demand for 13 taxi specific rapids, 7 for vans and the remaining 6 for rapid charge capable cars and motorcycles, but it would be sensible for many to be shared access, providing greater flexibility and improved access.

The Corporation should make plans to install at least 65 standard chargers (7kW+), **each with two connectors** by 2025 (130 x 7kW sockets). These should be capable of **charging two vehicles simultaneously**. The analysis indicates that 15 of these could be dedicated to electric motorcycles by 2025.

In support of infrastructure forecasts, Energy Saving Trust has made 6 key recommendations:

1. Develop a monitoring and evaluation framework. Observe and chart actual PiV uptake within CoL traffic flows and utilisation of existing charging infrastructure.

2. Prepare immediate plans for phased installation of 26 rapid chargers and 65 standard chargers, meeting the forecasts under the low scenario. The existing infrastructure should be assessed to consider what proportion of the forecast demand, it can meet.

3. Dynamically evaluate the suitability of the low scenario against technological developments and infrastructure plans across Greater London.

4. Prepare contingency plans that will mitigate against the impacts of unmet demand equivalent to the high scenario, and alternative proposals for oversupplied sites.

5. Work with neighbouring boroughs to identify collaborative opportunities for strategically placed, scalable and efficient infrastructure solutions on arterial routes.

6. Work with EVSE industry and other stakeholders, ensuring that commercial opportunities for market led, or partnership solutions are well publicised and free from unnecessary development barriers.

Summary of charging infrastructure forecasts up to 2025

Vehicle Group	Scenario	Daily Vehicle Demand	Standard Units/Sockets	Qty Rapid Units
All Vehicles	Current/ 2020 pipeline	-	~32/64	8
All Vehicles	Low 2025 forecast	680	65/130	26

Standard chargers

Rated at 7kW AC, each with **two type2** connectors for **simultaneous charging**. These are typically compatible with all PiVs.

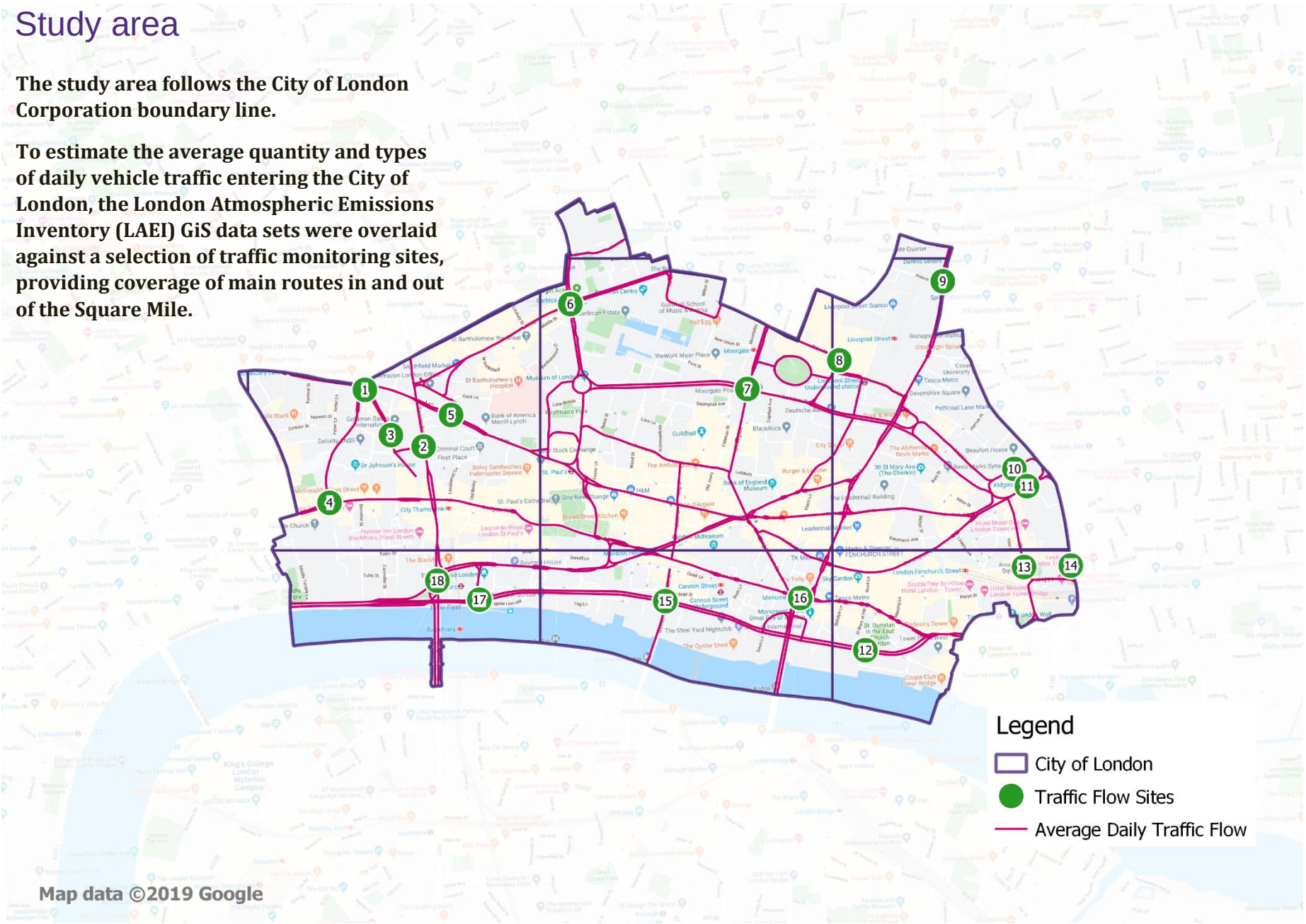
Rapid chargers

Units capable of delivering a maximum of 50kW DC via CCS and CHAdeMO connectors and optionally up to 43kW AC via a Type 2 connector.

Study area

The study area follows the City of London Corporation boundary line.

To estimate the average quantity and types of daily vehicle traffic entering the City of London, the London Atmospheric Emissions Inventory (LAEI) GiS data sets were overlaid against a selection of traffic monitoring sites, providing coverage of main routes in and out of the Square Mile.

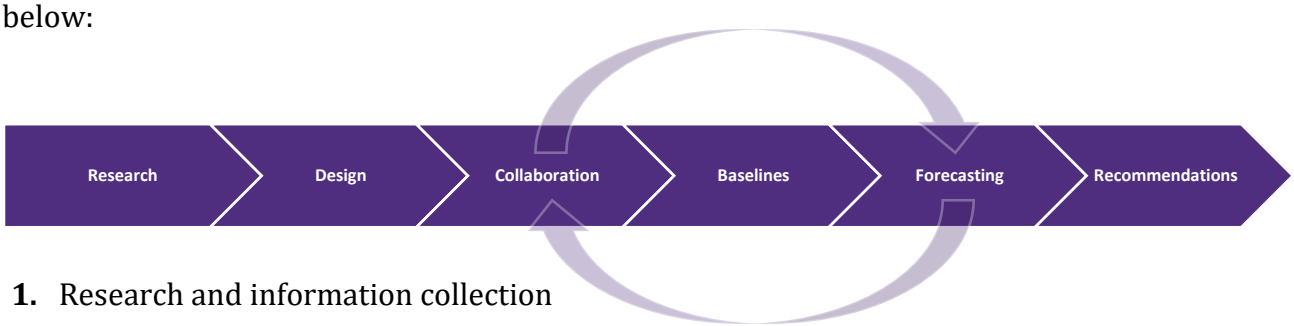


Approach

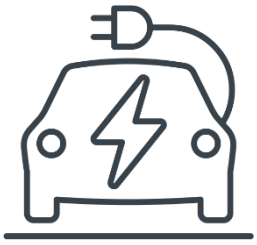
Transport planning methodologies are well established for London and so for consistency, we have used existing approved resources to inform analysis wherever possible. The objective of this report is to provide CoL officers with recommendations on the specification and quantity of infrastructure that would be necessary to meet the needs of a range of drivers who live in, or travel to the area on a regular basis.

Working with CoL officers, we agreed that the study should include four distinct vehicle categories, motorcycle, taxi (hackney carriage), car (including private hire) and light goods vehicle (<3.5t)

The project employed a multi-stage process, with activities broken into the six categories below:



1. Research and information collection
2. Design of analysis tools and geographical information system (GiS) working environment
3. Collaboration between CoL officers and Energy Saving Trust to identify, agree and model assumptions used to simulate future zero emission zone policy scenarios and ambitions for reduced traffic volumes
4. Preparation of baseline statistics, including:
    - The quantity of PiVs registered within the Greater London Authority area (GLA)
    - GLA PiV uptake trends 2011 - 2019
    - The quantity and specification of existing PiV charging infrastructure
    - Sampling and analysis of ANPR data
5. Preparation of forecasts for each user group to 2025, including:
    - The anticipated rate of PiV uptake
    - The quantity and specification of chargepoints to meet associated demand
    - Traffic flow volumes to 2025
6. Reporting and recommendations



Recommendations

Having considered all factors, Energy Saving Trust have established that that there is sufficient evidence to merit planning improved PiV charging infrastructure within the CoL boundary up to 2025. There is still some uncertainty over the exact rate and timing of uptake that will be experienced, as well as the impacts of zero emission policy on modal shift; however, long delivery lead times mean that infrastructure must be planned well in advance.

