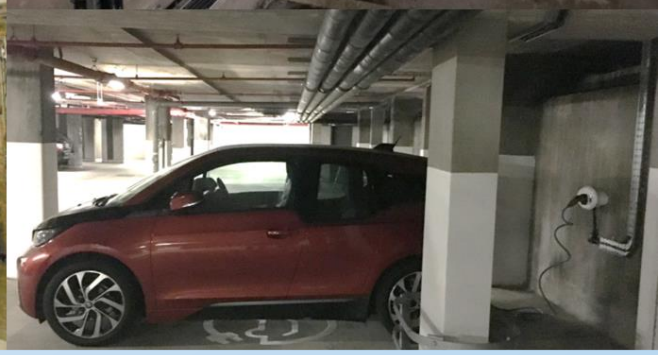
City of London Corporation

BARBICAN ESTATE RESIDENTS ELECTRIC VEHICLE CHARGING INFRASTRUCTURE STUDY

Draft Final Report



-

JANUARY 2019

City of **London Corporation**

BARBICAN ESTATE RESIDENTS ELECTRIC VEHICLE CHARGING INFRASTRUCTURE STUDY

Draft Final Report

WSP

WSP House
70 Chancery Lane
London
WC2A 1AF

Phone: +44 20 7314 5000

Fax: +44 20 7314 5111

WSP.com

QUALITY CONTROL

Issue/revision	Draft issue	Draft Final	Final
Date	January 2019	January 2019	
Prepared by	Matt Croucher Fiona Coull Hiren Patel	Matt Croucher Fiona Coull Hiren Patel	
Checked by	Matt Croucher Glenn Higgs Mark Moscrop	Matt Croucher Glenn Higgs Mark Moscrop	
Authorised by	Glenn Higgs Matt Croucher	Glenn Higgs Matt Croucher	
Project number	70040803	70040803	
Report number	1	2	
File reference	Draft Report – Barbican EV Infrastructure Study v1.0	Draft Final Report – Barbican EV Infrastructure Study v2.00p	

CONTENTS

TABLES

FIGURES

1

BACKGROUND AND OBJECTIVES

1. BACKGROUND AND OBJECTIVES

1.1. BACKGROUND

1.1.1. The City of London has some of the worst air pollution levels in the UK. The City of London Corporation has made improving local air quality a key objective within its forward-looking policies and strategies.

1.1.2. In July 2016 the Corporation was successful in securing £1million funding from the Mayor of London, as part of the Mayors Air Quality Fund, to develop a Low Emission Neighbourhood (LEN) in the Barbican area of the City.

1.1.3. The LEN includes a range of innovative approaches to improve air quality and reduce the impacts of air pollution on residents, visitors and workers in the Square Mile.

1.1.4. The City has been a trailblazer in the past when it comes to tackling air quality, with the first smokeless zone introduced in1954, and preventing the burning of sulphurous fuels in 1971.

1.1.5. Transport related emissions are now the largest source of air pollution in London, and so a key component of the City's Low Emission Neighbourhood strategy is to support and accelerate the uptake of ultra-low emission vehicles (ULEVs)[1] amongst residents in the Barbican Estate.

1.1.6. In December 2016, the Barbican Residential Committee approved the formation of a Working Party to pilot the introduction of Electric Vehicle charging points on the Barbican Estate. The Working Party comprised appointed resident representatives, Barbican Estate Officers and the Low Emission Neighbourhood project team. The Working Party met quarterly from January 2017, and worked closely to deliver and implement the pilot of EV charging on the Barbican Estate. This report would like to acknowledge and thank Working Party members for their input, time and support.

1.1.7. In June 2017 the Barbican Residential Committee approved the pilot project to install 22 electric vehicle charging points (EVCPs) of different charging capabilities, servicing 30 bays, across five car parks on the Barbican Estate, with the installations completed and launched in May 2018. However, in addition to the installation of a number of charge points in the immediate term as part of the LEN programme, it was also recognised that it will be essential to learn from the experience of these initial installations.

1.1.8. In December 2017 WSP was commissioned to monitor and support a six-month pilot project from May – November 2018, with the intention of determining the best solution for

[1] EV or ULEV refers to any electric vehicle or plug-in ultra-low emission vehicle with a battery that can be charged from an external source (i.e. not only from regenerative breaking), and emits no more than 75 grams of CO_2 per kilometre.

the wider rollout of electric vehicle charging infrastructure across City of London Corporation managed residential car parks.

1.2. OBJECTIVES

1.2.1. The objective of this study is help the City Corporation understand how it can:

- Best meet the needs and requirements of residents when charging their vehicles;
- Future-proof car parks to accommodate growth in electric vehicles;
- Ensure an EV charging scheme will be sustainable and self-financing in the future; and
- Ensure any scheme is straight forward to manage with minimal resources required from the Residential Services Management team.

1.3. REPORT STRUCTURE

1.3.1. The remainder of this report is set out as follows:

- Chapter 2 – Background and Objectives
- Chapter 3 – Approach
- Chapter 4 – Barbican Car Park – Site Information
- Chapter 5 – Pilot Study – Charging Infrastructure and Participants
- Chapter 6 – Pilot Study Findings – User Experience and Charge Point Usage
- Chapter 7 – Forecast Future Charging Requirements
- Chapter 8 – Review of Charging Technologies and Trends
- Chapter 9 – Recommendations
- Chapter 10 – Case Study Examples and Best Practice Guidance

2. APPROACH

2.1.1. This study approach is outlined in the figure below:

Figure 2-1 - Approach

Stage A – Stakeholder Engagement, Communications and Implementation

2.1.2. The first stage of the project was to engage with the residents and other key stakeholders, undertake a baseline survey to establish existing EV ownership, and identify participants to take part in the pilot study. It also sought to understand potential future demand for EVs, and views around charging infrastructure requirements and preferences.

Online Survey Prior to Pilot

2.1.3. A web survey of residents was developed, alongside a package stakeholder communications and marketing materials, to promote awareness of the web survey, prior to the EVCPs being installed and the pilot beginning in May.

2.1.4. The web survey was developed in a user-friendly format designed to route respondents only questions applicable to them based on their preceding responses. This enabled us to capture detailed feedback from respondents where they were EV owners, and establish whether they were interested in participating in the pilot, whilst also collecting short-form responses from residents who for example do not own a vehicle and do not plan to purchase one. The survey questions included the following topic areas:

- → User Profile – Residential Building/ Car Park
- → Vehicle Type - who presently owns an EV
- → Who is intending to buy an EV (electric or hybrid vehicles in the near future)

- What residents require to support the shift from internal combustion engines (ICEs) to electric vehicles (EVs)?
- Key factors likely to influence if/ when they would switch to an EV.
- Mileage and journey purposes
- Working Status
- Preferred charge point type
- Charging habits – use of workplace, destination and intermediate charging
- Views on communal versus dedicated charging bays.
- Interest in participating in the pilot study
- Willingness to use a charge point in a neighbouring car park

Communications and Marketing

2.1.5. WSP worked with the City LEN project team to market the EVCP pilot, both to prospective users but also more widely to raise awareness of the scheme, using the same format and branding as applied to other LEN materials, and through pre-existing channels where appropriate, including:

- Twitter via the City Air account, which has over 2,000 followers.
- City Resident magazine – published 2 times a year for all residents in the City of London
- Leaflets/ pamphlets focused specifically on the EVCP pilot
- Posters on community notice boards in community spaces
- Emails to over 1,200 residents via the weekly bulletin from the BEO

2.1.6. The web survey and marketing were used to identify and recruit participants to take part in the trial, and commit to using an allocated charge point within the Barbican.

2.1.7. A launch event was held and the charge points were activated on 14th May 2017. Over 80 people attended the event, which included demonstrations of how to use the charge points, with a number of EVs supplied by BMW, Nissan and ZipCar for residents to experience and discuss with representatives.

2.1.8. This was followed by an evening reception at nearby Ironmongers' Hall, which included presentations regarding electric vehicle developments by Nissan, the Low Emission Neighbourhood project, the pilot, and a prize draw for the respondents to the survey. It also provided an opportunity to further advertise the web survey, and the availability of charge points for those interested in participating in the pilot by making use of the charge points.

http://democracy.cityoflondon.gov.uk/documents/s102138/LEN%20Update_Appendix_28Sept18_PHES%20Committee.pdf

Stage B – Monitoring of Usage

2.1.9. Having assembled the participants and launched the pilot, the next stage was to undertake the monitoring of charge point usage and the experience of residents and other stakeholders throughout this period.

2.1.10. The electricity consumption and charging events were recorded, processed and aggregated from the data available from the ChargeVision data platform. Where EVCPs did not provide remote communications data, monthly data on electricity consumption was collected by either BEO staff or WSP staff.

2.1.11. In addition to data monitoring, further qualitative and quantitative information was recorded of the user experiences through:

- web surveys of the participants;
- one-to-one interviews with a residents and other stakeholders; and
- a consultative workshop with residents.

Online surveys during the pilot

2.1.12. An intermediate survey of the residents participating in the scheme was undertaken 3 months into the pilot in August/September, building on the initial web survey undertaken when the pilot began. This enabled us to establish user satisfaction with their allocated charge points, any issues encountered, and to collect supporting data around their charge point usage, re-charging times and habits, to supplement the more limited data available through the charging portal. It also enabled us to revisit questions around their mileage, and use of other charging infrastructure, and to invite their estimates of the electricity they had used.

One-to-one interviews with stakeholders

2.1.13. In addition to the web surveys, more detailed one-to-one interviews were undertaken with a sample of the participating residents, as well as a number of other stakeholders, including Barbican Estate officers. They also included a representative from ZipCar, recognising that they will have a distinct set of requirements to the residents.

