# Mapping rapid chargepoint locations for commercial vehicles in London

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# Project overview and technical background

Energy Saving Trust (EST) was commissioned by Transport for London to identify illustrative locations for rapid chargepoints for commercial vehicles up to 12.5 tonnes operating in London. Increased access to rapid chargepoints is expected to encourage uptake of plug-in vehicles and maximise the associated economic and environmental benefits. Infrastructure locations must be determined based on available land to site the chargepoint, sufficient electricity to provide power, and demand from vehicle operators. This project considers only the third of these factors.

A fleet mapping pilot project was completed by EST in 2013 and identified chargepoint locations without considering the rate of charge required. It also concluded that fleets would benefit significantly from opportunity rapid charging during the day. The 2015 Chargepoint Mapping exercise therefore builds on this pilot study by focusing on rapid charging, the provision of which is, we believe, crucial to stimulating widespread plug-in vehicle uptake.

This study forms part of a wider suite of research being undertaken by TfL to understand the needs of all users, including taxis, private hire, commercial fleets and car clubs. This includes a feasibility study into a rapid chargepoint network for plug-in taxis, also carried out by EST. All the research, alongside the results of TfL's market and stakeholder engagement work, will be used to inform TfL's deployment strategy for rapid chargepoints in London.

## Air quality

Road transport is a major source of air pollution in Greater London, accounting for 35 per cent of $NO_x$ and 47 per cent of $PM_{10}$ emissions[1]. The different sources of road transport contributing to air pollution levels are illustrated in the graphs below:

[1] London Atmospheric Emissions Inventory, 2010

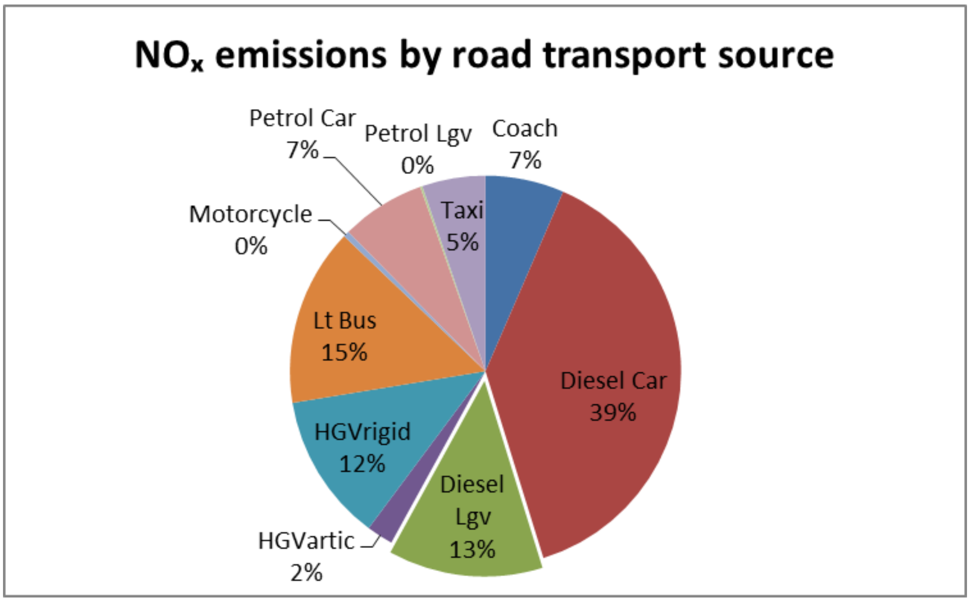


Figure 1: $NO_X$ emissions in Greater London by source of transport (LAEI, 2010)

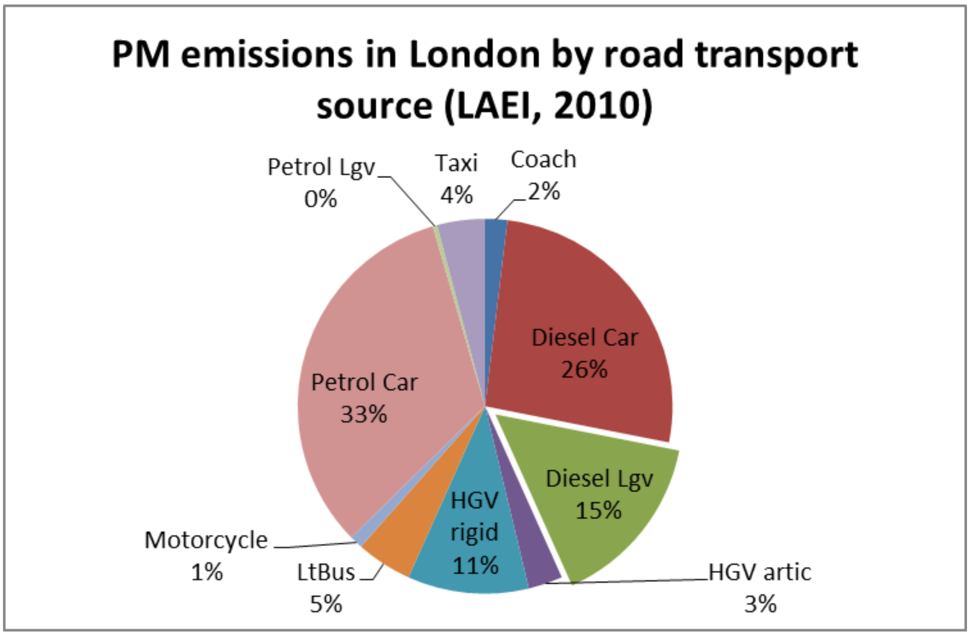


Figure 2: $PM_{10}$ emissions in Greater London by source of transport (LAEI, 2010)

Diesel light goods vehicles are responsible for 13% of $NO_x$ and 15% of $PM_{10}$ emissions produced from transport in Greater London. Therefore, reducing emissions from these vehicles can offer substantial air quality benefits.

The Mayor of London recognises that improving London's air quality is an urgent challenge and has therefore implemented a wide range of measures to reduce pollution levels. Significant recent developments include:

- The publication in September 2014 of the Transport Emissions Roadmap (TERM), which suggests initiatives to reduce emissions from ground-based transport.