Well-designed charging infrastructure plans will complement the existing transport strategies and will help ensure that CoL is well positioned enable zero emission transport adoption. The following set of six recommendations, if followed, will allow CoL to make sensible preparations for the next five years:

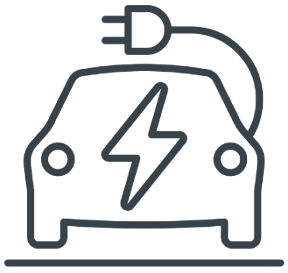
Table 6 – Summary of recommendations

1	Develop a monitoring and evaluation framework. Observe and chart actual PiV uptake within CoL traffic flows and utilisation of existing charging infrastructure.
2	Prepare immediate plans for phased installation of 26 rapid chargers and 65 standard chargers, meeting the forecasts under the low scenario.
3	Dynamically evaluate the suitability of the low scenario against technological developments and infrastructure plans across Greater London.
4	Prepare contingency plans that will mitigate against the impacts of unmet demand equivalent to the high scenario, and alternative proposals for oversupplied sites.
5	Work with neighbouring boroughs to identify collaborative opportunities for strategically placed, scalable and efficient infrastructure solutions on arterial routes.
6	Work with EVSE industry and other stakeholders, to ensure that commercial opportunities for market led, or partnership solutions are well publicised and free from unnecessary development barriers.

Recommendation 1

The analysis has highlighted that there are still considerable uncertainties which will affect the quantity and specification of infrastructure required in 2025 and beyond. There is a clear and immediate case for more infrastructure but insufficient clarity at present to indicate that CoL must facilitate charging infrastructure to meet charging demand under higher levels of PiV uptake – that responsibility is likely split with neighboring boroughs and industry.

CoL should ensure sufficient resource is available to develop a monitoring and evaluation framework or procure such services on a commercial basis. Meeting this recommendation will help de-risk the investment and ensure that the best value proposition is delivered.



Ideally, these monitoring and evaluation measures should be co-developed with the early stages of immediate infrastructure plans. This will ensure that the monitoring and evaluation tools and processes are available as soon as practicable, and that they can be applied to evaluate the current and next phase of infrastructure sufficiently early, for learnings to be useful for adjusting future plans.

Recommendation 2

Immediate plans should be made for the phased installation of 26 Rapid chargers and 65 standard chargers. The initial analysis has indicated that theoretically, there is a valid case for specific infrastructure for each vehicle category.

Each category will have vehicles with very different operational behavior, and charging requirements; however, since the ambition is to reduce total motor traffic by 25%, it would be sensible to co-locate slower chargers with alternative transport methods for onwards travel. This could include co-location of e-bikes and other shared mobility facilities with e-bike/e-cargo bikes/PiV charge-points. The spatial constraints of CoL's built environment may make this ambition challenging to deliver, but the concept should be a key consideration when scoping charge point locations within CoL, or when working with neighboring boroughs.

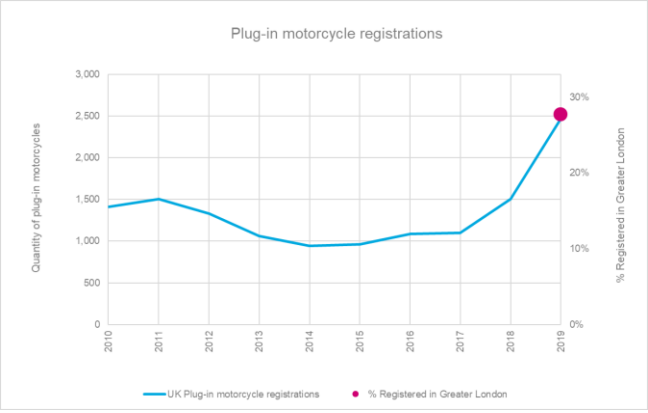
Motorcycles

Most existing electric motorcycles are designed to use either a domestic 3-pin plug, or a type 2 connector. As a consequence, these are largely charged at lower power rates using AC electricity. Some premium electric motorcycle models are starting to offer optional faster DC charging but there is no clarity on the rate that this will become an affordable and popular option. Electric motorcycles capable of faster charging speeds may prove popular with courier and delivery drivers in the future, but purchase costs might be a barrier until new prices reduce, or the used market becomes more established.

In Q3 of 2019, there were around 2,500 plug-in motorcycles registered in the UK and 28% of these were recorded in Greater London.

Anecdotal evidence in the motorcycle media suggests that despite impressive rideability, uptake of electric technology by motorcycle riders may be slower than drivers of other vehicles.

With such a large share of the UK market, London is highly likely to experience significant growth in Plug-in motorcycle registrations up to and beyond 2025.



Charging an electric motorcycle may prove challenging for those without access to off-street parking and public charging in central London would remove this barrier. CoL should assess existing motorcycle designated parking for suitability of type 2 charger installation. The installation should be highly visible, well promoted and should incentivise new and existing riders to switch.

Taxi (Hackney Carriage)

There is a strong business case for driving electric taxis in London but access to convenient rapid charging infrastructure is critical to help drivers incorporate charging events into their working days. The analysis has shown that there is strong evidence for specific rapid charge points to cater for taxi drivers' requirements within the CoL. To maximise taxi driver experience, infrastructure needs to be sufficient to meet peak demand and well located to correspond with popular drop off and dwell locations.

The analysis highlights that under the high scenario, PiV uptake rate for taxis could meet or exceed 75% of vehicle parc by 2025 and this could result in c.524 taxis charging in CoL each day. Under this level of demand, 32 rapid chargers would be required. With drivers covering an assumed total mileage of 110 miles and charging on average 1.5 times per day, this is equivalent to each charger accommodating around 24 sessions per 24 hours.

With the introduction of zero emission zones, it is increasingly likely that there will be high numbers of plug-in taxis operating in the CoL area each day but the infrastructure for CoL cannot be considered in isolation. Greater London Authority and Transport for London (TfL) have already installed significant quantities of rapid charging infrastructure for the taxi industry, with more planned. While these plans are being delivered and the impact that these have on taxi charging behavior are being understood, CoL should make plans to install sufficient enabling infrastructure, that represents a value proposition.

With reference to our first recommendation Energy Saving Trust propose that CoL make immediate plans for the taxi specific infrastructure forecast under the low scenario and dynamically evaluate these against the wider TfL taxi charging network. Plans under this scenario would see CoL install a total of 13 rapid chargers and this would include their existing hub at Baynard Street car park. Analysis shows that this is equivalent to meeting demand from 175 taxis per day, charging on average 1.5 times per day – each charger supporting an average of 20 sessions per 24 hours.

At an average of 20 sessions per day, per rapid charger and assuming that sessions are not too heavily concentrated, there will be some built in spare capacity to allow CoL to monitor use and to work with TfL, industry and other stakeholders to understand how the wider charging infrastructure provision meets demand and technological developments.

Cars (including private hire vehicles)

The case for car focused PiV charging infrastructure is three-fold, with demand for charging likely to come from residents, commuters and a significant quantity of private hire vehicles. The nature of the data inputs meant that it was not possible to filter out private hire vehicles from other cars; however, with around 88,000 private hire vehicles operating in London, it is clear that a large proportion of the demand for charging will come from this vehicle group.

CoL should explore opportunities for installation of charge points specifically targeting domestic and business residents/visitors across the city, and these should be publicly accessible (for at least part of each day). Most of these will likely have to be in underground, or multi-story locations to minimise conversion of on-street parking bays.

Early installation locations could be identified by recording resident interest, and these should be assessed for viability.

Ideally, sites should be scalable, and should accommodate multiple double units, or multiple single satellite chargers. This could also be extended to business permit areas; however, care needs to be taken that these bays do not become permanently blocked.

PiV drivers prefer co-located, mixed specification chargers, so a proportion of the 6 rapids should be installed near to the standard chargers, allowing drivers the option for a quick top up when they have insufficient time for longer charge sessions.

Light commercial vehicles (LCV)

The low scenario forecasts 7 rapid chargers to meet demand from light commercial vehicles by 2025. CoL have expressed ambitions for LCV charging infrastructure to be installed at a selection of locations including last mile logistics hubs, private loading bays, and public car parks throughout the City. It is intended that facilities be integrated with other parking and logistics facilities which are being developed. Energy Saving Trust agree that this is a logical approach.

Recommendation 3

Evolving vehicle technology and market conditions up to 2025 could impact the efficacy of the forecasts. There is sufficient evidence available for Energy Saving Trust to recommend that CoL plan for at least the low scenario; however, officers should continually monitor developments, as these could quickly impact the specification, total number and rate of installation.

Examples of strong influencers might include oil price volatility, sustained fuel shortages, over or under supply of charging infrastructure across Greater London and plug-in vehicle supply chain certainty. Multiple concurrent influencing developments could amplify the effects and early awareness will be critical to ensure that plans can be adjusted sufficiently early for impacts to be mitigated against.

Recommendation 4

Locating sites, assessing viability, pricing, procuring and installing new charging infrastructure can take up to a year, and even longer in some cases. For this reason, Energy Saving Trust recommend that CoL mitigate against undersupply of charging infrastructure by

ensuring that wherever practicable, sites are scalable and capable of meeting future unmet demand with minimal work.

Mitigative measures could include specifying extended cable conduit runs, sizing sub-stations to accommodate installing more or higher power charging units in the future, or developing a 'longlist' of potential sites, which are fully scoped, but which will not proceed to installation, until anticipated demand provides justification. This should be consistent throughout all planning process.

Recommendation 5

The geography of CoL and other central London districts may make it more challenging to develop charging infrastructure at scale compared to more suburban areas. It's possible that improving PiV range and greater provision of charging infrastructure in suburban boroughs of London might largely remove the need for most vehicles to charge in central locations often.