2.1.14. These enabled us to explore in further detail their experiences, and to understand some individual perspectives from each stakeholder group.

2.1.15. In the case of local stakeholders – such as the residents and the Barbican Estate team, we were seeking to understand their experiences to date, what is working well, what isn't, any concerns, any actual or perceived difficulties or barriers in terms of usage, installation maintenance, preferences in terms of EVCP types, layouts, operational arrangements, management methods, payment processes and pricing considerations.

2.1.16. In terms of wider stakeholders such as charge point operators – we were looking to understand from them any delivery challenges and opportunities, costs, planned or anticipated future market developments and upcoming technologies.

2.1.17. The interviews took between 30-45 minutes on average, and took a structured approach around discussion areas to keep the conversation reasonably focused, whilst still allowing it to flow.

2.1.18. We also approached representatives from UKPN and Tesla to take part in a one-to-one interview, to record their perspectives as an OEM (Original Equipment Manufacturer – a car manufacturer) and DNO (Electrical Distribution Network Operator), but neither were available within the project timescales.

Consultative Workshop

2.1.19. A workshop was held on 1st November for residents participating in the trial, with remaining spaces opened up to other interested residents. The session was hosted on Barbican Estate for the convenience of attendees, with 11 residents attending.

2.1.20. This was an interactive workshop, and provided an opportunity for all trial participants, Barbican Estate staff and any other interested residents to hear about the results of the trial, and ask questions.

2.1.21. The workshop consisted of a 30-minute overview of the trial and the findings, and 30 min Question and Answers/ discussion.

2.1.22. The workshop enabled us to sense check the emerging findings and outputs from the monitoring and usage of the EVCPs, and the findings of the interim online survey. It also enabled residents to meet other EV owners' resident in the Barbican, and for those interested in purchasing an EV to speak with their peers about their experiences.

2.1.23. We were also keen to open up the discussion to wider feedback from the group on their experiences to date – framed within a series of specific topic headings.

Stage C – Assessment of the scheme and recommendations

2.1.24. Upon completing the 6-month pilot period, and having gathered the usage data and experience of the range of stakeholders consulted throughout, we undertook a detailed review and analysis to inform our subsequent recommendations.

2.1.25. Forecasts of the future demand for EVCPs at the Barbican were then developed. These were developed in conjunction with assessing how the demand would be catered for, informed by the feedback collected from residents, the car club operator, the Estate team and the charger point operator.

2.1.26. We also undertook a review of the latest EVCPs available on the market, through desktop research and discussions with EVCP suppliers and operators. To ensure that our recommendations are future proofed.

2.1.27. These differing charging options were then combined with the demand forecasts to determine EVCP requirements in a range of different scenarios.

2.1.28. Based on the preceding analysis of current and forecast future demand for EVCPs, and the review of technologies, cost and stakeholder feedback, we developed a business case outlining appropriate pricing levels, management platforms, delivery mechanisms.

Power capacities and upgrade requirements for future demand

2.1.29. We interviewed the facility management teams and undertook detailed reviews to establish the current power capacities, an incremental range of indicative costed upgrades required to facilitate the forecast demand, and accounting for the impact of differing EVCP types and applications such as demand management and smart charging on costs, deliverability,

charging capabilities to users, and trigger points for the requirements of more substantial infrastructure improvements such as new sub-stations.

2.1.30. Recommendations across a range of scenarios were then developed, including best practice guidance and case study examples for consideration when rolling out charge points more widely across the City.

Stage D – Reporting and Presentation

2.1.31. A draft report was prepared and issued for comments by the Working Party, followed by a final report.

2.1.32. A concluding presentation was delivered to the Barbican Estates Electric Vehicle Charging Points Working Party, summarising the findings of the pilot study.

2.1.33. This report will also be presented to the Residents Consultation Committee and Barbican Residential Committee for information, and for a decision on future management and expansion of EV charging on the Barbican Estate.

3. BARBICAN ESTATE - CAR PARK UTILISATION AND ELECTRICAL SUPPLY

3.1. BARBICAN BUILDING

3.1.1. The Barbican Estate was constructed between 1969 and 1976, and covers a 40-acre site. The complex was built in a distinctive brutalist architectural style. In 2001 it was Grade II listed and designated a site of special architectural interest, as one of London's principal examples of concrete brutalist architecture.

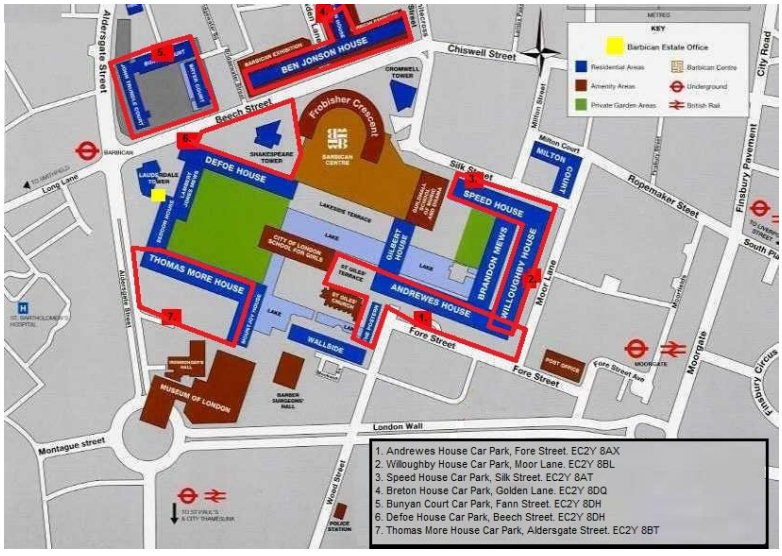
3.1.2. The residential estate consists of 21 residential blocks, including 3 tower blocks, 13 terrace blocks, 2 mews and The Postern, Wallside and Milton Court. The residential blocks are set on a raised podium and features underground parking, making space available for public squares. There are total of **2,059 flats** and approximately **4,500 to 5,000 residents**.

3.2. CAR PARKS

3.2.1. The Barbican Estate includes a total of **10 secure car parks** (7 of which have 24-hour Estate Concierge staff), with an overall capacity of **1,273 parking spaces** as of November 2018:

- Andrewes House
- Breton House
- Bunyan Court
- Cromwell Tower
- Defoe House
- Speed House
- Lauderdale House
- Thomas More
- Willoughby House (Level 01)
- Willoughby House (Level 03)

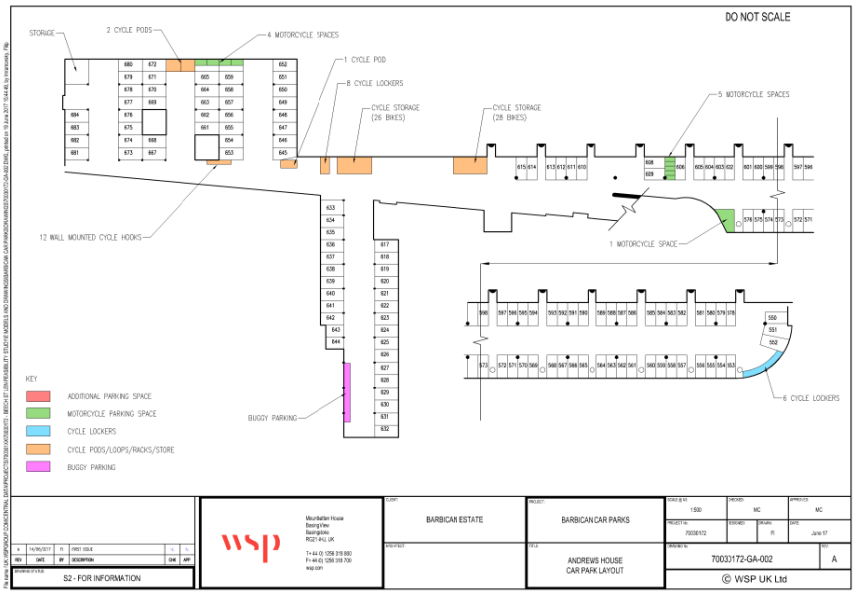
Figure 3-1 - Barbican Estate Map



Access Arrangements

3.2.2. The concierge service help with parking, deliveries and maintaining resident and visitor safety.

3.2.3. Each car park bay is numbered and allocated for use by the permit holder. There are no 'right to park' unallocated bays.



Car Park Licences

3.2.4. The Barbican Estate car parks are available to residents, lease holders and sub-tenants. The Barbican also has a few commercial arrangements with local businesses and operators.

3.2.5. Barbican Estate leaseholders/ homeowners and their sub-tenants must obtain parking permits to use car parking on the Barbican Estate. Ongoing long-term licenses are offered to leaseholders, and short-term licenses (3-, 6-, 9-, 12-month) are offered to sub-tenants.

3.2.6. Leaseholders are charged an initial administration fee (£62), plus quarterly charges which can be added to their quarterly service charges, or leaseholders may elect to pay in advance for a fixed term duration.

3.2.7. Sub-tenants may purchase parking permits for periods of up to 12 months, with the option to renew the permit for a further period. Permits are provided to be displayed in the car showing the expiry date.