- The announcement that from 2020 the Ultra Low Emission Zone (ULEZ) will require all vehicles to meet exhaust emission standards (ULEZ standards) or pay an additional daily charge to travel within the zone. For vans, the standard will be Euro IV compliance for petrol vehicles and Euro VI compliance for diesel vehicles.

## Plug-in vehicles and rapid charging

There are three main types of plug-in vehicle (battery electric or pure electric, plug-in hybrid and extended range electric vehicle). For the purposes of this project, we are only interested in pure electric vehicles, i.e. vehicles powered only by electricity. Vehicles are charged by an external power source and incorporate regenerative braking which extends the available range.

Pure electric vehicles emit zero tailpipe emissions, making them the ideal solution to reduce the impact of road transport on London's air quality. Equally, commercial vehicles' duty cycles in the capital make them ideal for switching to plug-in technology supported by rapid charging:

1. They are driven predominantly in a stop-start environment, where plug-in vehicles operate most effectively.
2. Longer journeys (over 80 miles) within Greater London are less common, therefore many trips can be carried out on a single charge.
3. Many commercial vehicles' duty cycles include periods of downtime, for example during a delivery or collection window, or during breaks. Rapid charging at strategic locations can be incorporated into these times to minimise disruption.

At the time of writing, there are over 1,400 chargepoints in the Source London network. However, the majority provide a slow rate of charge which would not meet the needs of commercial vehicle operators and drivers. 'Rapid charging' involves charging a plug-in vehicle at typical rates of at least 43kW AC or 50kW DC, which would supply a typical small electric van with an 80% charge in 30 minutes or fewer. Carrying a charging cable in the vehicle is only necessary when using AC public chargepoints which deliver no more than 22kW. Rapid AC and all DC chargepoints have a tethered cable making them straightforward for drivers to use.

## Project objectives

This project identifies illustrative locations for rapid chargepoints to support uptake of plug-in commercial vehicles. It also highlights where cost efficiency may be increased by siting infrastructure such that it could be used by multiple fleets. The research achieves the following four objectives.

1. **Support TfL's goal of facilitating strategically and commercially installed electric vehicle infrastructure.**

As described in the TERM, part of TfL's vision is to drive the uptake of low emission vehicles and transform London's commercial fleets. This project aims to address a commonly cited barrier to electric vehicle uptake; the requirement for strategically located infrastructure offering an appropriate rate of charge. With specific reference to commercial vehicle fleets, this can provide a solution to three scenarios:

- Many larger commercial vehicles and some smaller vans are returned to employer's premises when not in use. While depot charging alone may be sufficient for some of these vehicles, for those that cover higher daily mileages, strategically placed rapid chargepoints can increase vehicle utilisation and reduce cost.
- In London it is common for drivers of small commercial vehicles to take them home between shifts. However, many employees live in accommodation which is not suitable for the installation of charge posts and would therefore require access to rapid charging while working.
- Organisations which work in London and are based a significant distance (perhaps up to 80 miles) outside the capital can potentially run electric vehicles by topping up from a rapid chargepoint.

2. **Inform local authorities and private sector investors by identifying locations based on potential user demand.**

A number of local authorities in London were awarded grant funding from the Office of Low Emission Vehicles (OLEV) to contribute towards the costs of rapid chargepoint installations. A further £8m will be available to 2020 to support public infrastructure across the UK. Alongside £15m of funding from the Highways Agency, this will deliver rapid charging across the Strategic Road Network and elsewhere around the capital. There are also some private sector operators seeking to expand the provision of rapid chargepoints. The results of this project will inform both of these stakeholder groups and should stimulate dialogue between local authorities and the private sector.

3. **Enable fleets already operating electric vans to maximise their use and encourage more organisations to acquire plug-in vehicles.**

We believe that increasing access to rapid chargepoints will be essential to facilitate widespread adoption of plug-in vehicles.

- Although some fleets have integrated plug-in vehicles into their fleet the constraint of finding reliable charging infrastructure makes it difficult for them to maximise the benefits these vehicles have to offer.
- Plug-in vehicles are only cost effective when utilisation levels are optimised. Lack of appropriate infrastructure limits utilisation levels and therefore potential economic and environmental savings.

**4. Raise organisations' awareness of the economic, environmental and safety benefits of plug-in vehicles.**

Participating fleets received a bespoke report outlining the business case for the adoption of electric vehicles (if such a case was identified). The reports also show where rapid chargepoints should be installed to support the adoption of plug-in vehicles for that individual fleet. In addition, an action plan is provided to advise organisations on the opportunities to acquire electric vehicles into their fleets.

# Data analysis and chargepoint mapping

## Participating fleets

26 fleets (shown in the table below) were recruited to take part in the project.

| Organisation name | Fleet size[2] | Organisation name | Fleet size |
|---|---|---|---|
| Argos (Home Retail Group) | 12 | Axis Europe | 215 |
| British Gas | 786 | Celesio UK | 111 |
| City Sprint | 211 | Culina Ambient Logistics | 13 |
| Duct Clean | 9 | FM Conway | 43 |
| Gnewt Cargo | 14 | Grafton Merchanting GB | 9 |
| Hobart UK | 24 | Iceland | 19 |
| Integral UK | 131 | John Lewis Partnership | 19 |
| Kingston University | 11 | O'Donovan Waste Disposal | 3 |
| PJ Carey Plant Hire | 43 | Quattro Plant | 26 |
| Skanska Construction | 40 | The Clancy Group | 34 |
| TNT Express | 64 | Transport for London | 175 |
| Urban Planters | 7 | Veolia | 11 |
| Virgin Media | 180 | Z-tech Control Systems | 40 |

We engaged with organisations operating a total of 2,250 vehicles including car-derived and 3.5 tonne vans through to 11.5 tonne tippers and skip lorries. Fleets were asked to supply the following data:

- Live fleet list of vehicles operating wholly or partially with the M25. Vehicle registrations were used to obtain information such as official fuel consumption and gross vehicle weight from the DVLA database.
- Telematics or scheduling data showing vehicle movements in London in order to accurately determine routes taken and distance driven.
- If available, real-world fuel consumption for their current vehicles, which would improve the comparisons between ICE and plug-in vehicles. This information was not usually made available, so for most fleets we applied an uplift of 21%[3] to the vehicle's official fuel consumption figure to reflect real-world driving.