It's clear that even with a reduction in total traffic volumes, electrification of road transport will increase the requirement for chargepoints on CoL's roads. What isn't as clear, is what proportion of PiVs will choose to charge outside the CoL limits. CoL officers should work closely with neighboring authorities to monitor how charging infrastructure provision and utilisation varies between other London districts and their own.

Recommendation 6

CoL Corporation are playing an important enabling role in the installation of the area's next phase of charging infrastructure and there is strong evidence that they should continue this role in the immediate future; however, there is also some evidence that where demand is proven, market led solutions will meet these needs.

CoL officers should make sure that new infrastructure is well publicised and advertised, helping ensure that chargpoint utilisation is maximised and evidenced by evaluation activity. The outputs from monitoring and evaluation activities should be used to support the opportunity for future infrastructure delivery partnerships.

Appendices

The following section provides supplementary information on the specific methods used to complete the analysis, and references to data and information sources that have informed the project.

Method

The following sections expand on the approach summarised above and provide specific details on the methods employed for producing the project' outputs.

Research

Desk-based research explored the information sources, data resources, local and national policy environments that are anticipated to influence the rate of PiV uptake to 2025.

Information was mainly sourced from online resources and were supported with input from CoL officers and internal subject matter expertise from across EST's transport teams (where required). A full list of information references is available at the end of this document.

Research highlighted that existing government data sets and transport statistics for the Greater London area would provide a sensible foundation on which to build evidenced recommendations within the scope. The table below provides details on the data sources accessed and their use:

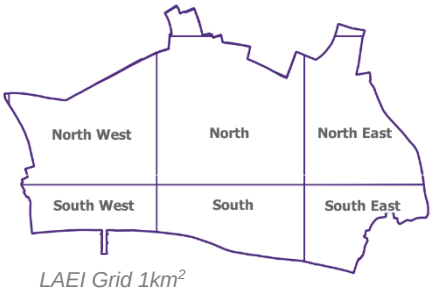
Table 1 – data resources

Data Resource	Source	Purpose
Plug-in Vehicle Registrations	VEH 0131[5]	Inputs for generating baseline PiV uptake
Total Vehicle Registrations	VEH 0105[6]	Inputs for calculating vehicle ownership
CoL Transport Strategy 2019	Online PDF[7]	Rationale for forecast assumptions
Greater London Transport Strategy 2018	Online PDF[8]	Rationale for forecast assumptions
London Atmospheric Emissions Inventory	LAEI 2016[9]	Average daily traffic flow volumes by category
TFL SCOOT Data 2018	Online CSV[10]	Traffic flow monitoring site locations

Design

Desk-based working environments for analysis of datasets were developed, with spatial elements constructed in a 2d GiS environment. These were supplemented with 3d satellite imagery and street level photography (as required).

The London Atmospheric Emissions Inventory 2016 (LAEI) provided a range of sensible, pre-approved spatial data sets covering the CoL. Despite the relatively compact nature of the study area, the central location and economic importance means that there are many high flow traffic routes in and out of the area.

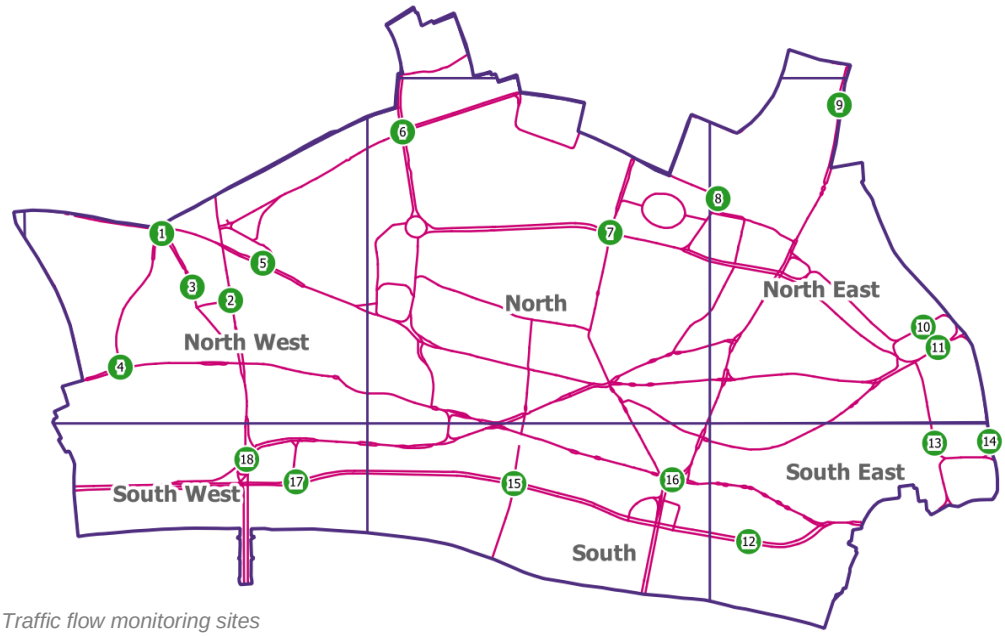


LAEI Grid 1km²

The LAEI GIS datasets include a 1km^2 grid layer and this was applied to the CoL boundary extent, providing six distinct areas for classification and labelling of numerical analysis (see image above).

The LAEI also provided average annual daily traffic flow information (AADT) for the road network throughout the study area. To minimise double counting, a selection of 18 fixed points were chosen.

Table 3 – traffic monitoring sites



Traffic flow monitoring sites

Map ID	Data ID	Grid Sector	OS Coordinates (X, Y)	Average Annual Daily Traffic Flow (LAEI 2016 - Unadjusted)				Adjusted AADT (Grid Sector)
				MC	Taxi	Car	LCV	
1	00-004	NW	531400, 181550	690	1391	3375	677	1499
2	00-027		531601, 181356	1475	2505	5437	1906	
3	EST-001		531489, 181395	628	1535	3708	1176	
4	00-031		531279, 181163	52	741	1445	276	
5	00-057		531695, 181464	712	2280	5535	1036	
6	00-028	N	532103, 181844	786	1593	3898	1298	871
7	00-009		532709, 181553	1734	2896	7015	2061	
8	00-107	NE	533024, 181651	38	571	1109	208	1500
9	00-065		533378, 181922	875	2068	5067	1387	
10	00-101		533623, 181279	1122	4009	4700	1694	
11	00-103		533666, 181220	1180	847	7890	1949	
12	00-118	SE	533113, 180658	2095	3382	8312	3066	
13	00-003		533656, 180943	257	585	1412	745	2073
14	05-230		533816, 180948	1039	1189	11040	2433	
15	00-015	S	532428, 180826	1483	2268	5583	1429	
16	00-019		532890, 180837	3194	3524	8577	3645	1214
17	00-059	SW	531792, 180831	1890	2732	6673	2442	
18	00-006		531648, 180896	1727	2909	7148	2187	1133

These fixed sites are listed by Transport for London (TfL) as Split Cycle and Offset Optimisation Technique (SCOOT) locations, with the exception of map reference 2, which was selected to fill a gap on the road network that did not have a suitable SCOOT location. 3-dimensional and street level imagery was used to confirm if the corresponding roads were one or two-way, and the AADT quantities were scaled accordingly.

Collaboration

Collaboration featured strongly throughout the project but most of these interactions were concentrated on developing and refining the outputs from the early analysis. This helped ensure that the final outputs were consistent with existing strategy, plans and ambitions.

The following table provides a summary of the key assumptions that were agreed between CoL's and Energy Saving Trust's team:

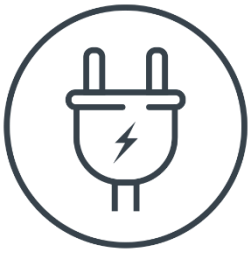


Table 2 – table of assumptions

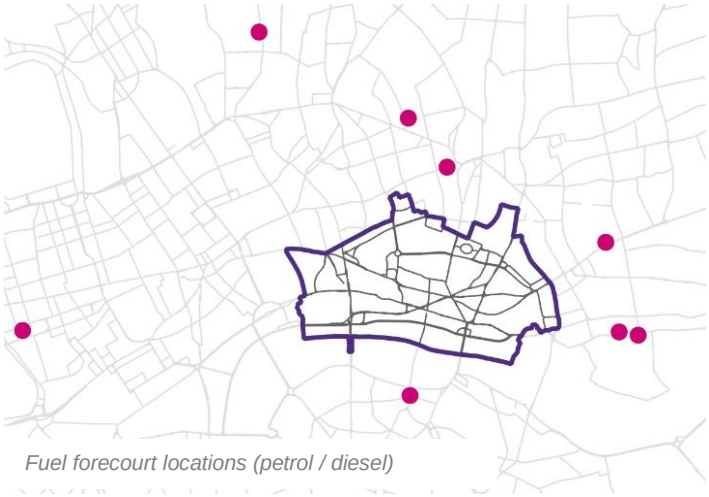
Assumption	Category	Value	Logic
CoL charge demand	MC	9% x AADT	CoL has no existing petrol/diesel re-fueling infrastructure, but we anticipate EVSE will be required within CoL to make PiVs viable for all categories of vehicle, and to support planned zero emission zones. Informed by UKPN statistics.
	taxi		
	Car		
	LCV		
Traffic flow reduction 2025	MC	-12.5%	The CoL transport strategy expresses an ambition for total traffic volume to fall by 25% by 2030 and 15% for commercial vehicles. 12.5% and 7.5% represent the mid-point.
	taxi	-	
	Car	-12.5%	
	LCV	-7.5%	
LAEI AADT adjustment	2-way	-50%	Traffic travelling to the CoL and passing a monitoring site will either return via the same route, or an alternative route. AADT values must be halved to reflect.
	1-way	-	
PiV uptake 2025 (High Scenario)	MC	30%	CoL transport strategy outlines an ambition for 90% of traffic to be zero emission by 2030. EST and CoL agree that there will likely be an exponential rate of change in the proportion of PiVs to 2030. 30% is the value agreed between EST and CoL for forecasting infrastructure requirements on high optimism scenarios. Using the replacement schedule provided by TfL in 2017 the normal taxi license renewal would have been 12,826 by 2025 or c.58% of the taxi parc. With incentives for drivers to change early and the reduction of the age limit to 12 years by November 2022, 75% should be achieved across the parc. Zero emission zones have the potential to bring this further forward still. The low scenario is based on projection of historical trends.
	taxi	75%	
	Car	30%	
	LCV	30%	
% Off-Street parking (home address)	MC	40%	Values for taxi drivers with access to off-street parking were informed by previous EST driver surveys and engagement. Values for other categories are representative of national averages.
	Taxi	60%	
	Car	40%	
	LCV	40%	
Daily Mileage	MC	30	Values for daily mileage will vary greatly between individual vehicles. The values for motorcycles and cars are based on UK averages, and the values for taxi and LCV are based on EST engagement.
	Taxi	110	
	Car	30	
	LCV	100	
Daily charge opportunity (hours per 24)	MC	24	These values are blended estimates for each vehicle group and are informed by both EST expertise and evaluation of SCOOT flow over 24hrs. These are used to help forecast concentration of peak demand.
	Taxi	24	
	Car	12/24	
	LCV	15	
Duration of charge (hours)	MC	10	These are blended estimates of averages based on anticipated demand in kWh, current technology, driver behavior and vehicle use. There will be considerable variation from vehicle to vehicle.
	Taxi	0.35	
	Car	0.75/10	
	LCV	0.5	