Table 3-1 – Resident Car Park Charges

Car Park Licenses	Parking Charges*
3 Month License	£397
6 Month License	£732
9 Month License	£1,067
Annual License	£1,402
Long Terms Lease/ Bay Purchase (£8,598)	£962

Current Charge Point Application Process

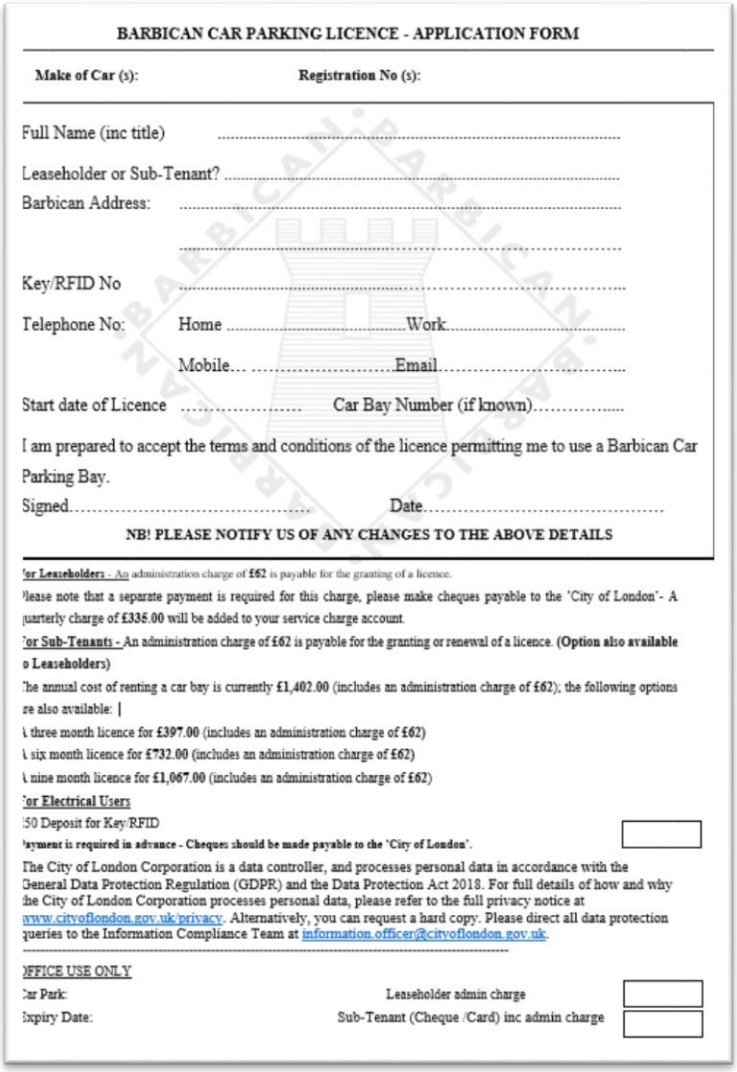
3.2.8. At present Electric Vehicle charge point provision is limited to providing residents with access to one of the 30 bays with accessible charging infrastructure installed as part of this pilot study.

3.2.9. At the time of writing, no charge is levied for access to the charge point or the electricity consumed, though a £50 deposit is required for the charge point key/ RFID.

3.2.10. The process of registering interest in a charge point, and making the deposit for the key, is administered through the application form that residents and others must complete to secure a parking space. The form includes a tick box option where the user specifies they are an 'Electrical User'. Payment of the deposit is to be made via a cheque made payable to the 'City of London'.

3.2.11. There is no further information provided in the permit application form in terms of where the existing charge points are available, or opportunity for the applicant to specify what type of charge point they require.

Figure 3-2 - Application Form for Parking Permit



BARBICAN CAR PARKING LICENCE - APPLICATION FORM

Make of Car (s): **Registration No (s):**

Full Name (inc title) .....

Leaseholder or Sub-Tenant? .....

Barbican Address: .....

.....

Key/RFID No .....

Telephone No: Home .....Work.....

Mobile... .....Email.....

Start date of Licence ..... Car Bay Number (if known).....

I am prepared to accept the terms and conditions of the licence permitting me to use a Barbican Car Parking Bay.

Signed..... Date.....

NB! PLEASE NOTIFY US OF ANY CHANGES TO THE ABOVE DETAILS

'or Leaseholders - An administration charge of **£62** is payable for the granting of a licence.

Please note that a separate payment is required for this charge, please make cheques payable to the 'City of London'- A quarterly charge of **£335.00** will be added to your service charge account.

'or Sub-Tenants - An administration charge of **£62** is payable for the granting or renewal of a licence. **(Option also available o Leaseholders)**

The annual cost of renting a car bay is currently **£1,402.00** (includes an administration charge of **£62**); the following options re also available:

- three month licence for **£397.00** (includes an administration charge of **£62**)
- six month licence for **£732.00** (includes an administration charge of **£62**)
- nine month licence for **£1,067.00** (includes an administration charge of **£62**)

'or Electrical Users

50 Deposit for Key/RFID

Payment is required in advance - Cheques should be made payable to the 'City of London'.

The City of London Corporation is a data controller, and processes personal data in accordance with the General Data Protection Regulation (GDPR) and the Data Protection Act 2018. For full details of how and why the City of London Corporation processes personal data, please refer to the full privacy notice at www.cityoflondon.gov.uk/privacy. Alternatively, you can request a hard copy. Please direct all data protection queries to the Information Compliance Team at information.officer@cityoflondon.gov.uk.

OFFICE USE ONLY

Car Park: Leaseholder admin charge

Expiry Date: Sub-Tenant (Cheque /Card) inc admin charge

Car Park Occupancy

3.2.12. **926 (73%) spaces are utilised** as of November 2018, from the 1,273 spaces across the Barbican.

3.2.13. The car parks across the Barbican Estate feature varying levels of utilisation, and differing compositions of residential, commercial and longer term lets, as demonstrated in the table below.

3.2.14. The most heavily utilised car park is Speed House, with occupancy at 93%, whilst Breton House operates at around 51% of capacity.

3.2.15. The commercially let bays are concentrated in Willoughby House (Level 01) – 25 of 27, including 2 EV charging car club bays used by ZipCar.

3.2.16. The long-term car bay agreements are concentrated in Speed House (110) and Willoughby House (Level 03) (77).

Table 3-2 – Car Park Utilisation *(July 2018)*

Car Park Bays	Andrewes House	Breton House	Bunyan Court	Cromwell Tower	Defoe House	Speed House	Lauderdale House	Thomas More	Willoughby House (Level 01)	Willoughby House (Level 03)	Totals
Total Bays	134	127	120	92	162	155	106	147	133	97	**1,273**
Total Occupancy	69%	51%	73%	63%	78%	93%	82%	61%	74%	80%	**73%**
Residential Short-Term Permits	81	65	87	50	91	32	70	82	68	1	**627**
Commercial	0	0	0	0	0	2	0	0	25	0	**27**
Long Term Car Bay Agreements	11	0	1	8	35	110	17	8	5	77	**272**
Vacant	42	62	32	34	36	11	19	57	35	19	**347**

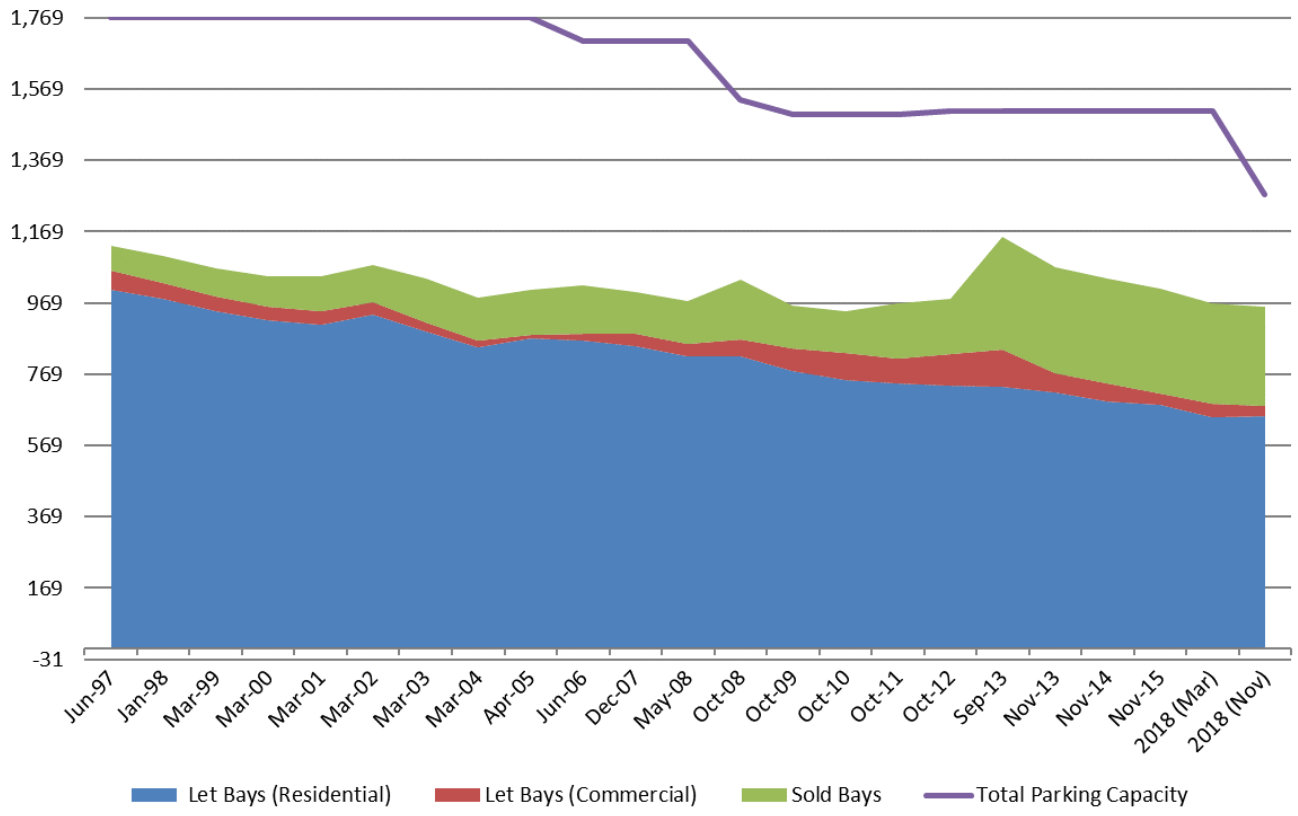
Trends

3.2.17. There has been a declining demand for parking bays amongst residents over the past twenty years, with 332 (34%) fewer residents parking compared to 1998. Over this period this equates an average annual reduction in resident parking of 1.9%.