[2] The number of vehicles analysed as part of this project; in many cases the total fleet size is significantly higher.
[3] http://www.theicct.org/sites/default/files/publications/ICCT_EU_fuelconsumption2_workingpaper_2012.pdf

## Fleet data analysis

Energy Saving Trust engaged Route Monkey as its service delivery partner for the rapid chargepoint mapping project. Route Monkey's Electric Vehicles Optimisation System (EVOS) software is designed specifically to help fleets integrate electric vehicles by:

1. Identifying and qualifying suitable routes for electric vehicles.
2. Using algorithms to calculate the impact of a wide range of factors on electric vehicle range, including payload, average speed, topography, ambient temperature and driver style.
3. Optimising electric vehicle use to help organisations "sweat the asset".
4. Maximising the miles covered by electric vehicles, thus reducing the payback period on the initial investment.

Route Monkey was appointed to analyse fleet data in order to determine illustrative chargepoint locations, providing the results on a map and in GIS format. The methodology for analysing fleet data and identifying sites is summarised here and described in full in Appendix A.

**Stage 1 – Individual route analysis**

1. Fleet data was imported into Route Monkey's EVOS to determine benchmark routes[4] and mileage.
2. Suitable plug-in vehicle alternatives were selected by EST, including appropriate battery size and vehicle range. For fleets operating medium to large vans where no equivalent electric vehicle exists, we modelled a hypothetical 3.5t GVW electric vehicle, based on data supplied by Paneltex (see Appendix B for more information).
3. Routes suitable for further analysis were identified based on the total route mileage and the range of the equivalent plug-in vehicle.
4. For routes that require one or two rapid charges, the recharging "windows" within routes were identified, i.e. the geographical area the vehicle is expected to be in when recharging is required.
5. Optimal chargepoint locations within the M25 were derived using a combination of EVOS and Google Maps to identify sites. Chargepoint locations recommended for fleets already analysed were specified if the detour was less than one mile and would not prohibit the completion of the remainder of the journey. Therefore the final map of locations was built up iteratively as additional data was analysed.
6. Cost and $CO_2$ savings were estimated for each route using EST's methodologies.

[4] A route is defined as all miles travelled, per vehicle, per working day.

7. A £7 user fee for a 30 minute rapid charge was assumed and incorporated into the overall cost.
8. Routes were analysed to determine which vehicles could be switched to a plug-in alternative. Routes were only considered suitable for completion by a plug-in vehicle if no more than two rapid charges were required. While some fleets may be able to build in three rapid charge events into their daily duty cycle, this is unlikely to be practicable for the majority of organisations. Vehicles where at least 80% of routes met this criterion were considered suitable for switching to a plug-in alternative. We assume that fleets will undertake vehicle optimisation to allocate the unsuitable routes to ICEs where necessary.

**Stage 2 – Consolidation of data and final maps**

9. All fleet data was scaled to seven days to aid comparison between organisations and show expected weekly chargepoint usage.
10. Chargepoint locations were allocated a unique reference number ordered from west to east, and co-ordinates provided for each location.
11. Utilisation analysis was performed to determine the total number of rapid charges, across all fleets, which are scheduled to take place at each chargepoint.
12. Fleet density analysis was performed to estimate the number of fleets that are forecast to use each chargepoint.

**Stage 3 – Final formatting and presentation**

13. The chargepoint sites were mapped together with location co-ordinates, chargepoint reference number and scaled utilisation forecasts.
14. This data was imported into ArcMAP to produce six Shapefiles (SHPs); one file containing all chargepoint locations, and five files showing the locations disaggregated by utilisation levels.