Public infrastructure demand

The AADT flow information for each vehicle category and monitoring site was reduced by 50% for two-way roads and left unadjusted for 1-way. Understanding that not all vehicles will need or choose to charge in the CoL each day, the maximum theoretical flow values were further reduced by 91%, since UK Power Networks (UKPN) insights[11] suggest that by 2025, 9% of charging sessions will be destination charging.

The same UKPN statistics predict a further 8% of charge sessions will take place en-route, but for the purposes of this study, we have assumed that this demand is more likely to be met by infrastructure outside the CoL.

These assumptions are consistent with the existing re-fueling infrastructure provisions for petrol and diesel vehicles around the CoL, on trunk routes in and out of the Square Mile (see image).



Fuel forecourt locations (petrol / diesel)

Finally, to forecast the AADT flow to 2025, further reductions were made of 12.5% for motorcycles and cars, and 7.5% for light goods. These values are half of the CoL's 2030 ambitions to reduce total traffic volumes by 25%, and 15% for freight.

Uncertainty

The LAEI 2016 analysis is based on the LAEI 2013 methodology[12] and extrapolates AADT flows using a mixture of manual classified counts (MCC), and statistical data from TfL's LoHAM and LTS models. Consequently, the data will have some inherent error, but these are approved for atmospheric emissions reporting, and are therefore sufficient for estimating future PiV infrastructure scenarios.

Each location was selected to provide strategic coverage of CoL's trunk routes and to minimise double counting of vehicles; however, some error is inevitable without collection of custom data. An alternative to LAEI derived data, would be to collect traffic flow statistics for trunk routes over a defined period, using number plate recognition to identify unique vehicle flow.

Collection of ANPR records was outside project scope; however, CoL officers did provide 138,983 ANPR records for the area surrounding Bank Junction, and a randomised sample of 4,000 records from this data set was used to sense check the precentage of vehicles visiting central CoL by category and against the LAEI. The results of this analysis is available as an appendice.

Baselines and forecasting

Local and national policy ambition indicates that PiV uptake will need to be exponential in the years up to and beyond 2025 if objectives are to be met. Sensible infrastructure forecasts take a balanced approach and consider different scenarios and the corresponding impacts. For this reason, policy ambitions and historical evidence have been represented in forecasts by three scenarios of varying optimism:

- Low – An exponential projection based on historical uptake 2011- 2019 (lower optimism)
- Mid – The mid-point between high and low scenarios (medium optimism)
- High – Informed by CoL and Greater London Transport Strategies (higher optimism)

Low scenario

The low scenario is the least optimistic; however, this scenario is still reliant on some uncertain factors, such as vehicle supply. The low scenario is informed by historical PiV uptake shown by Department of Transport dataset VEH0131 for Greater London from 2011 to 2019. The average quarterly rate of change from Q1 2017 to Q2 2019 was applied to generate an exponential trend line to 2025. Since the rate of uptake for Greater London is being used as a proxy to calculate uptake within CoL traffic, this projection has been adjusted to reflect a CoL's policy objective of a drop in total motor vehicles volume of 12.5% by 2025.

Mid scenario

The mid scenario is simply the mid-point between the low and high scenarios. This projection is designed to help with future monitoring and evaluation against baselines, as new evidence becomes available. This can provide a useful indicator to establish which scenario actual uptake most closely follows and changes over time.

High scenario

The high scenario is informed by the CoL and Greater London Authority transport strategies, taking the current proportion of PiVs and illustrating the step change that is required to achieve the local policy ambitions, and corresponding charging infrastructure requirements. This includes the introduction of zero emission zones, which theoretically could result in a significant and sharp increase in the proportion of PiVs travelling into the CoL.

Zero emission policies could result in further significant modal shift from personal vehicles to active travel and public transport in the CoL area. For certain drivers and journeys, particularly taxi, private hire and other commercial operators, this will not be possible. Until there is greater clarity on the future impact of zero emission policy on driver behavior and travel choice, there is insufficient evidence to rule out large quantities of electric vehicles requiring access to charging infrastructure within, en-route to, or near the CoL. The high scenario could be argued to have the highest uncertainty, but also the highest impacts if this level of uptake is experienced and the charging demand is left unmet by a range of local and national measures.

Recommendations

The scenarios developed provide the evidence base for CoL officers to develop their immediate plans for improved enabling infrastructure and will provide a useful resource for future monitoring and evaluation activities. Informed by the research undertaken, analysis outputs and collaborative interactions, Energy Saving Trust have outlined a range of recommendations for the delivery of public charging infrastructure for the period up to 2025.

Results

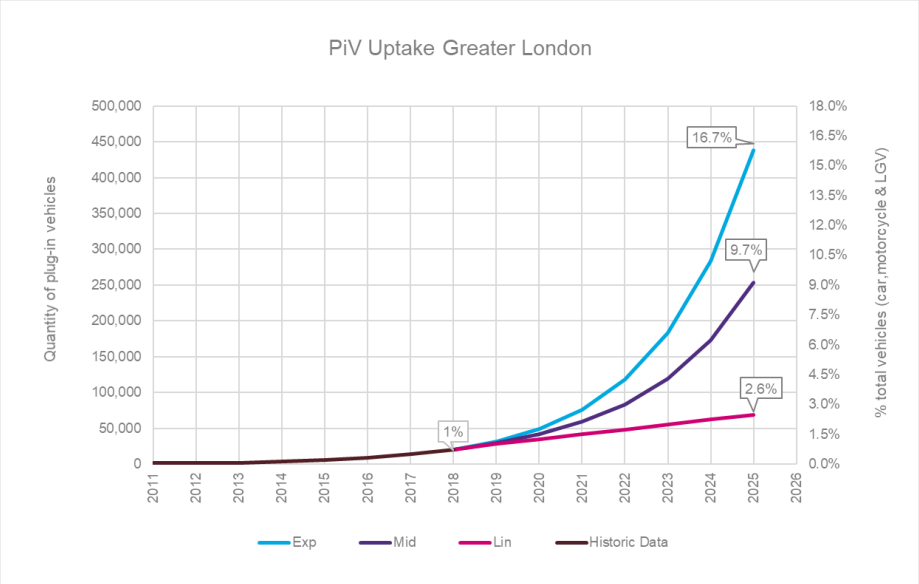
This section provides a summary of the analysis outputs, including baseline projections, modeling scenarios, infrastructure forecasts and ANPR results.

Baselines

In 2018, there were over 2.6 million motorcycles, cars and light commercial vehicles registered in Greater London. Only 2,900 (0.4%) of these were registered in the CoL itself.

A large proportion of CoL traffic originates from the Greater London (GLA) area - PiV uptake from GLA is deemed a good proxy for forecasting the kind of vehicles that are likely to travel within CoL on a regular basis in 2025.

The chart (right) plots PiV uptake for GLA from 2011 to 2019 against percentage of selected vehicles registered.



Good uptake in recent years leaves the current share for PiVs at 1%. New EU emissions legislation and new vehicle models should result in further shift in 2020/2021.

Three trendlines from 2019 to 2025 are also shown; a linear, a mid-point and an exponential forecast. The exponential (Exp) projection has been chosen to represent the low scenario for future infrastructure requirements – equivalent to 16.7% of traffic flow being a PiV by 2025 for the vehicle categories studied.