3.2.18. This has been partly counterbalanced by a growing number of “sold bays”, which are sold on long term leases as opposed to regular short-term renewals. These “sold bays” have increased by 201 (264%) since 1998.

3.2.19. The total number of bays has also fallen over the past twenty years as a number of bays have been repurposed for alternative purposes, such as storage and cycle parking.

Figure 3-3 - Car Park Utilisation Trends (1997-2018)



Longer Term City Car Park Policy and Strategy

3.2.20. A new Future of City Car Parks report is also due to be produced by City Transportation, and presented to the Planning and Transportation and Policy and Resources Committee's in March 2019. The report will include a 25-year strategy, and considers potential decreases in volume of traffic, and the demands from other users, delivery hubs and cargo bicycles.

3.3. ELECTRICAL SUPPLY CAPACITY

3.3.1. The choice of charging system is in part limited by the existing electrical network capacity in the chosen area. It is therefore important that this is considered and assessed as early as possible within the infrastructure planning / development process. This may limit what can be achieved or require advance work from the electricity companies to increase their capacity in that area.

3.3.2. As such, it is necessary to also consider the question of the UK electricity grid and its ability to meet the load requirements. We are already seeing the electrical supply industry requiring 'electrical capacity' surveys for all EV proposed locations, and a number of these are being highlighted as unsuitable based upon the current capacity of the electrical

network. This can lead to some specific challenges at the local level, as the DNOs (Electrical Distribution Network Operator) cannot always meet the required electrical load locally.

3.3.3. The Energy Networks Association (ENA) www.energynetworks.org have developed an electric vehicle charging infrastructure installation notification procedure. This looks at the capacity requirements to determine the level of electrical supply capacity that currently exists, which then enables consideration for the EV charging facilities in terms of type, electrical load and quantify of charge points, provided a capacity exists on the network.

Existing and available electrical capacity

3.3.4. The car parks with charge points installed as part of the pilot scheme (5 of the Barbicans 10 resident's car parks) currently have UKPN supplies consisting of 3 Phase 100A and BS1361 Fuses. The available electrical capacity that has been agreed with UKPN is 68kVA or 98A per phase.

3.3.5. Based on the existing installations and arrangement of UKPN transformers and electrical switch rooms, it is expected that additional 68kVA 3 Phase supplies could be provided to the 5 remaining car parks not currently fitted with charge points. However, in order to confirm the availability of new connections an application must be submitted to UKPN before any dialog can take place.

3.3.6. In the case of the car parks with charge points, a sub-main cable was installed from the switch room to the sub-distribution board in each of the car parks. Prior to installing any additional charge points the sub-main cable would need to be inspected physically and from test certificates to confirm that the current carrying capacity is not exceeded. Our initial surveys indicated that 25mm cable was used, which can typically carry around 99A depending on method of installation.

DNO (Distribution Network Operator) assessment of supply

3.3.7. In order to assess the available supply for those car parks which do not currently have EV charge points, a formal assessment of the supply is required by the DNO. UKPN are the DNO for the London area and they have advised that based wholly on the existing installations carried out last year, it would be a fair assumption that 68kVA supplies could be made available for each car park for the provision of EV charge points.

Limitations in the data available

3.3.8. Unfortunately, due to the age of the building and record keeping over the years, information and plans to further inform these assessments is limited.

Key point summary

- Declining parking demand and available bays in Barbican Estate car parks
- All parking bays are allocated, with no right to park bays.
- Issues with determining available electrical supply due to lack of plans and records due to age of the building

4. PILOT STUDY - CHARGING INFRASTRUCTURE AND PARTICIPANTS

4.1. CHARGE POINTS DEPLOYED

4.1.1. As part of the pilot study a total of 22 charge point units were deployed across the Barbican Estate for City residents, and officially activated and launched on 14th May 2018.

4.1.2. The charging points were procured by the City of London Corporation using the LEN funding, supplied and commissioned by Chargemaster, and were installed by SRG Electrical.

4.1.3. A range of charge point types were installed in order to gauge feedback on each from users and the estate team, to inform future decision-making. The units included:

- Power outputs ranging from 3.5kW, 7kW to 22Kw.
- Both tethered[2] and socketed units
- RFID[3] card or Key operated systems
- Single or Dual chargers

4.1.4. The charge points were installed in five car parks identified by the Barbican Estate Office as being most suitable for introducing charging points as part of a pilot project. The car parks are:

- Bunyan Court
- Breton House.
- Cromwell Tower (Level 02)
- Thomas More
- Willoughby House (Level 01)

4.1.5. A further point of variation between the charge points installed as part of the pilot, and the user experience, is where a resident from a different block which does not have its own charge points, is using the charge points in a neighbouring car park, and the extent to which residents would be willing to incur this potential inconvenience.

4.1.6. The range of electric vehicle charge points installed means a variety of recharging times were available. For example, the indicative timings to recharge a Nissan Leaf (40kW battery) from a fully drained battery using the charge points deployed are:

[2] A tethered charge point refers to the charging cable being integrated into the unit, rather than featuring a socket for the user to plug a cable into.

[3] RFID is an acronym for “radio-frequency identification” and refers to a technology whereby digital data encoded in RFID card communicates with a reader via radio waves.

- Slow Charger (~3.5kW), type 2, single phase[4] – 12hrs
- Standard Charger (~7kW), type 2, single phase - 6hrs
- Fast Charger (~22kW), type 2, three phase - 2hrs

4.1.7. The charge points include a range of RFID and Key operated models:

- The RFID operated units are unlocked and activated using an RFID card supplied to the user.
- The key operated units feature a lock and key mechanism, and a key is provided to the user.

4.1.8. The RFID units use GSM (Sim Cards) to enable communications. This also means they are able report data on electricity consumption, charge events and duration via Chargemaster's ChargeVision portal. The key operated units have a meter installed on their electricity supply cable. This must be manually checked to determine electrical use.

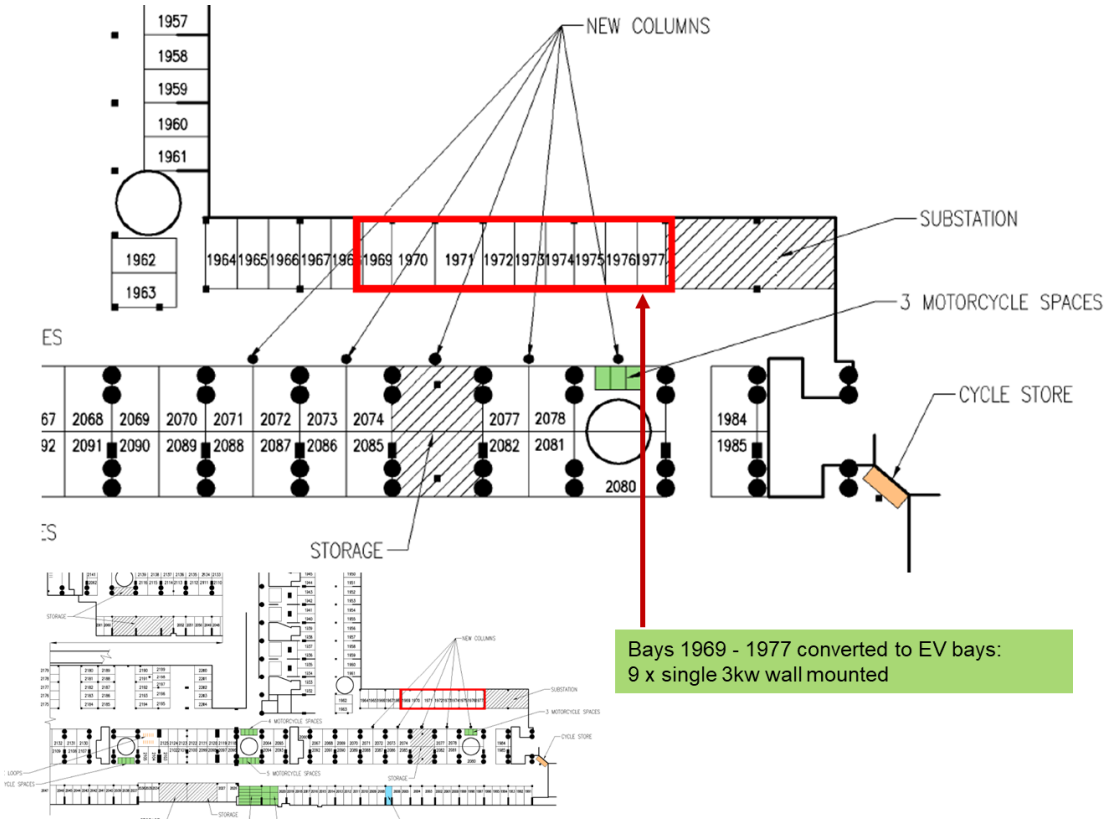
Table 4-1 – Barbican Pilot Charge Points