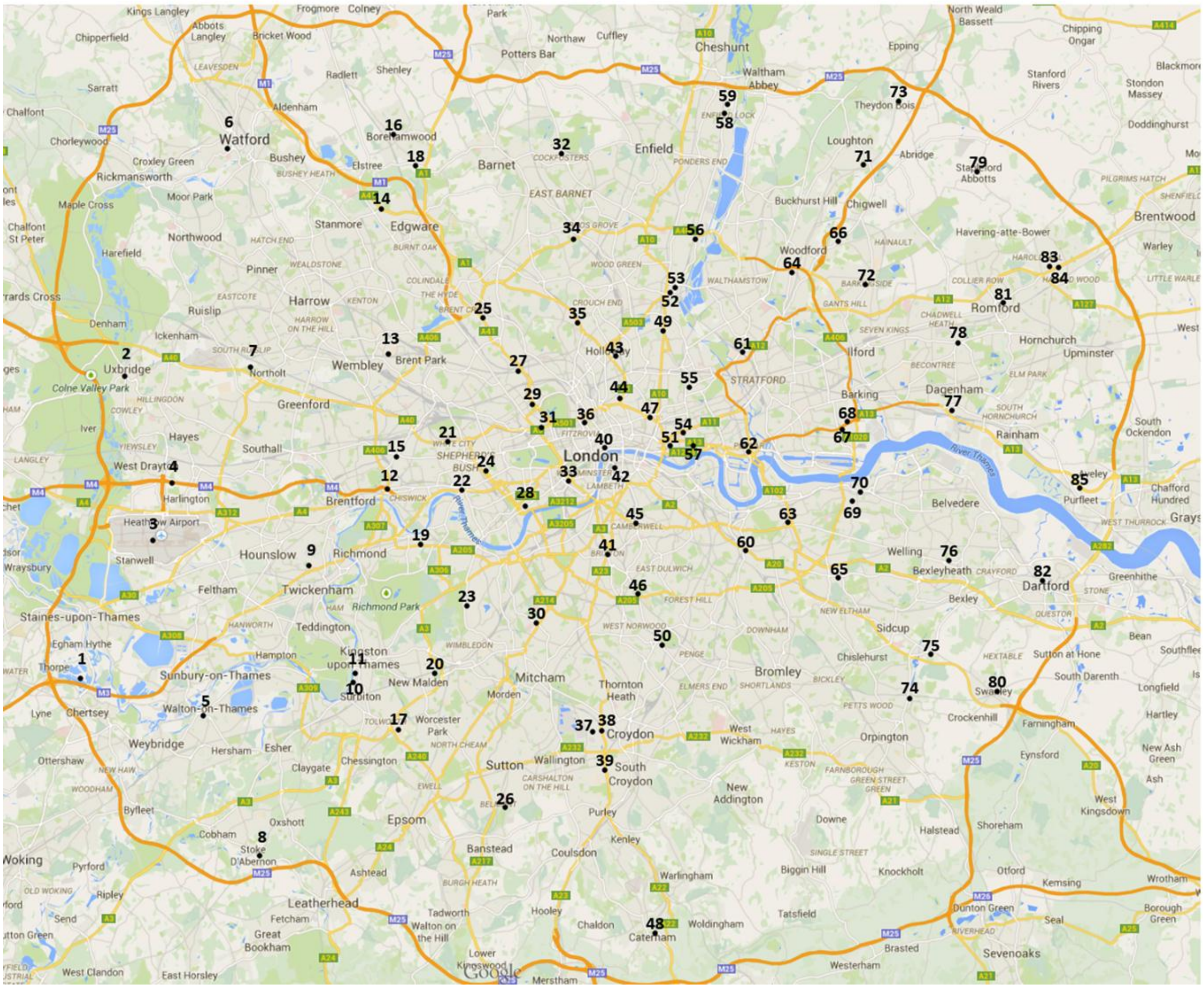
## Illustrative chargepoint locations

The analysis identified a business case for operating plug-in vehicles in 20 of the 26 fleet datasets analysed. The analysis found that installing rapid chargepoints at 85 locations within the M25 would support the acquisition of over 1,900 plug-in vehicles by 20 organisations[5].

These suggested locations are shown on the map below. Please note that these are illustrative locations which are only based on the research and analysis described in this report, and have been selected based on factors such as public parking facilities

[5] Some of these 1,900 vehicles could be acquired without the need for rapid charging; however the availability of rapid charging would likely provide these fleets with additional confidence and help overcome 'range anxiety'.

and long access hours. We have not engaged with any of the relevant business or land owners to discuss the potential for hosting chargepoints. The number next to each site refers to the key in the table below the map.