Existing chargepoints

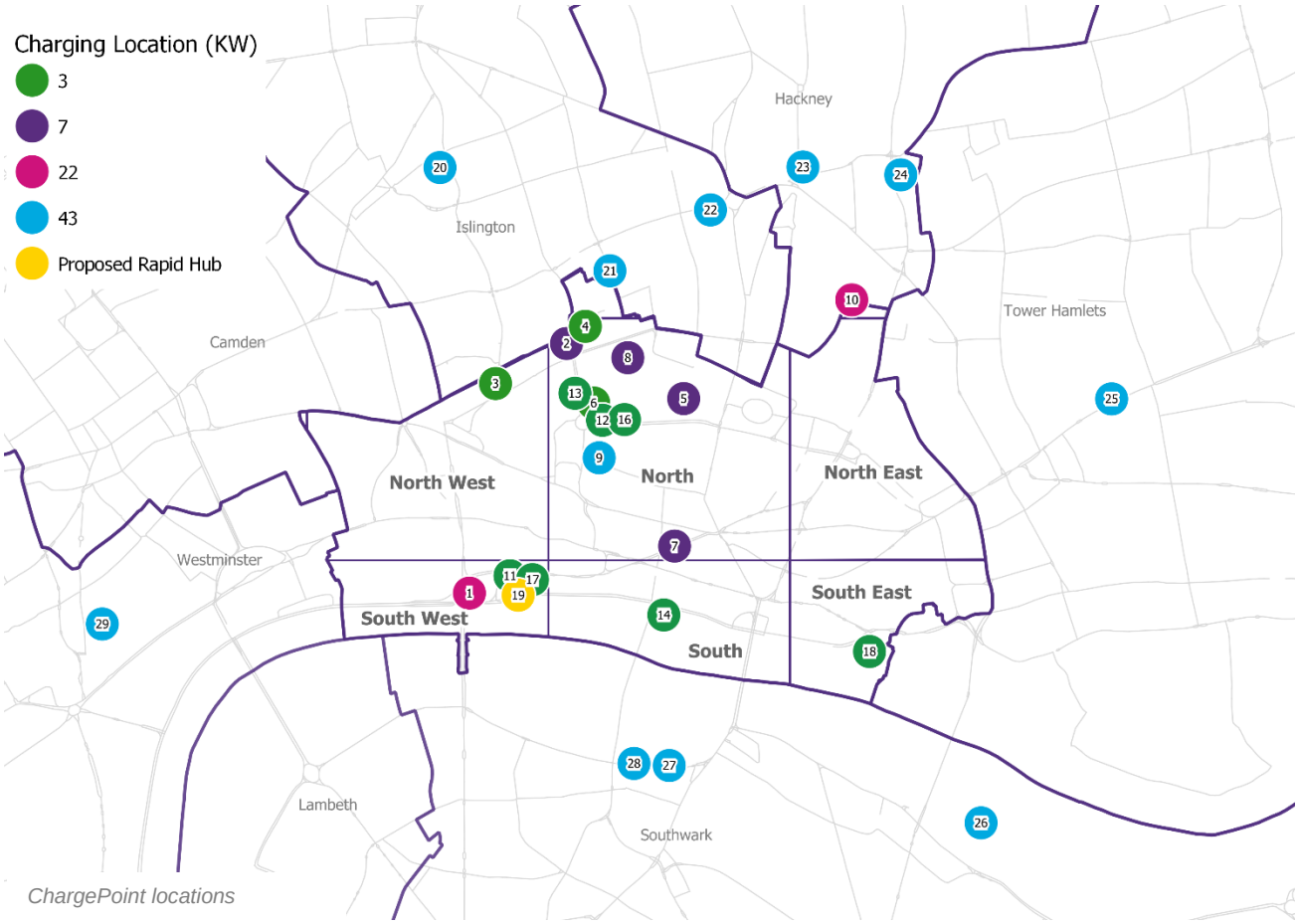
There are 18 existing chargepoint locations listed on Zapmap, open charge map or the National Chargepoint Registry as both publicly accessible and within the CoL Boundary (see map below). These sites are recorded as having chargers ranging from 3-50kW and are managed by commercial operators. Not all sites can be accessed freely, but the chargers are listed as accessible to the public using PayGo technology, a membership card or mobile app.

Some chargers are installed in on-street locations, but given the densely developed nature of the area, many are within multi-story or underground car park locations. For subterranean locations, end-users often report some issues initiating charge sessions. These Issues could be due to insufficient communication links between the charge unit and the ChargePoint back office, or poor mobile reception and problems accessing the internet to use ChargePoint network mobile applications.

Noble St (location 9) has a single rapid charger reserved for taxi use, but there are CoL led plans for a new multi-purpose rapid charging hub, to be located in the Baynard House car park (location 19).

There are 10 other general access rapid charge sites (locations 20-29) with a total of 14 rapid charge units listed in neighboring boroughs within 0.5 miles of the boundary. These and restricted access or private chargers meet some of the en-route charging demand within CoL itself, but these will not be sufficient to meet all projected demand.

There is an on-street rapid charge site on Golden Lane, on the northern border between CoL and Islington, but there has been some negative feedback about this site's reliability, left via comments on Zapmap. A reliable ChargePoint end user experience is critical to ensure that drivers see PiVs as a viable option and lessons should be learned from poor experiences, so that solutions are developed and applied to future charging infrastructure projects.

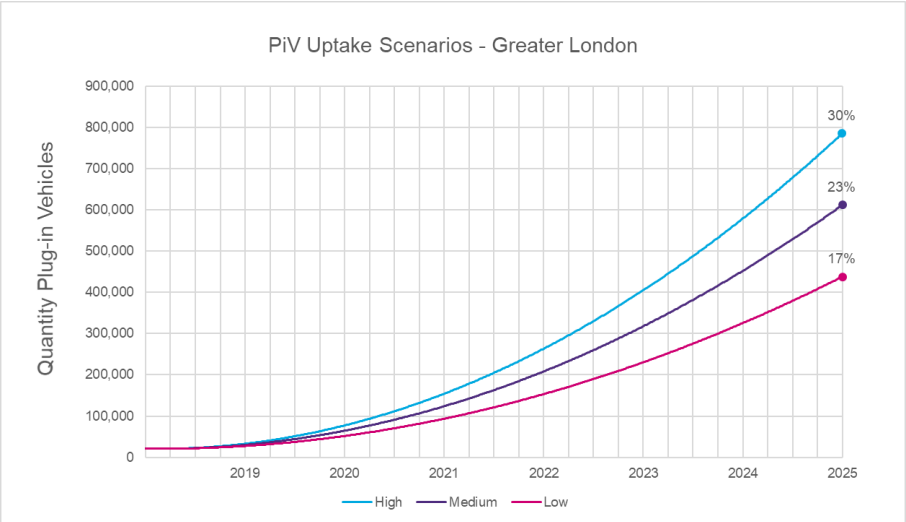


ChargePoint locations

Table 3 – ChargePoint locations summary

Location	Map Ref	Qty Sockets (all Connections)	Highest Power (kW)	Network	OS Listed coordinates (X, Y)
City of London	1	4	22	In Charge	531672,180864
	2	4	7	POLAR	532075,181895
	3	6	3	POLAR	531781,181730
	4	6	3	Charge Your Car	532152,181966
	5	2	7	POLAR	532560,181668
	6	4	3	Charge Your Car	532187,181649
	7	2	7	Life	532522,181058
	8	2	7	Other	532328,181837
	9	1	50	ESB EV Solutions	532210,181423
	10	2	22	Source London	533256,182075
	11	2	3.7	Source London	531910,180939
	12	2	3.7	Source London	532257,181580
	13	2	3.7	Source London	532110,181690
	14	4	3.7	Source London	532477,180774
	15	2	3.7	Source London	533328,180621
	16	8	3.7	Source London	532281,181581
	17	8	3.7	Source London	531934,180920
	18	10	3.7	Source London	533329,180622
	19	TBC	50	TBC	531874,180855
Islington	20	6	50	ESB EV Solutions	531550,182622
	21	6	50	ESB EV Solutions	532254,182196
	22	3	50	Shell Recharge	532671,182447
Hackney	23	3	50	POLAR	533054,182624
	24	3	50	Hackney Council	533459,182592
Tower Hamlets	25	3	50	Shell Recharge	534332,181666
Southwark	26	6	50	POLAR	533791,179915
	27	3	50	ESB EV Solutions	532500,180152
	28	3	50	POLAR	532354,180160
Westminster	29	6	50	POLAR	530152,180736

Infrastructure forecasts



The chart (left) plots the three PiV uptake scenarios chosen for infrastructure modeling:

- High (30%)
- Mid (23.4%)
- Low (16.7%)

There could be 800,000 light vehicles registered in Greater London by 2025.

Applying each percentage under the three scenarios against the assumption adjusted AADT flows from the LAEI 2016 allowed PiV uptake to be forecast for each vehicle category. The table below details the specification and quantity of chargers required:

Table 4 – charging infrastructure forecasts 2025

Vehicle Group	Scenario	Vehicle Demand*	Qty Charging Units	
			Standard	Rapid
Motorcycles	low	62	15	-
	mid	86	20	-
	high	111	25	-
Taxis	low	175	-	13
	mid	349	-	22
	high	524	-	32
Cars (inc private hire)	low	309	50	6
	mid	431	69	6
	high	554	89	7
LCV (<3.5t)	low	135	-	7
	mid	188	-	10
	high	242	-	12
All Vehicles (Total)	**low**	**680**	**65**	**26**

*The approximate quantity of PiVs supported e.g. 175 taxis, charging 1.5 times per day under the low scenario

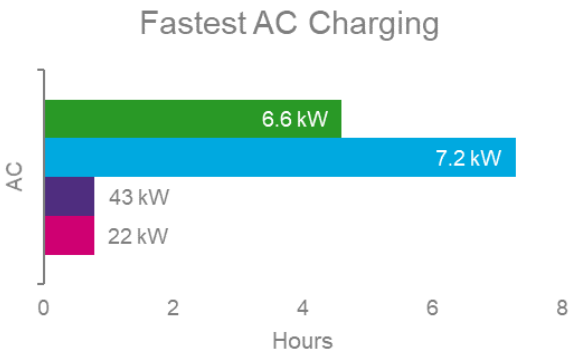
Charging infrastructure specification

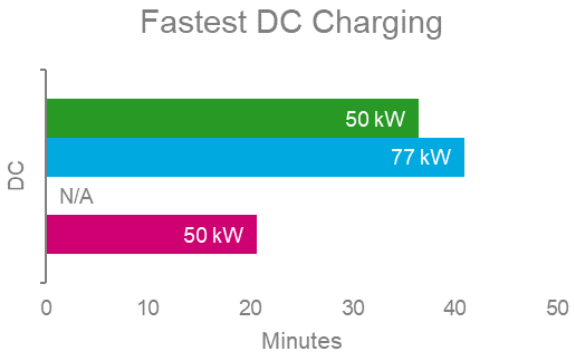
Analysis is based on standard chargers rated at a minimum of 7kW AC, each with two type2 connectors for **simultaneous charging**. These are typically compatible with all PiVs, though the actual maximum rate of charge will vary depending on the power rating of the vehicles on board AC charging equipment.