Car Park	Number. of points	Single/ dual	Wall/ post	Socket/ tethered	Power (KW)	RFID or Key	Number of bays
Breton	9	Single	Wall	Socket	3kw	Key	9
Bunyan	2	Dual	Wall	Socket	7kw	RFID	4
Bunyan	1	Dual	Wall	Socket	3kw	RFID	2
Cromwell	3	Single	Wall	Socket	22kw	Key	3
Thomas More	1	Dual	Wall	Socket	7kw	RFID	2
Thomas More	1	Dual	Wall	Socket	22kw	RFID	2
Willoughby (Level 01)	3	Dual	Wall	Socket	7kw	RFID	6
Willoughby (Level 01)	2	Single	Wall	Tethered	7kw	RFID	2
Total	22						30

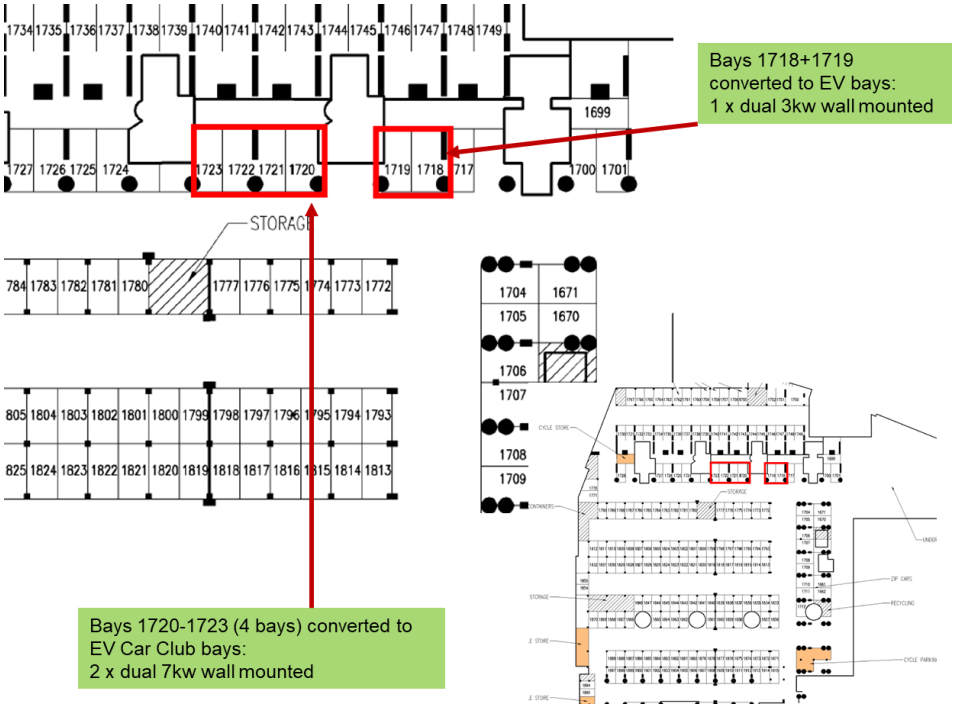
4.1.9. The charge points are installed in banks of between 2 and 9 parking bays.

[4] Single phase and three phase power systems use alternating current (AC) electric power. With AC power, the flow of current is constantly alternating directions. The primary difference between single phase and three phase is the constancy of delivery. With a three-phase power supply a steady stream of power is delivered at a constant rate, making it possible to carry more load. For most businesses and industrial units, it is delivered in three phase to accommodate higher loads, whereas residences are generally provided single phase to sufficiently power household items.