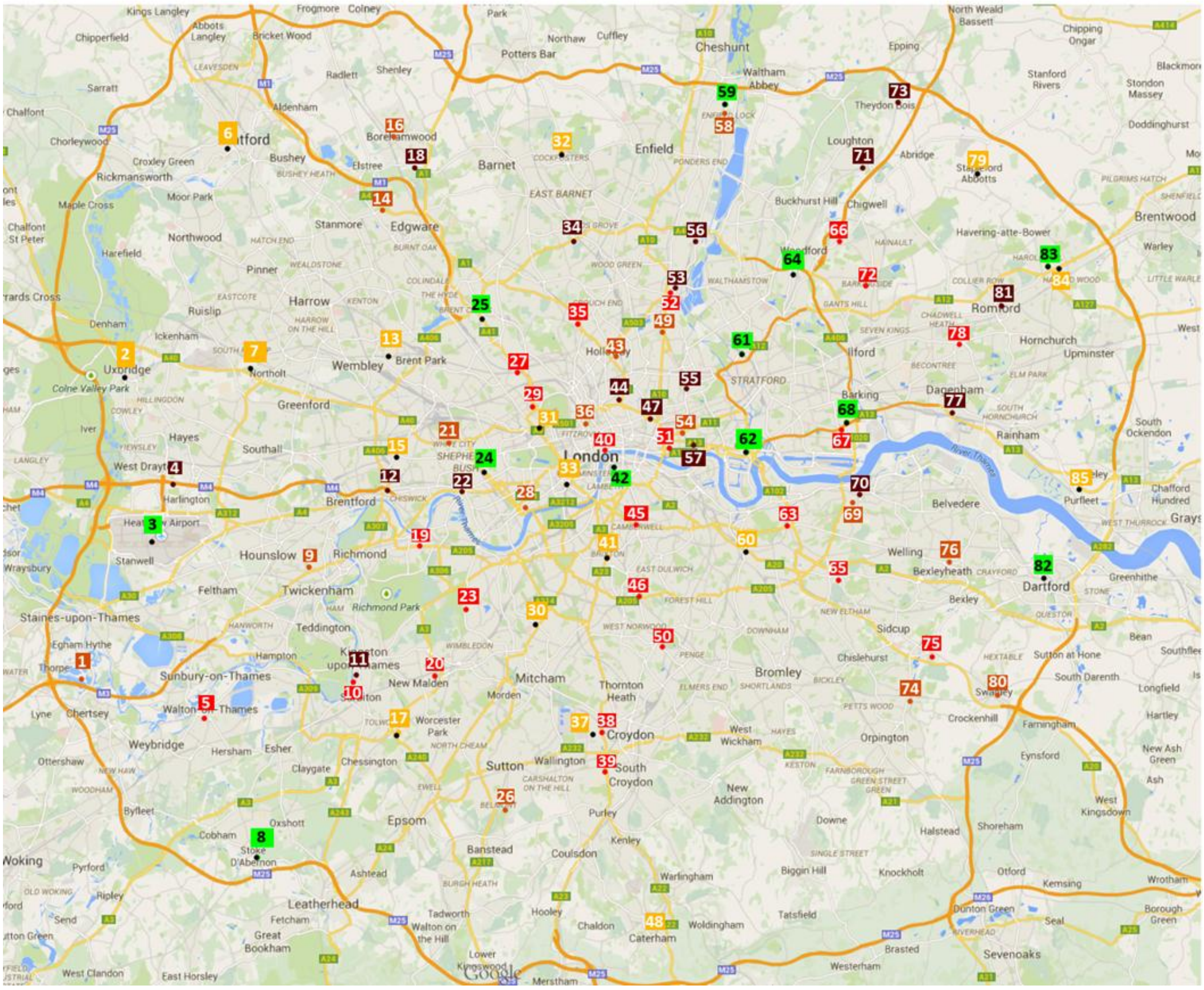

*Illustrative rapid chargepoint locations*

| Reference | Description | Latitude | Longitude |
|---|---|---|---|
| 1 | Thorpe Park | 51.404408 | -0.51289 |
| 2 | Intu Uxbridge | 51.54503 | -0.475288 |
| 3 | Heathrow Airport | 51.469768 | -0.454258 |
| 4 | Premier Inn Heathrow Airport | 51.49599 | -0.448406 |
| 5 | Sainsbury's Superstore Walton-On-Thames | 51.384963 | -0.421708 |
| 6 | Watford General Hospital | 51.649393 | -0.40365 |
| 7 | Ruislip Depot, AAH Pharmaceuticals, South Ruislip | 51.555545 | -0.385341 |
| 8 | Squires Garden Centre, Cobham | 51.315576 | -0.378218 |
| 9 | Twickenham Rugby Stadium | 51.455883 | -0.341189 |
| 10 | Kingston University - Penrhyn Road Campus | 51.403873 | -0.303695 |
| 11 | Eden Walk Shopping Centre | 51.410033 | -0.303197 |
| 12 | B&Q Gunnersbury | 51.49325 | -0.282867 |
| 13 | Wembley Stadium | 51.555938 | -0.2788 |
| 14 | Broadwalk Centre Edgeware | 51.612403 | -0.274661 |
| 15 | Morrisons Acton | 51.508389 | -0.272705 |
| 16 | Tesco Borehamwood | 51.655812 | -0.270007 |

| | | | |
|---|---|---|---|
| **17** | Rokeby Sports Ground | 51.377473 | -0.266156 |
| **18** | Morrisons, Stirling Way, Borehamwood | 51.644315 | -0.256521 |
| **19** | Barnes Hospital | 51.466868 | -0.256172 |
| **20** | B&Q New Malden | 51.400216 | -0.244063 |
| **21** | Hammersmith Hospital | 51.516377 | -0.236769 |
| **22** | Hammersmith Station | 51.492365 | -0.223702 |
| **23** | Parkside Hospital | 51.435801 | -0.223103 |
| **24** | Westfield London | 51.50749 | -0.22075 |
| **25** | Tesco Brent Cross | 51.574242 | -0.215027 |
| **26** | Royal Marsden Hospital (Surrey) | 51.343052 | -0.191446 |
| **27** | O2 Centre | 51.548089 | -0.181385 |
| **28** | Chelsea and Westminster Hospital | 51.484203 | -0.180998 |
| **29** | St John's Hospice | 51.533213 | -0.175376 |
| **30** | St George's Hospital | 51.426721 | -0.173377 |
| **31** | St Mary's Hospital | 51.517123 | -0.173313 |
| **32** | BP Cockfosters | 51.652265 | -0.149732 |
| **33** | London Victoria Train Station | 51.495237 | -0.14327 |
| **34** | Friern Bridge Retail Park | 51.611422 | -0.14223 |
| **35** | Whittington Hospital | 51.566504 | -0.138952 |
| **36** | University College London | 51.524626 | -0.133734 |
| **37** | Asda Wallington Superstore Croydon | 51.37678 | -0.129383 |
| **38** | IKEA Croydon | 51.379914 | -0.123336 |
| **39** | Airport House, Croydon | 51.356532 | -0.117835 |
| **40** | Somerset House | 51.511139 | -0.116628 |
| **41** | O2 Academy Brixton | 51.465585 | -0.114306 |
| **42** | King's College London | 51.505723 | -0.112297 |
| **43** | Emirates Stadium | 51.554901 | -0.107864 |
| **44** | O2 Academy Islington | 51.534367 | -0.106718 |
| **45** | Morrisons Camberwell | 51.472927 | -0.092067 |
| **46** | Tesco Croxted Road | 51.436187 | -0.090937 |
| **47** | 58-62 Scrutton Street | 51.523358 | -0.080707 |
| **48** | Morrisons Caterham | 51.280843 | -0.077207 |
| **49** | Morrisons Stoke Newington | 51.566726 | -0.074672 |
| **50** | Crystal Palace Train Station | 51.41811 | -0.072199 |
| **51** | 11B&C Dock Street | 51.509804 | -0.067657 |
| **52** | O'Donovan's Waste Disposal | 51.583014 | -0.06265 |
| **53** | Tottenham Hale Retail Park | 51.587052 | -0.060446 |
| **54** | Royal London Hospital | 51.518663 | -0.058996 |
| **55** | Iceland South Hackney | 51.539591 | -0.053245 |
| **56** | Tesco Extra Lea Valley | 51.609955 | -0.048288 |
| **57** | Holiday Inn Express - Limehouse | 51.510998 | -0.043505 |
| **58** | WENTA Business Centre, Enfield | 51.674364 | -0.02062 |
| **59** | Premier Inn Enfield | 51.675149 | -0.019593 |
| **60** | Lewisham Shopping Centre | 51.46184 | -0.011565 |
| **61** | Asda Stratford | 51.556179 | -0.008436 |
| **62** | Hotel IBIS London Docklands | 51.507076 | -0.006707 |
| **63** | Marks & Spencer, Stratheden Road, Greenwich | 51.476588 | 0.019758 |
| **64** | Waitrose South Woodford | 51.595742 | 0.024909 |
| **65** | Iceland Eltham | 51.450714 | 0.05654 |
| **66** | Travelodge Hotel London Chigwell | 51.609411 | 0.059181 |
| **67** | 1a Whitings Way, London | 51.519105 | 0.063025 |
| **68** | Sainsbury's Barking | 51.521184 | 0.065925 |
| **69** | Tesco Extra Woolwich | 51.489326 | 0.066981 |
| **70** | Iceland Woolwich | 51.491376 | 0.069244 |