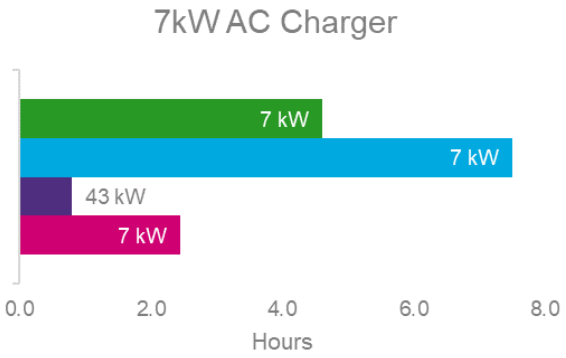
Historically few vehicles use AC charging for their highest rates; however, various specifications and options are usually available on new vehicles. The LEVC TX can accept 22kW AC, and some Renault Zoe models can charge at up to 43kW AC.

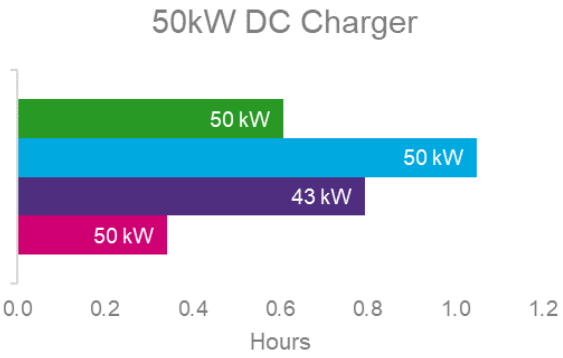
Rapid charger forecasts are based on equipment capable of delivering a maximum of 50kW DC via CCS and CHAdeMO connectors and optionally up to 43kW AC via a Type 2 connector.

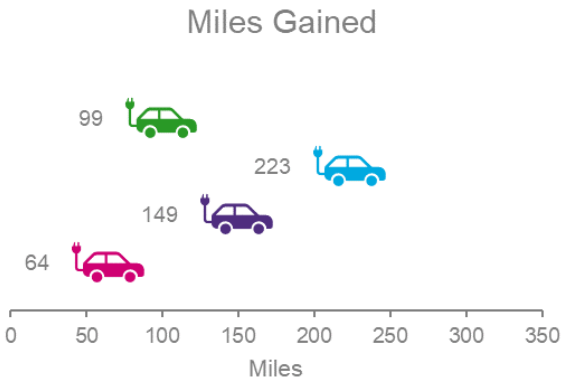
In addition to on-board charging equipment, instantaneous rates of charge can be limited by a vehicles battery temperature and grid availability. The charts below illustrate and compare maximum charging profiles for a sample of different PiV models for their maximum charge rate using 50kW rapid and 7kW standard chargers (5 miles range remaining to 80% capacity).

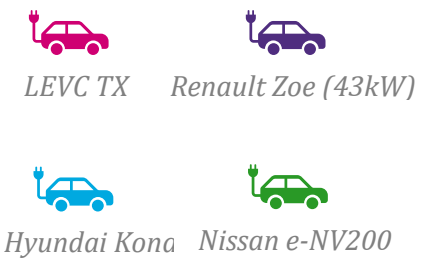












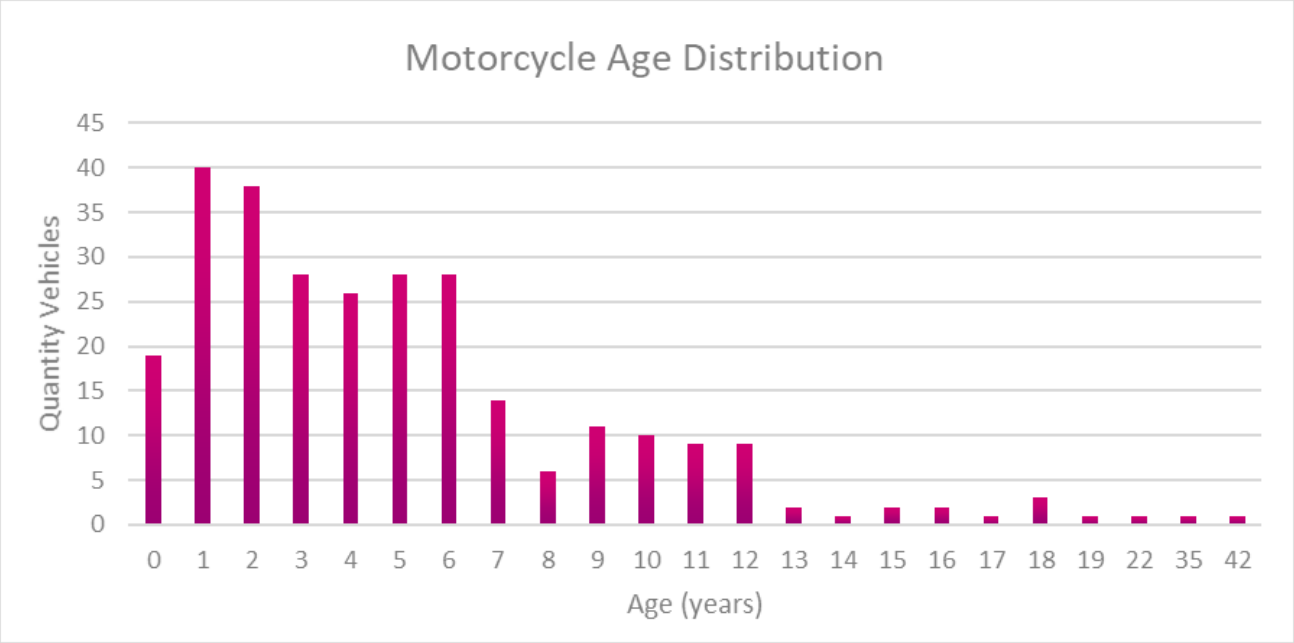
ANPR analysis summary

This section summarises the results from analysis of 3,999 ANPR enforcement records for vehicles travelling in and around Bank Junction between 27th September and 23rd October 2019 during the restricted hours of 7am and 7pm. This analysis was completed as an additional sense check to show the types of traffic visiting central CoL, but the outputs have not been used for forecasts, since LAEI is assumed to be more representative of free traffic flow. Not all vehicle records returned information for each category, so there will be minor variations in the total number of records versus individual tallies.

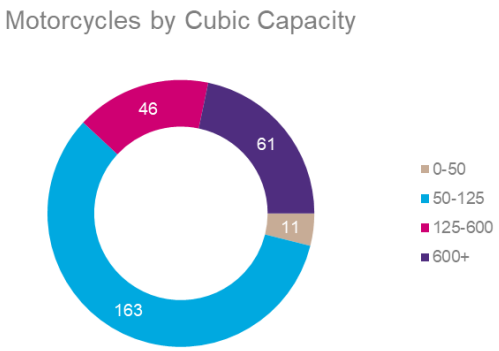
Motorcycles and mopeds

Of the around 4,000 vehicle ANPR records analysed, 281 were motorcycles (7%).

The AADT data for LAEI has 10% motorcycles - providing extra confidence in the average volume of motorcycles visiting CoL on a regular basis, 64% were five years, or younger, so by 2025, over two thirds of motorcycles could naturally transition to electric technology under regular buying cycles.