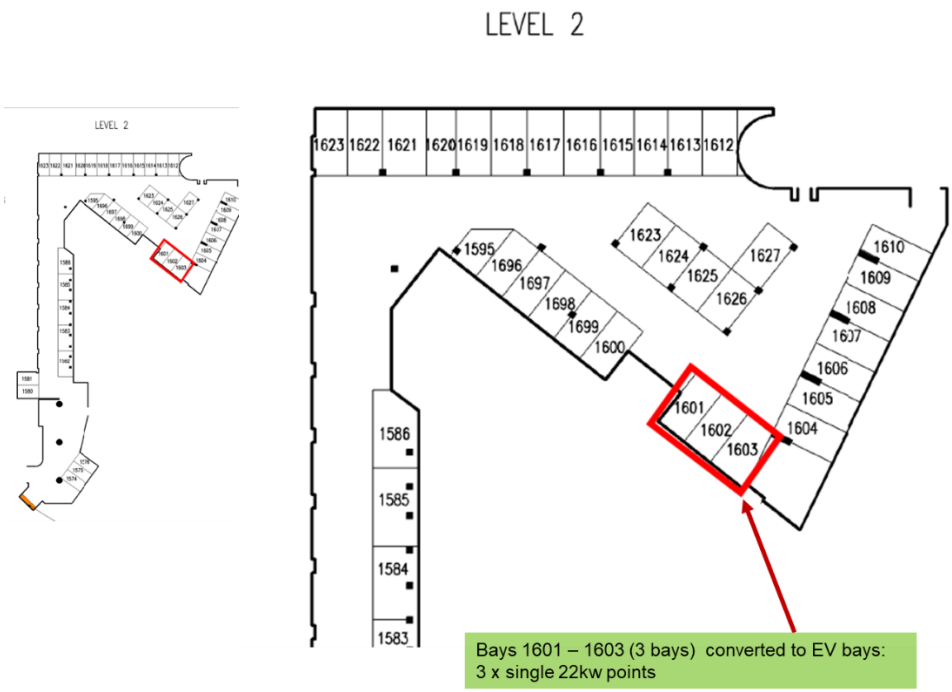
Breton House Car Park



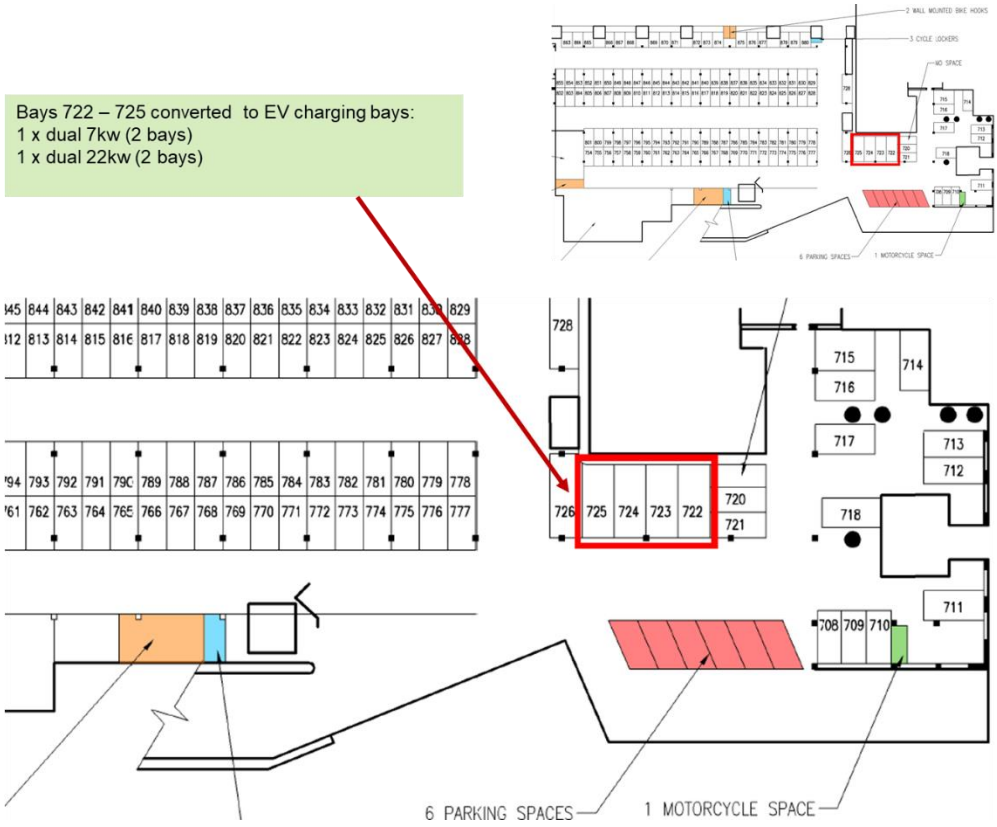
Bunyan Court Car Park



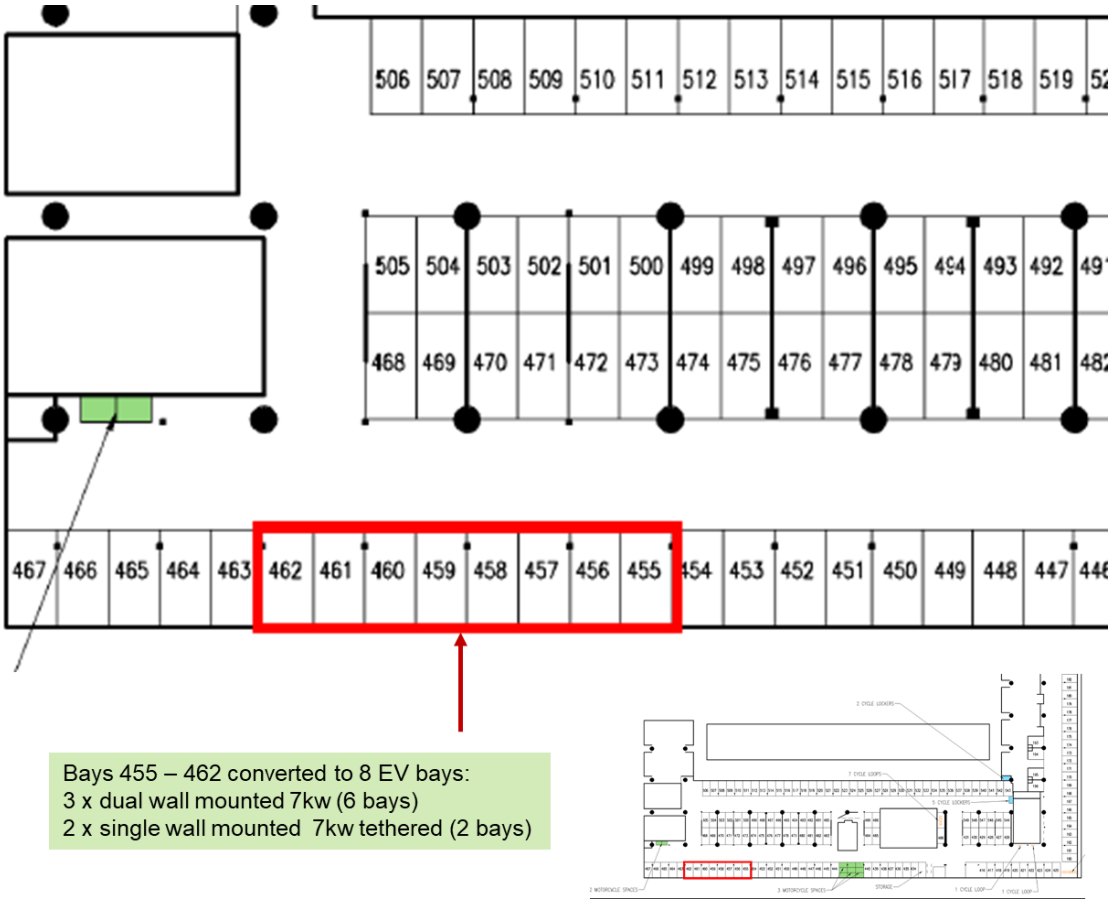
Cromwell (Level 02) Car Park



Thomas More House Car Park



Willoughby House (Level 01) Car Park



4.1.10. The pilot project also includes the installation of EVCPs at 4 Zipcar car club bays, enabling Zipcar to offer all electric and hybrid car club vehicles.

4.2. PILOT STUDY PARTICIPANTS

4.2.1. The Barbican Estate team estimate that there are approximately twenty **Electric Vehicles** (EVs[5]) or **Plug-in Hybrid Electric Vehicles** (PHEVs[6]) using the Barbican car parks on a regular basis.

4.2.2. The pilot study was successful in recruiting 15 participants to take part in the trial, and commit to using an allocated charge point within Barbican, and participating in the surveys.

4.2.3. The participants selected include a range of characteristics and differing vehicle types, as summarised in Table 4.2 on the following pages.

4.2.4. It is notable that the majority of the vehicles are PHEVs (74%, 11) as opposed to **Battery Electric Vehicles** (BEVs[7]) (26%, 4). This is however reflective of the UK average.

4.2.5. Charge points were allocated on basis of a residents preferred car park where available, and in the nearest adjacent car park if their usual car park did not include a charge point. The charge points were also allocated on the basis of ensuring a wide range of charge point types were utilised.

4.2.6. It was notable that a number of EV owners declined to take part in the pilot, with some stating they would not wish to use a charge point if it meant having to park in an adjacent car park further from their flat. This serves to emphasise how essential it is for the charge points to be convenient, as in this case the charge points and electricity are being offered for free for the duration of the pilot at least, and these were still declined in some cases. Other residents declined as they used charge points external to the Barbican Estate, or because they parked their vehicle somewhere other than the Barbican car parks.

4.2.7. It is also notable that whilst the majority of the participants (11) joined the scheme in May when it was launched, a number (4) joined only for the remaining 2 months of the scheme, including the two ZipCar vehicles, which were delayed to due concerns from the operator over the small parking bays they were initially allocated, as well as contractual issues.

---

[5] **Electric Vehicle (EV)** – also referred to in the UK as an Ultra-low Emission Vehicle (ULEV) – a collective term for vehicles using low carbon technologies, produce less than 75g of CO_2 per Kilometre driven, and are capable of operating in zero tailpipe emission mode for a range of at least ten miles. This can include different types of vehicles, including BEVs and PHEVs

[6] **Plug-in Hybrid Electric Vehicle (PHEV)** - A vehicle which combines a battery, electric drive motor and an internal combustion engine (ICE) and the ability to charge the battery from an external power source. The vehicle can be driven by the ICE, by the electric drive motor, or both together.

[7] **Battery Electric Vehicle (BEV)** - A vehicle powered only by electricity. The vehicle is charged by an external power source and incorporates regenerative braking which helps to extend the available range.

Table 4-2 – Pilot Scheme Participants

Participant	Vehicle Type	Building	Working Status	Allocated Charge Point
Resident 1	BMW i3 (BEV)	Frobisher Crescent	Full Time Employment	▪ 3kW Charger ▪ Lockable Key ▪ Breton Car Park
Resident 2	BMW i3 REX (REEV)	Ben Jonson House	Full Time Employment	▪ 3kW Charger ▪ Lockable Key ▪ Breton Car Park
Resident 3	VW Golf GTE (PHEV) -	Ben Jonson House	Retired	▪ 3kW Dual Charger ▪ RFID Access ▪ Bunyan Car Park
Resident 4	TBC (PHEV)	Shakespeare Tower	Not known	▪ 7kW Dual Charger ▪ RFID Access ▪ Bunyan Car Park
Resident 5	BMW X5 (PHEV)	Shakespeare Tower	Full Time Employment Young Family	▪ 7kW Dual Charger ▪ RFID Access ▪ Bunyan Car Park
Resident 6	TBC (PHEV)	Lauderdale Tower	Not known	▪ 22kW Dual Charger ▪ RFID Access ▪ Thomas More Car Park
Resident 7	Mitsubishi Outlander PHEV (PHEV)	Lauderdale Tower	Retired	▪ 22kW Dual Charger ▪ RFID Access ▪ Thomas More Car Park

Resident 8	Mercedes C350E plug-in hybrid (PHEV)	Willoughby House	Retired	▪ 7kW Dual Charger ▪ RFID Access ▪ Willoughby Car Park
Resident 9	VW Golf GTE (PHEV)	Speed House	Full Time Employment	▪ 7kW Dual Charger ▪ RFID Access ▪ Willoughby Car Park
Resident 10	VW Golf GTE (PHEV)	Willoughby House	Not known	▪ 7kW Charger with tethered cable ▪ Lockable Key ▪ Willoughby Car Park
Resident 11	BMW 225XE (PHEV)	Frobisher Crescent	Retired	▪ 22kW Charger ▪ Lockable Key ▪ Cromwell Car Park
Resident 12	Mercedes E350e (PHEV)	Cromwell Tower	Retired	▪ 22kW Charger ▪ Lockable Key ▪ Cromwell Car Park
Zipcar 1	VW E-Golf (BEV)	N/A	N/A	▪ 7kW Dual Charger ▪ RFID Access ▪ Willoughby Car Park
Zipcar 2	VW E-Golf (BEV)	N/A	N/A	▪ 7kW Dual Charger ▪ RFID Access ▪ Willoughby Car Park
City of London Mail Van	VW E-Crafter (prototype) (BEV)	N/A	Full Time Employment	▪ 7kW Dual Charger ▪ RFID Access ▪ Thomas More Car Park

5. PILOT STUDY FINDINGS – USER EXPERIENCE AND ELECTRICITY USAGE

5.1. MONITORING AND STAKEHOLDER ENGAGEMENT

5.1.1. This chapter draws together and summarises the findings of the monitoring and stakeholder engagement, approved by the Working Party, undertaken throughout the pilot study, including:

- **Baseline survey** of Barbican residents – completed February to June 2018
- **Interim survey** of residents participating in the pilot study – August to September 2018
- **One-to-one interviews** with a sample of participating residents and other stakeholders – October 2018
- **Workshop** with residents participating in the scheme and other interested residents – November 2018
- **Charge point usage data and electricity consumption** - duration of pilot study (May to November 2018

5.2. BASELINE FINDINGS

5.2.1. Prior to the pilot study beginning, a web survey was undertaken to establish the baseline position for a range of factors that have bearing on the current and future EV charging infrastructure requirements of the Barbican residents.

5.2.2. The factors and parameters the survey sought to establish included:

- Current level of EV ownership by Barbican Estate residents
- Attitudes to EVs and vehicle purchasing plans
- Charging requirements – actual and perceived
- Preferred charger types and arrangements

5.2.3. The baseline survey was developed as a web survey, with participants routed to applicable questions based on their preceding answers. The survey was widely publicised in the Barbican Broadcast weekly email received by subscribed residents, through posters in communal areas and information boards across the Estate, and leaflets in the reception. It was also publicised through posters and leaflets within each block. It was also promoted at the launch event at Ironmongers Hall on 23rd May.

5.2.4. In total 81 residents responded to the survey – which equates to approximately 4% of flats (2,059), or 2% of residents (4,500 to 5,000).

Car Ownership and Sample Rates

5.2.5. Whilst this is a relatively low sample rate, based on the preceding analysis in Chapter 4 of the number of resident car park permits issued (927), vehicle ownership at the Barbican is relatively low (0.45 cars per flat), which is not unexpected given the central location of the site and the excellent access to public transport and local amenities. As such, the survey will only be directly relevant to a proportion of the Barbican residents.

5.2.6. 64% (52) of respondents to the baseline survey owned a car. 10% (11) of the respondents owned more than one vehicle (1.2 on average).

5.2.7. In total, the survey respondents made up 7% (64) of the all resident permits (927) at the Barbican, so provides a reasonable representation of the baseline position.