| | | | |
|---|---|---|---|
| **71** | Sainsbury's Chigwell | 51.646347 | 0.082029 |
| **72** | Tesco Superstore Ilford | 51.585912 | 0.083231 |
| **73** | Tesco Express Theydon Bois | 51.671887 | 0.099514 |
| **74** | Nugent Shopping Park Orpington | 51.393022 | 0.113393 |
| **75** | Tesco Sidcup | 51.412695 | 0.122577 |
| **76** | Asda Bexleyheath | 51.457215 | 0.143133 |
| **77** | Asda Dagenham | 51.530235 | 0.14324 |
| **78** | Morrisons Dagenham | 51.559431 | 0.148577 |
| **79** | Oakhouse Foods, Stapleford Abbotts | 51.64369 | 0.164037 |
| **80** | Asda Swanley | 51.397026 | 0.175099 |
| **81** | Asda Romford | 51.579738 | 0.184792 |
| **82** | Asda Dartford | 51.447467 | 0.21736 |
| **83** | Romford Depot, AAH Pharmaceuticals, Harold Hill | 51.599619 | 0.220077 |
| **84** | B&Q Harold Hill | 51.595666 | 0.220411 |
| **85** | Purfleet Train Station | 51.481003 | 0.236505 |

An additional map was created to illustrate the total number of rapid charge events, across all fleets, which are scheduled to take place at each chargepoint.




*Illustrative rapid chargepoint locations showing expected utilisation levels*

| Colour of marker | Forecast weekly charging events |
| --- | --- |
| Green | 50 |
| Light amber | 20-49 |
| Dark amber | 10-19 |
| Light red | 3-9 |
| Dark red | 1-2 |

Finally fleet density analysis was performed to estimate the number of fleets that are forecast to use each chargepoint. This indicates that:

- Seven locations would be accessed by 10 or more fleets.
- 30 locations would be accessed by five or more fleets.
- 49 locations would be accessed by two or more fleets.

Clearly, based on this exercise alone, there are a large number of chargepoints which would have relatively low utilisation levels if they were installed today. However, the analysis is based on a sample of around 2,000 vehicles. If more fleet data was analysed, it is likely that many of these locations would be used by multiple organisations and therefore the installation of chargepoints could prove to be economically viable.

# Recommendations for TfL

## Benefits of rapid charging for commercial vehicles

Access to rapid charging offers several advantages for commercial vehicle operators and transport planners:

- If the charging infrastructure is available, the limited range of plug-in vehicles on a single charge is effectively no longer an issue given the speed at which vehicles can be recharged. The upper threshold to daily mileage is effectively removed for the majority of vehicles.
- The low 'fuel' cost per mile offsets the higher upfront vehicle cost (depending on the price per rapid charging event). As more miles are driven, total cost of ownership reduces compared to conventionally fuelled alternatives.
- Rapid charging allows the operation of electric vehicles by users who would otherwise not find them practicable, such as:
  - Drivers who take their van home but who don't have off street parking can rely primarily on accessing rapid chargepoints while working.
  - Organisations with a large fleet of electric vehicles may find they reach a limit on the number of workplace chargepoints that can be installed, and therefore can build in additional opportunity rapid charging.
- Fewer chargepoints need to be installed in total than for a network of slow or fast chargepoints, thus diminishing overall impact on streetscape.
- Property owners and developers could host chargepoints and grant access to other users, helping to recover upfront investment more quickly.

## Action plan

TfL may wish to consider taking forward some of the recommended actions below:

1. **Make the map and information contained in this report publically available and use this to stimulate dialogue with potential installers and investors.** We have been made aware of chargepoint installers with financial backers who would consider investing in a network of rapid chargepoints. One of the key pieces of information they will require before making a financial commitment is the likely demand from users; this report specifies the number of vehicles within the 26 fleets that will be using each charging point and this is a significantly useful source of information that will contribute towards that decision making process. Although the results of the study are based on the analysis of only 26 organisations, the findings indicate that a network of 85 rapid chargepoints would facilitate the adoption of electric vehicles by these fleets and a business case to build this network can be presented to potential

installers/investors. This analysis also provides valuable information on the likely optimum locations for installing rapid chargepoints, based on real fleet movements, helping to reduce the risk of under-utilisation.

2. **Facilitate cooperation between fleets which participated in this project.** Some of the organisations we engaged with are keen to have access to rapid charging to support additional acquisition of plug-in vehicles. These organisations may also find that there are common locations where infrastructure access would be beneficial to both of them. Opportunities may exist for fleets to work together to install a rapid chargepoint, possibly for their sole use but ideally made available for others to access as well.

3. **Discuss the illustrative locations with the relevant Distribution Network Operator, either UK Power Networks or Scottish and Southern Energy Power Distribution.** Installing rapid chargepoints will add significant demand to the already constrained electricity supply system in London. Electricity supply constraints at the substation level are potentially the biggest barrier to rapid chargepoint provision. TfL and the appropriate Distribution Network Operators should collaborate from the outset to manage rapid chargepoint installations and any necessary supply upgrades, including integrating chargepoints into new built environment developments where practicable.

4. **Engage with local authorities, particularly inner London Boroughs where large numbers of illustrative locations have been identified such as Westminster, Hackney, Camden and the City of London.** We are aware that many local authorities have encountered significant challenges in installing rapid chargepoints funded by OLEV grants, not least with finding suitable land. Discussing the identified locations with the local authorities well in advance of any potential network roll-out would allow them more time to find suitable sites.

5. **Identify and contact potential chargepoint hosts.** There are a number of businesses that are both regular destinations for fleet vehicles and could also be suitable hosts for chargepoints. These include fuel stations (particularly those with a café on site), supermarkets, drive through restaurants and business parks. Therefore locating rapid chargers at these sites would likely benefit fleets that are either already operating or are thinking of adopting plug-in vehicles. Discussions with potential hosts are likely to take time and would benefit from being commenced soon.