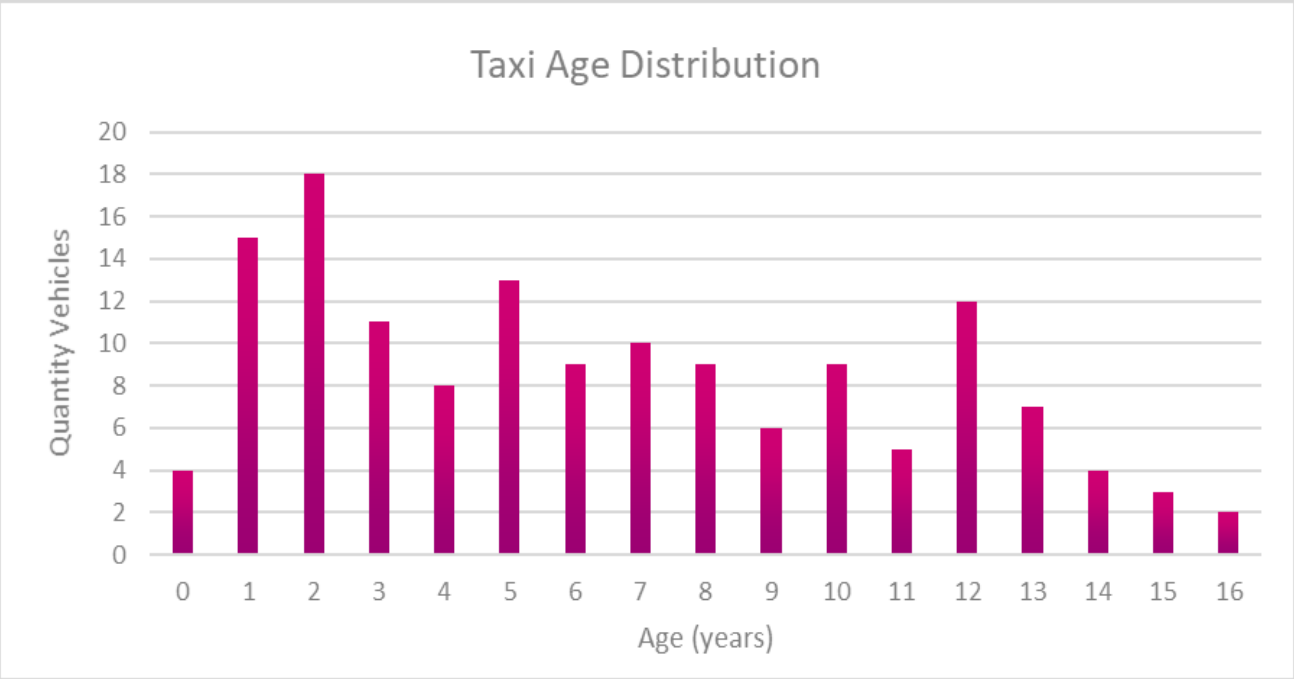
The majority of the motorcycles analysed were found to be in the 0-125cc category (62%). Motorcycles and mopeds of this size aren't permitted on motorways and 50-125cc are restricted to a top speed of 60mph. This suggests that they are unlikely to originate in areas outside the range of a modern electric alternative; however, some riders travelling greater daily distances in and around central London might benefit from a top up charge.



The CoL ambition is for 90% of all local traffic to be zero emission and specific charging infrastructure for plug-in motorcycles will help riders make the transition sooner and will be absolutely necessary for others.

Taxis

The ANPR results returned 148 records for taxi style vehicles (4%), significantly less than the LAEI, which works out at around 20% of AADT flow. This could be explained by taxi drivers enhanced knowledge over the streets restricted access. There is probably the least certainty within the analysis of taxi vehicles as VRNs were not cross-referenced against taxi licences.

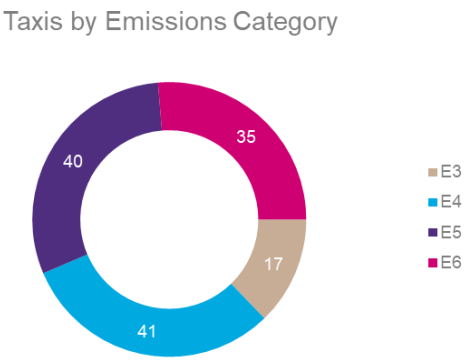


The results highlight that a significant proportion of hackney cabs are older vehicles, with median age of 6 years old.

Of note were 10 records of newer LEVC TX models, which are zero emission capable hackney carriage. 2019 has seen the release of a fully electric model called the Dynamo, based on the Nissan e-NV200.

Many of the taxi's engines don't meet modern emissions standards with 44% of taxis analysed classified as Euro 3, or Euro 4.

There are C.20,100[13] taxis registered in Greater London and c.3,000 of these are zero emission capable, highlighting both the progress to date, and the extent of challenge remaining.

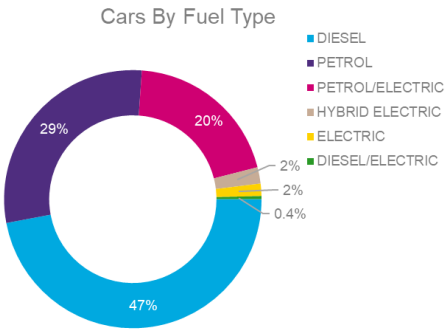


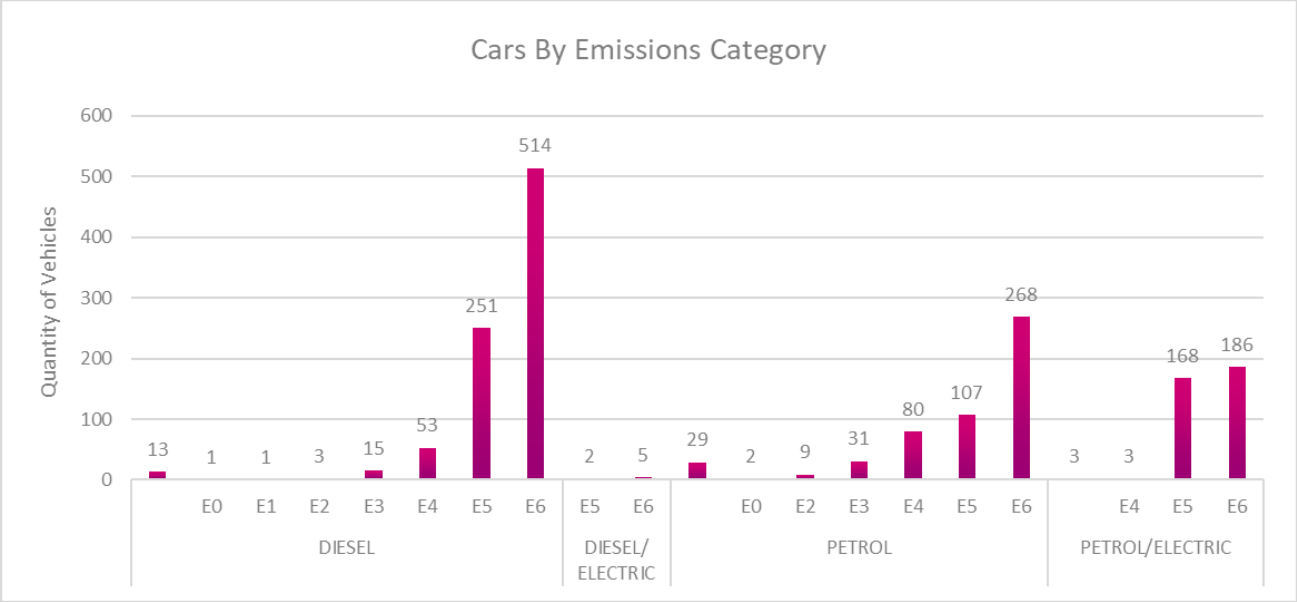
Zero emission zones and improved charging facilities will help with the electric transition for many older vehicles and others may naturally be replaced as drivers retire, or be incentivised to do so by the de-license fund[14] (up to £8,000 in exchange for surrendering license for qualifying taxis)

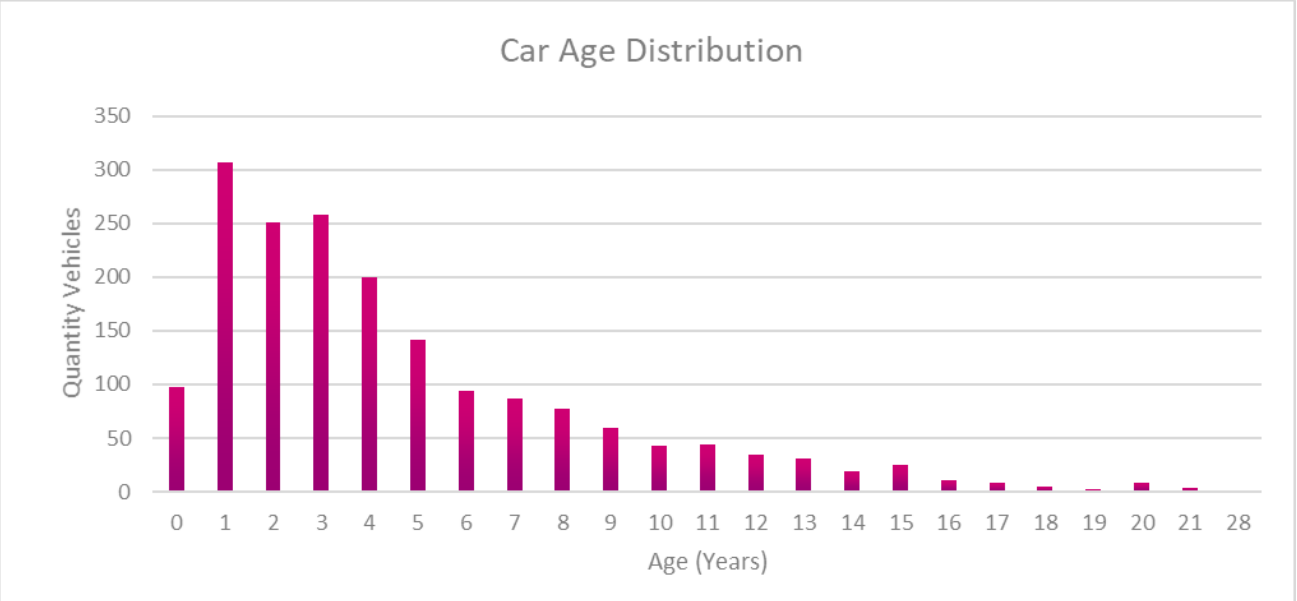
Cars and private hire vehicles

With 1,810 individual records returned and 45% share of the results, the proportion of cars is almost identical to that expected under LAEI (46%). Almost half (47%) of the records are for diesel fueled vehicles, with 60% of these Euro 6.

The analysis illustrates that 337 of these Diesel vehicles were Euro 5, or older; however, there were also records for 28 pure electric and 360 petrol/electric hybrids, many of which will likely be private hire vehicles.