Current EV Ownership

5.2.8. 24% (12) of all survey respondents owned a plug-in electric vehicle (including hybrids)

5.2.9. It is important to recognise however that the nature of the survey will likely have attracted a disproportionately high response rate from EV owners relative to conventional EV owners.

Plans to purchase or replace a vehicle

5.2.10. Residents were asked whether they plan to purchase a vehicle, or replace their existing vehicle. 69% (27) of those that responded to the question (39) advised they did, with 30% (8) of these considering doing so in the near term (within the next 6 months). Most were planning to so in the longer term (63%, 17).

5.2.11. 91% (39) of those that responded said they would consider purchasing an electric vehicle, with:

- 28% would consider a BEV
- 63% would consider a PHEV/ REEV

5.2.12. Of the remaining 9% of respondents, 2% were not sure and 7% would not consider purchasing an EV.

5.2.13. These findings correspond with an earlier survey of residents undertaken in 2014, which revealed that 150 residents would consider buying an EV, with 22 actively planning to do so.

5.2.14. It should be noted that since the baseline survey was undertaken the Government has withdrawn the plug-in car grant for PHEVs, and reduced it from £4.5k to £3.5k for BEVs, which will likely have a bearing on future purchase decisions.

Key factors influencing resident decisions to purchase an EV

5.2.15. Respondents were asked to rank which factors would be more key in informing their decision to purchase an electric vehicle.

5.2.16. The key factors prioritised by respondents were:

1	Availability of charge points overnight
2	Wider availability of charging points
3	Wider availability of rapid charge points
4	Vehicle price
5	Availability of electric vehicle (EV) models that appeal to me
6	Vehicle range (miles per charge)
7	Availability of allocated parking for EV users across London
8	Introduction of Ultra Low Emissions Zone

9	Exemption from Congestion charge
10	Ethical reasons - improving local air quality
11	Other anticipated charges for non-ultra-low emissions vehicles
12	Ethical reasons - wider environmental benefits
13	Enjoyment of new technology

5.2.17. The “Availability of charge points overnight” was considered a high priority amongst all respondents.

Parking Arrangements

5.2.18. Most, but not all, of the residents park their vehicle at the Barbican. 90% (46) of respondent’s park at the Barbican, with 10% (5) parking elsewhere.

Preferred Charge Point Access

5.2.19. There was a preference amongst respondents for either charging via a dedicated charge point, or the option for faster charging from a shared communal charge point used by a number of residents.

Table 5-1 – Residents Preferred Charging Arrangements

5.2.20. Resident who owned EVs or are considering buying on were asked their preferred charging options. Residents were able to select multiple responses.

Charge Point Type	Resident Preferred Options	
Charging via a dedicated charge point, for use by you only	15	42%
Occasional charging via a shared charge point, used by a number of residents	3	8%
Fast charging from a shared communal charge point, used by a number of residents	11	31%
Occasional rapid charges at intermediate locations, with occasionally top up charges at home when necessary/available	3	8%
Not Sure	4	11%

Resident Mileage and Travel Trends

5.2.21. Residents were asked “What is your estimated typical annual mileage?” and “What do you estimate your mileage to have been over the past week?”

Table 5-2 – Residents Estimate Annual Mileage

Annual Mileage	Respondents	
0-1,000 miles	2	6%
1,001 - 5,000 miles	10	29%
5,001 - 10,000 miles	16	47%
10,001 - 20,000 miles	6	18%

Table 5-3 - Residents Estimate Mileage in the past week (Spring 2018)

Mileage over the past week	Respondents	
10-50 miles	9	24%
51-100 miles	8	22%
101-200 miles	6	16%
201-300 miles	3	8%
I have not driven any miles	11	30%

5.2.22. As would be expected given the location of the Barbican, the typical mileage by vehicles is low compared to the average UK mileage (7,800 miles).

5.2.23. Respondents were asked whether this was representative of how many miles they ordinarily drive per week - 67% answered yes, 18% answered “No - I drove more miles than I usually would” and 15% answered “No - I drove less miles than I usually would”. On balance therefore, we can reasonably infer that the responses are broadly reflective of typical mileage.

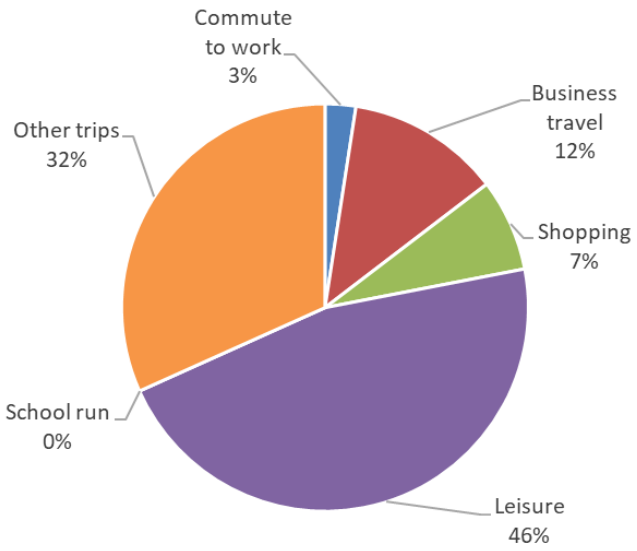
Journey Purpose

5.2.24. The journey purposes of trips made in cars by Barbican residents was most commonly for leisure purposes (46%), or other trips (32%), with very few of trips made up by commuting to work (3%) or business travel (12%).

5.2.25. These findings correlate with some of the related findings around low mileage, reflecting the very central location of the Barbican, and the more convenient access to employment and business travel by walking, cycling and public transport. Consequently, cars are instead primarily used for leisure purposes, such as weekend travel out of London.

5.2.26. The ‘other trips’ may correspond with the findings of some of the surveys and interviews, where residents had a second home, and were based in the Barbican during the working week, travelling back to their other home at weekends.

Figure 5-1 – Journey purposes of car travel by Barbican residents



Charging Habits of Existing EV Owners

5.2.27. For those Barbican residents who are EV owners, less than half (43%) were aware of any convenient intermediate or destination charging opportunities they could have used, or did use, over the past week.

5.2.28. 50% of those aware of an option had used them once within the past week, the other 50% had not.

5.2.29. Whilst these responses only represent a very small sample size, they provide some interesting insights into the extent of the role of public charging infrastructure for the Barbican's existing EV owners, which could be summarised as limited. With approximately only 1 in 4 using a public charging point in a week.

5.2.30. The reasons cited by those that did use intermediate chargers were:

- "Convenience (was going nearby anyway - opportunity charging)"
- "Rapid charge times"
- "I am unable to charge at home"

5.2.31. The reasons given by those who hadn't used an intermediate charger in the last week were:

- "I did not encounter any"
- "Inconvenient (i.e. didn't otherwise need to be there)"

5.2.32. Participants were also asked whether they considered using any convenient workplace charging opportunities over the past week.

- Yes 14% (1)
- No 86% (6)

5.2.33. The reasons given by those who hadn't used a workplace charger in the last week were that "none were available"

5.2.34. This finding serves to highlight the continued importance of home charging in enabling EV uptake.

Range Anxiety

5.2.35. Participants were asked whether they have ever experienced range anxiety (i.e. worrying that you might not have enough charge to reach your destination)

- Yes 28% (2)
- No 72% (5)

5.2.36. This finding is a common one amongst EV owners, and whilst a quarter of respondents reporting themselves as having encountered range anxiety is problematic, it is a lower proportion of respondents than many non-EV drivers often anticipate.

5.2.37. Have you ever found you've not had sufficient charge at the start of the day to meet your needs for that day without supplementing the overnight charge?

- Yes 43% (3)
- No 57% (4)

5.2.38. This is a less encourage finding and highlights more work is needed to better support EV uptake, as more mainstream, less committed EV purchasers are less inclined to tolerate such inconveniences.

Perception of Electricity Cost

5.2.39. EV owners were asked to estimate their monthly spend on electricity for charging their vehicles:

Table 5-4 – EV owners estimated monthly charging costs

Residents EV	Residents estimated monthly spend on electricity	Residents estimated annual spend on electricity	Estimated annual kW demand for EV charging[1]	Estimated electric powered mileage per annum[1]
BMW i3	£20	£240	800-1,846	3,200-7,385
BMW i3 REX	£5	£60	200-462	800-1,846
BMW i3	£250	£3,000	10,000-23,077	40,000-92,308
BMW225XE	£26	£312	1,040-2,400	4,160-9,600
Golf GTE	£1	£12	40-92	160-369
MB E350 e	£10	£120	400-923	1,600-3,692

Note: [1] assumes 13p (standard domestic rate) or 30p per kW (typical public charge point cost) and 4 miles per kW charged (average mile per kW of electricity, subject to conditions such as driving style and temperature)

Residents Current Occupation

5.2.40. 70% of all the respondents to the baseline survey were in full or part-time employment.

Table 5-5 – Current occupation of respondents

Current Occupation	Responses	
In full-time employment (30 hours or more per week)	39	59%
In part-time employment (less than 30 hours per week)	7	11%
Student (full time)	0	0%
Student (part time)	0	0%
Retired	13	20%
Not currently in employment	3	5%
Other	4	6%

Mobility Issues

5.2.41. 5% (3) of all the respondents declared they had mobility issues or special access considerations.

Key findings

- Low car ownership
- Low mileage
- Strong interest in EVs
- EVCPs for overnight charging seen as a key precondition
- More suited to PHEVs in some cases, longer distance but infrequent drives to second homes etc.

5.3. INTERIM SURVEY FINDINGS

5.3.1. The participants in the pilot study were contacted to take part in an interim survey midway through the 6-month period in August-September 2018.