6. **Open discussions with manufacturers regarding the unmet demand for a 3.5t GVW electric vehicle.** Smaller payload vans (less than one tonne) are

available from a few manufacturers, but currently no OEM offers a medium or large plug-in commercial vehicle. For fleets operating medium to large vans where no equivalent electric vehicle exists, we modelled a hypothetical 3.5t GVW electric vehicle, based on data supplied by Paneltex (see Appendix B for more information). The report findings are therefore theoretical in that they would depend on such vehicles becoming widely available and entering the commercial vehicle parc in London. This research found that this type of vehicle would be the most suitable (hypothetical) replacement for at least some vehicles operated by 19 of the 26 fleets, even with a reduced range to minimise the impact on payload. There are still a number of variables which require further investigation, including the reduced payload (even where a small battery is specified payload is reduced slightly), downtime during duty cycles to recharge and the likely higher vehicle funding costs and, crucially, likelihood of fleets adopting vehicles with a low range on a single charge. Despite these challenges it would appear to be an area worth exploring further.

## Environmental benefits and timescale

Quantifying the potential environmental benefits associated with electric commercial vehicle uptake supported by rapid charging as outlined in this report is challenging because in many cases the proposed electric vehicle is a hypothetical model which is not in production. Therefore any estimated environmental benefits could not be realised in the near term. Additionally, we do not have sufficient data, such as fuel or mileage records, to calculate the baseline environmental impacts of the ICE vehicles analysed. However, we can make a rough estimate of the potential improvements that could be achieved.

The analysis found that installing rapid chargepoints at 85 locations within the M25 would support the acquisition of over 1,900 plug-in vehicles by 20 organisations. The table below compares the tailpipe equivalent $CO_2$ emissions and tailpipe NOx and PM emissions for petrol Euro 4, diesel Euro 6 and pure electric Class II vans[6] per kilometre travelled.

| | Petrol Euro 4 | Diesel Euro 4 | Pure electric |
|---|---|---|---|
| **$CO_2$ (tailpipe equivalent)** | 211.5g | 226.7g | 115.5g[7] |
| **NOx (tailpipe)** | 0.1g | 0.33g | 0 |
| **PM (tailpipe)** | - | 0.04g | 0 |

[6] Goods vehicles with an unladen weight plus 100kg greater than 1305kg but not exceeding 1760kg.
[7] Based on an indicative real-world energy consumption figure of 250 Wh/km

The table below shows the emissions associated with the same vehicles grossed up for a fleet of 100 vehicles covering an average of 10,000 miles per annum each.

| | Petrol Euro 4 | Diesel Euro 4 | Pure electric |
|---|---|---|---|
| **$CO_2$ (tailpipe equivalent)** | 340 tonnes | 365 tonnes | 186 tonnes |
| **NOx (tailpipe)** | 161kg | 531kg | 0 |
| **PM (tailpipe)** | - | 64kg | 0 |

Clearly there are some substantial generalisations and assumptions made here so we would urge that these figures are used with appropriate caution and caveats. However, they do serve to give an approximate indication of the relative environmental performance of petrol, diesel and electric commercial vehicles.

This study was commissioned by TfL as part of their work to understand the requirements for chargepoint infrastructure in London over the coming years. At this stage it is not possible to provide a suggested timescale for the deployment of the chargepoint network for commercial vehicles outlined in this report. Much is dependent on the availability of suitable vehicles; in addition substantial work will be required to investigate the factors influencing fleet uptake of electric commercial vehicles. We would recommend TfL continue to monitor developments in this area and consider updating this report when appropriate.

## Links with other research projects

Transport for London is undertaking a comprehensive research programme on likely ULEV growth in London and the infrastructure needed to support that growth. The Energy Saving Trust has previously undertaken another study on behalf of TfL: *A feasibility study for rapid charging for taxis*. The report has not yet been published; however the interim findings have identified the need for 90 rapid chargepoints across the capital to meet the needs of zero emissions capable (ZEC) taxis. Based on current taxi driver working patterns and the likely capabilities of ZEC taxis currently being designed, the study recommended types of locations that would fit best with taxis drivers' needs. For example, these could be where taxis already congregate, such as stations, hotels, airports, or cabmen's shelters. This research, alongside the results of TfL's market and stakeholder engagement work, will be used to inform the deployment strategy for rapid chargepoints in London.

# Appendix A: fleet data analysis methodology

## Stage 1 – Individual route analysis

1. A pivot table was created to facilitate identification of routes[8] that could be covered by a plug-in vehicle. This fleet data was then imported into Route Monkey's Electric Vehicles Optimisation System (EVOS).
2. Benchmark routes and mileage were determined by EVOS.
3. Suitable plug-in vehicle alternatives were selected by EST, including appropriate battery size and vehicle range. For fleets operating medium to large vans where no equivalent electric vehicle exists, we modelled a hypothetical 3.5t GVW electric vehicle, based on data supplied by Paneltex (see Appendix B for more information).
4. Overall fleet productivity was calculated. Fleet productivity is the number of days each vehicle was utilised divided by the maximum productivity. Maximum productivity is the total number of days multiplied by the number of vehicles in the data set provided; a fleet that is utilising every vehicle, seven days per week throughout the duration of the dataset provided would score 100%.
5. Routes suitable for further analysis were identified based on the total route mileage and the range of the equivalent plug-in vehicle. Using this information each route was categorised into one of the following:
   a. Recharge back at base only
   b. One rapid charge
   c. Two rapid charges
   d. Three or more rapid charges – these routes were marked as unsuitable for completion by a plug-in vehicle.
6. For routes that require one or two rapid charges, the recharging "windows" within routes were identified, i.e. the geographical area the vehicle is expected to be in when recharging is required.
7. The data was then filtered to show only those geographical areas where recharging is required within the M25. From this the optimal chargepoint locations were derived using a combination of EVOS and Google Maps to identify sites. For example shopping centres and supermarkets are considered suitable as they typically have parking facilities and long access hours. Chargepoint locations recommended for fleets already analysed were specified if the detour was less than one mile and would not prohibit the completion of the remainder of the journey. Therefore the final map of locations was built up iteratively as additional data was analysed.

[8] A route is defined as all miles travelled, per vehicle, per working day.