The average age of cars in the sample was found to be just under 5 years old – 251 records were for petrol hybrid vehicles that were 5 years or newer. This suggests that a significant proportion of these hybrids will need to be replaced before the end of their natural buying cycle to be compliant for free entry to zero emission zones.

Additional charge points will be needed in CoL and surrounding areas to support the transition to zero emission zone compliant technology. For destination charging, these can be slower speed but for private hire, these will need to be capable of faster charging speeds.

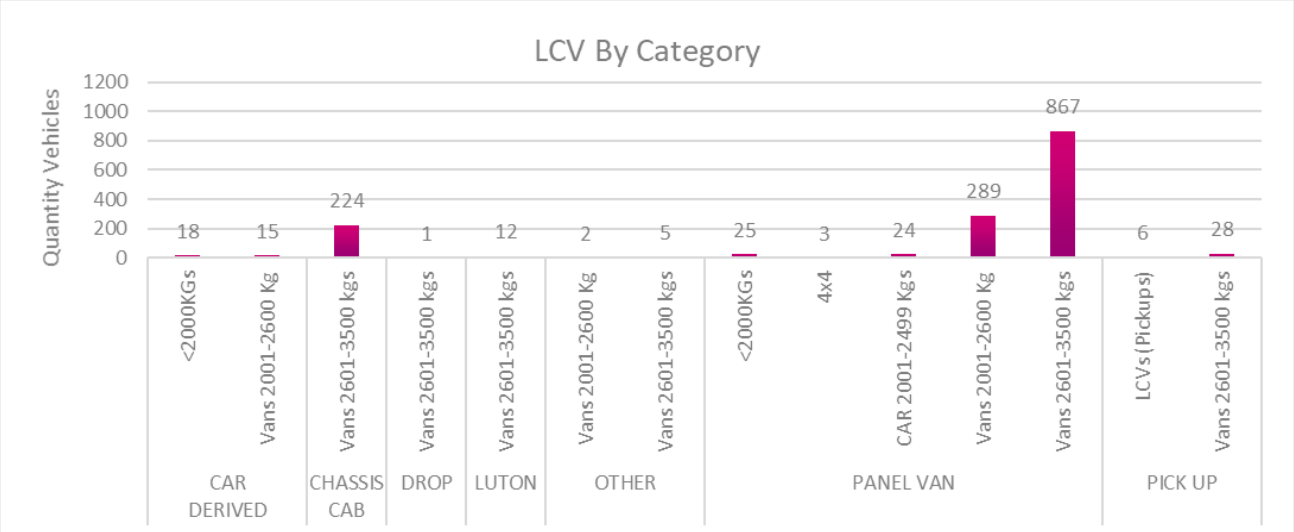
Light commercial vehicles (<3.5t)

The light commercial vehicle category has the highest variation from that expected under LAEI. It's worth remembering that the dataset is not fully representative of free flow traffic throughout CoL.

There were 1,520 records of light commercial vehicles (38%), compared to (14%) under LAEI. There could be many reasons for the discrepancy, including:

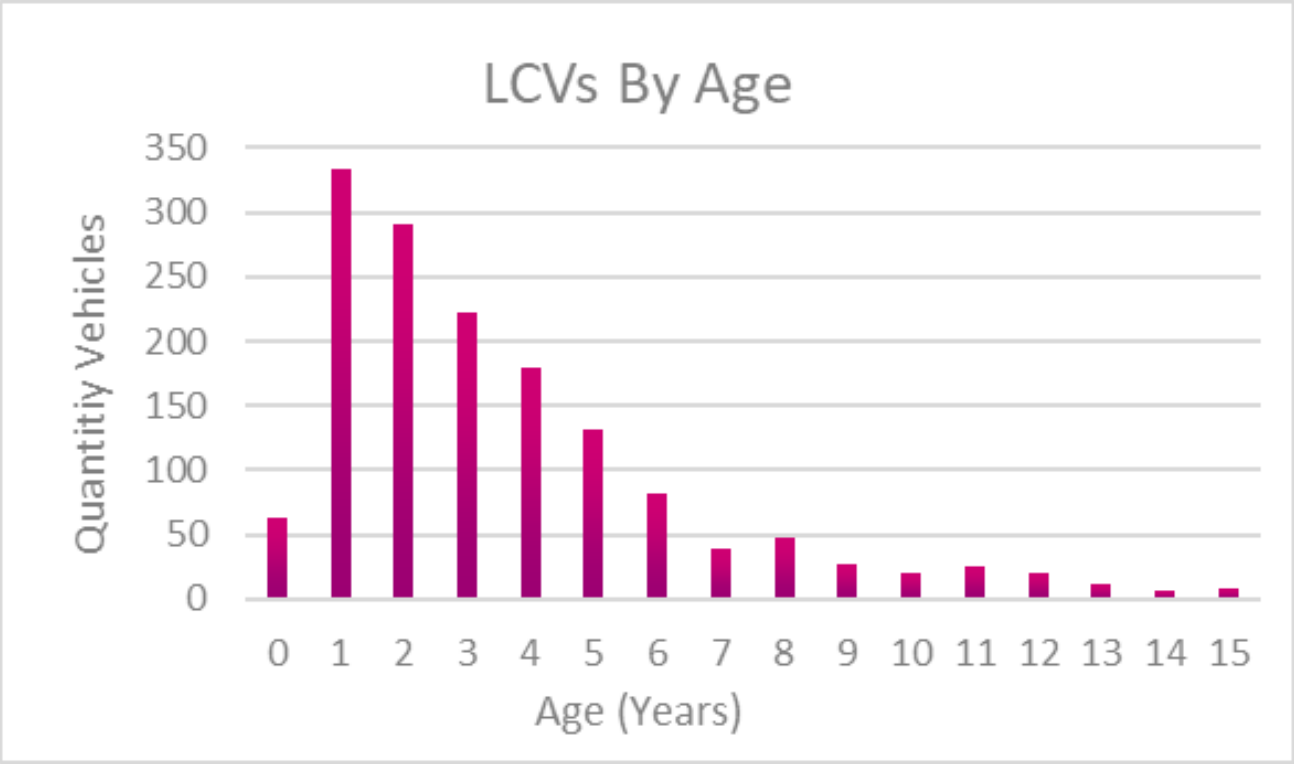
- Compared to other vehicle groups, a disproportionate quantity of commercial vehicles might have an operational need to circumvent access restrictions
- Commercial vehicle drivers could be less likely to be financially liable for penalties and therefore less conscious about entering prohibited zones
- For some drivers requiring less frequent access, the penalty cost may be less than the compliance cost

Analysis highlighted that most of the LCVs (57%) were heavy vans with a gross weight of 2600-3500 and 19% were medium vans (gross weight 2001-2600 kg). The medium vans already have proven replacements, such as the Nissan e-NV200, but for the larger payload, long wheelbase vehicles there are only a few market ready options.



There are light commercial, fully electric models such as the LDV EV30, which will go on sale in the UK in 2020 - it has a load volume of 6.3m^3, slightly more volume than a MWB Ford Transit but 160kg less payload.

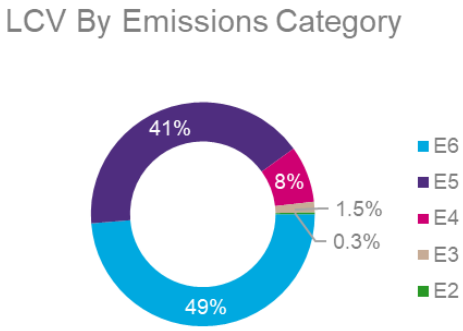
Operators that need large volume payload capacities and are looking for plug-in options will be reliant on Luton conversions, or LWB EV models – some of which can be quite expensive.



A well located, fairly priced network of rapid chargers will be critical to make plug-in vans viable for many businesses.

The majority (60%) of LCVs analysed were found to be 3 years old, or newer, and 49% were registered as Euro 6 diesel. There is still a relatively high proportion of Euro 5 vans (41%).

A high proportion of Euro 6 is good for meeting current standards, but with an equally high proportion of Euro 5 and poorer classified vans, there is room for improvement.



TfL's scrappage scheme for vans and minibuses[15] offers up to £9,500 to small businesses to help replace vehicles that don't meet ULEZ standards.

The introduction of zero emission zones will also improve the operational business case for electric vans even further by giving operators an opportunity to enter central London without incurring a penalty.

References

[1] www.smmt.co.uk/vehicle-data/car-registrations/
[2] www.ec.europa.eu/clima/policies/transport/vehicles/regulation_en
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[4] www.cityoflondon.gov.uk/services/transport-and-streets/Documents/city-of-london-transport-strategy.pdf
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[10] www.roads.data.tfl.gov.uk/CongestionScoot/CSV.zip http://roads.data.tfl.gov.uk/CongestionScoot/CSV.zip
[11] www.ukpowernetworks.co.uk/internet/asset/82ec84bb-3966-4470-a5dd-0b6efd39ebcc/UK%20Power%20Networks%20-%20Competition%20in%20Connections%20Workshop%20-%20Slide%20Pack%2012%20Sept%20%202019%20v1.1.pdf
[12] www.data.london.gov.uk/download/london-atmospheric-emissions-inventory-2013/4e14c9e8-24cb-4e10-8654-2e4fd488c307/LAEI%202013%20methodology_.pdf https://data.london.gov.uk/download/london-atmospheric-emissions-inventory-2013/4e14c9e8-24cb-4e10-8654-2e4fd488c307/LAEI%202013%20methodology_.pdf
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[15] www.tfl.gov.uk/modes/driving/ultra-low-emission-zone/scrappage-scheme#eligibility

End of Report