8. Cost and $CO_2$ savings were estimated for each route.
    a. Cost savings were estimated by comparing ICE fuel costs per mile (based on official MPG adjusted to reflect real world driving) with EV running costs per mile (based on vehicle range, also adjusted to reflect real world driving).
    b. $CO_2$ emission savings were calculated by converting MPG into g/km and comparing this to the emissions per kWh of electricity taken from the National Grid.
9. A £7 user fee for a 30 minute rapid charge was incorporated into the cost to charge in addition to the electricity consumed.
10. The route information was then grouped to create a single view of all routes completed by an individual vehicle.
11. Routes were analysed to determine which vehicles could be switched for a plug-in alternative. As noted in step five, routes were only considered suitable for completion by a plug-in vehicle if no more than two rapid charges were required. Vehicles where at least 80% of routes met this criterion were considered suitable for switching to a plug-in alternative. We assume that fleets will undertake vehicle optimisation to allocate the unsuitable routes to ICEs where necessary.

## Stage 2 – Consolidation of data and final maps

12. All fleet data was scaled to seven days to aid comparison between organisations and show expected weekly chargepoint usage.
13. Chargepoint locations were allocated a unique reference number ordered from west to east, and co-ordinates provided for each location.
14. Utilisation analysis was performed to determine the total number of rapid charges, across all fleets, which are scheduled to take place at each chargepoint.
15. Fleet density analysis was performed to estimate the number of fleets that are forecast to use each chargepoint.

## Stage 3 – Final formatting and presentation

16. The chargepoint sites were mapped together with location co-ordinates, chargepoint reference number and scaled utilisation forecasts.
17. This data was imported into ArcMAP to produce six Shapefiles (SHPs); one file containing all chargepoint locations, and five files showing the locations disaggregated by utilisation levels.

# Appendix B: vehicle specifications

Although the scope of this project is vehicles up to 12.5 tonnes GVW, the only rapid charge compatible vans available from volume manufacturers have payloads below one tonne. We selected the Nissan eNV200 as the proposed EV alternative for fleets operating small commercial vehicles such as Transit Connects or car-derived vans.

Since there are currently no larger electric vehicles available from volume manufacturers, we worked with Paneltex to determine suitable range and energy consumption figures. Paneltex has developed a range of battery electric vehicles based on the Isuzu chassis cab. At the time of writing, 5.5, 7.5 and 11 tonne vehicles are available from Paneltex. We were provided with modular battery size, range and energy consumption data for these vehicles, and take this opportunity to thank Paneltex for their invaluable input. Using this information, we were also able to specify a hypothetical 3.5 tonne vehicle, with a smaller battery to reduce the impact on payload.

The following tables provide the specifications of the vehicles used in the analysis:

<u>Nissan eNV200:</u>

| GVW | Payload (kg) | Range (miles) | kWh per mile | kWh charge in 15 mins | Miles added in 15 mins | kWh charge in 30 mins | Miles added in 30 mins |
|---|---|---|---|---|---|---|---|
| **2.2 tonnes** | 700 | 105 | 0.32 | 10 | 32 | 21 | 60 |

<u>Isuzu / Paneltex conversion (96 kW battery pack):</u>

| GVW | Payload (kg) | Range (miles) | kWh per mile | kWh charge in 15 mins | Miles added in 15 mins | kWh charge in 30 mins | Miles added in 30 mins |
|---|---|---|---|---|---|---|---|
| **5.5 tonnes** | 2,300 | 120 | 0.96 | 10 | 11 | 21 | 22 |
| **6.5 tonnes** | 3,145 | 110 | 1.05 | 10 | 10 | 21 | 20 |
| **7.5 tonnes** | 3,820 | 100 | 1.15 | 10 | 9 | 21 | 18 |
| **11 tonnes** | 6,750 | 85 | 1.36 | 10 | 8 | 21 | 15 |

<u>Isuzu / Paneltex conversion (84 kW battery pack):</u>

| GVW | Payload (kg) | Range (miles) | kWh per mile | kWh charge in 15 mins | Miles added in 15 mins | kWh charge in 30 mins | Miles added in 30 mins |
|---|---|---|---|---|---|---|---|
| **5.5 tonnes** | 2,410 | 100 | 1.01 | 10 | 10 | 21 | 21 |
| **6.5 tonnes** | 3,255 | 90 | 1.12 | 10 | 9 | 21 | 19 |
| **7.5 tonnes** | 3,930 | 85 | 1.19 | 10 | 9 | 21 | 18 |
| **11 tonnes** | 6,860 | 70 | 1.44 | 10 | 7 | 21 | 15 |

Isuzu / Paneltex conversion (66 kW battery pack):

| GVW | Payload (kg) | Range (miles) | kWh per mile | kWh charge in 15 mins | Miles added in 15 mins | kWh charge in 30 mins | Miles added in 30 mins |
|---|---|---|---|---|---|---|---|
| **5.5 tonnes** | 2,600 | 80 | 0.99 | 10 | 11 | 21 | 21 |
| **6.5 tonnes** | 3,445 | 70 | 1.13 | 10 | 9 | 21 | 18 |
| **7.5 tonnes** | 4,120 | 65 | 1.22 | 10 | 9 | 21 | 17 |
| **11 tonnes** | 7,050 | 60 | 1.32 | 10 | 8 | 21 | 16 |

Isuzu / Paneltex conversion (48 kW battery pack):

| GVW | Payload (kg) | Range (miles) | kWh per mile | kWh charge in 15 mins | Miles added in 15 mins | kWh charge in 30 mins | Miles added in 30 mins |
|---|---|---|---|---|---|---|---|
| **5.5 tonnes** | 2,790 | 60 | 0.96 | 10 | 11 | 21 | 22 |
| **6.5 tonnes** | 3,635 | 50 | 1.15 | 10 | 9 | 21 | 18 |
| **7.5 tonnes** | 4,310 | 45 | 1.28 | 10 | 8 | 21 | 16 |
| **11 tonnes** | 7,220 | 40 | 1.44 | 10 | 7 | 21 | 15 |

Isuzu / Paneltex conversion (36 kW battery pack):

| GVW | Payload (kg) | Range (miles) | kWh per mile | kWh charge in 15 mins | Miles added in 15 mins | kWh charge in 30 mins | Miles added in 30 mins |
|---|---|---|---|---|---|---|---|
| **3.5 tonnes** | 2,185 | 50 | 0.64 | 10 | 16 | 21 | 33 |