5.3.2. Participants were asked how many times they had used their allocated residents EV Charging point throughout the course of the pilot period to date (from mid-May onwards).

Table 5-6 – Participants usage of allocated charge point (May-August 2018)

Charge Point Usage	Number of Participants	Percentage of Participants
10 times or more (more than once a week)	3	21%
6 to 9 times (roughly once a week)	4	29%
3 to 5 times (roughly twice a month)	2	14%
Up to 3 times (once a month)	4	29%
Never	1	7%

5.3.3. The responses correspond with the relatively low levels of electricity consumption recorded in the parallel monitoring (see section 5.6), with 50% of participants having used their charge point less than once a week within that week.

5.3.4. Participants who responded 'Never' were asked if there was any reason they have not used their charge point throughout the course of the pilot period, and the participant advised thus was because "No charge required (battery fully charged)". The low levels of usage observed likely correspond with the low mileage and high proportion of PHEVs amongst the vehicles in the pilot.

5.3.5. To provide a snapshot of usage in the past week specifically, where respondents are likely to be more accurate in recalling their activities, participants were also asked how many times they had used their allocated charge point.

Table 5-7 - Participants usage of allocated charge point in the past week

Charge Point Usage	Number of Participants	Percentage of Participants
More than 6 times	1	8%
3 to 4 times	2	15%
1 to 2 times	5	38%
Not at all	5	38%

5.3.6. This also found relatively low levels of charge point usage, with 38% not having used their point at all that week, though 62% had said used at least once in a week. Interestingly these responses suggest slightly higher usage levels than the estimates over the course of the pilot, possibly indicating some increases in usage as their familiarity with the points has developed, or their routines have adapted away from previous charging regimes to utilise the home charging option.

5.3.7. For the respondents who had not used the points, the following reasons were given:

- Have not used or planned to use my car
- Have not used or planned to use my car in electric mode (if hybrid)
- Charged elsewhere
- Away on summer holidays

Experience of using the charge point

5.3.8. Participants were asked to describe their experience of recharging their electric vehicle using their allocated charge point.? They were able to select multiple responses where applicable.

Convenient	7	(33%)
Straightforward	10	(48%)
Reasonable	3	(14%)
Poor	0	(0%)
Problematic	1	(5%)

5.3.9. The majority of responses were positive, with 81% of responses describing the charge points as either straightforward or convenient, and a further 14% were neutral, describing their experience as reasonable. Only 5% of responses were more negative, describing some of their experiences as problematic. In the participant's own words, some of the problems encountered when trying to recharge their electric vehicle included:

Access issues to charge point:

- City trial electric van parked (not charging) in Bay 1 preventing use.
- Parking space is minimal as I have a large saloon.
- There have been issues with non-electric vehicles using the bays for parking.
- Bicycles parked nearby preventing me reversing into the bay.

Charge point not conveniently located:

- There are no points in Shakespeare Tower car park so needs an extra trip

Technical faults/ limitations with the charge point:

- Takes overnight to charge.
- The instructions on screen are confusing and don't update when charging is 'on'. And the screen shows charging in tiny numerals inconspicuously at the bottom of the screen. Difficult to check all is well!
- Once it did not charge, but that was probably my fault

Administrative/ Management error:

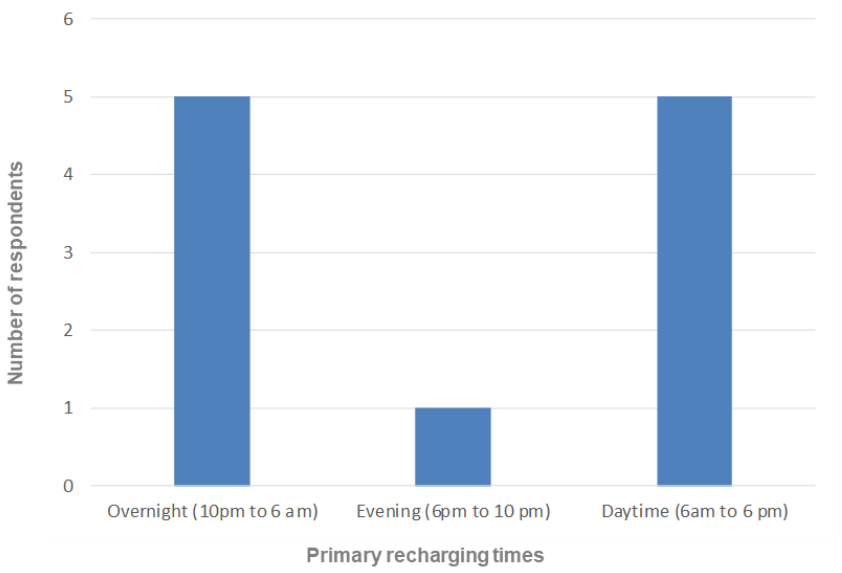
- Key allocated to me was incorrect.

5.3.10. The nature of the responses given in terms of problems encountered underline that for the most part the charge points themselves perform effectively. The only issues referenced that relate to the charge points themselves are regarding the power rating (i.e. the slow chargers require overnight charging to achieve a full charge), or secondary issues regarding the display screen, and a possible user error.

5.3.11. The remainder of the issues relate largely to access issues, with a number of users encountering obstructions to accessing their charge point, issues with the size of the parking bays, or a lack of charging points in the applicants' usual car park. These issues are within the remit of the parking management team as opposed to the charge points themselves, as was the administrative error regarding the wrong key being allocated to a user for their designated charge point.

Charging Times

5.3.12. The participants typical charging times are unusual relative to typical residential settings, with as many vehicles being charged during the daytime as overnight. This probably relates to some of the earlier findings whereby typical vehicle trips were not for commuting or business travel, but rather for leisure uses or travelling to second homes. In some cases, participants park and charge at the Barbican during the day whilst at work, and travel to a second home in the evening.



5.3.13. To provide a snapshot of vehicle usage in the past week specifically, where respondents are likely to be more accurate in recalling their activities, participants were also asked how many miles they had driven in the last week.

Table 5-8 - Participants mileage in the past week (Summer 2018)

Charge Point Usage	Number of Participants	Percentage of Participants
Up to 10 miles	1	8%
10 – 50 miles	1	8%
51 – 100 miles	2	17%
101 – 200 miles	4	33%
More than 300 miles	1	8%
I have not driven any miles	3	25%

5.3.14. The results indicate a significant degree of variation in the miles travelled by Barbican EV owners.

5.3.15. 58% (7) of participants drove fewer than 100 miles a week, including 3 respondents who did not drive any miles.

5.3.16. There were a number of participants (41%, 5) however whose mileage was more typical of average weekly vehicle mileage.

5.3.17. The participants responses indicative a slightly higher weekly mileage as compared to the baseline survey responses in the Spring, where 30% of respondents had not driven any miles, compared to 25% amongst the respondents in the Summer. It should though be noted that the baseline survey was open to all Barbican residents, whereas the interim survey was targeted at the pilot study participants.

5.3.18. Respondents were asked whether this was representative of how many miles they ordinarily drive per week - 50% answered yes, 30% answered “No - I drove more miles than I usually would” and 20% answered “No - I drove fewer miles than I usually would”. On balance therefore, we can reasonably infer that the responses are broadly reflective of typical mileage.

Intermediate or destination charging opportunities

5.3.19. 82% (9) participants were aware of some convenient intermediate or destination charging opportunities they could have used over the course of the pilot project.

Table 5-9 - Participants usage of intermediate/ destination charge points in last month (August/ September)

Charge Point Usage	Number of Participants	Percentage of Participants
Up to 3 times (once a month)	4	40%
3 to 5 times (roughly twice a month)	2	20%
6 to 9 times (roughly once a week)	1	10%
10 times or more (more than once a week)	2	20%
Never	1	10%

5.3.20. The type of intermediate or destination charge points participants had available to them were:

- Standard Charge point (3-7.5kW) 5 63%
- Fast Charger (11-22kW) 1 13%
- Rapid Charger (45kW+) 2 25%

5.3.21. Respondents typically used these charge points to fully charge their vehicles. We understand a number of the respondents have a charge point at their second homes, and so some of these figures will include home charging. It also was not clear from the responses whether a full charge was interpreted as topping up the vehicle until the battery was charged to 76% or more of its capacity, or whether electricity 76-100% of the battery capacities power had been drawn from the charge point.

▪ Full charge (76% or more)	5	56%
▪ Medium refill (34-75%)	2	22%
▪ Top up (33% or less)	1	11%
▪ Nothing	1	11%

5.3.22. Participants gave the following reason for using these charge points:

Opportunity Charging:

- Because I can: it is at a destination
- Convenience and inclusive parking
- Availability to top up

Second home with charge point:

- My main home in Buckinghamshire has one.
- car is based in oxford, periodic use in London

Necessary intermediate charging:

- Ran out of charge - longer journey
- To improve range

Range Anxiety

5.3.23. Participants were asked whether they have ever experienced range anxiety since the Barbican's charge points were installed - 83% (10) said no, 17% (2) said yes.

5.3.24. Whilst this figure is taken from a small sample size, this represents an improvement from the baseline survey, where a quarter of respondents had encountered range anxiety. This improvement may be attributable to the provision of the pilot scheme charge points, though it should be noted it will also depend on other factors, such as trip lengths, and the precise nature of the range anxiety.

5.3.25. Respondents were also asked whether throughout the pilot scheme to date, they had ever found that, despite overnight charging, they did not have sufficient charge at the start of the day to meet their needs. 83% (10) had not encountered such an issue, 17% (2) had, an improvement on the baseline survey results (5.2.36) which showed 43% if respondents had insufficient charge after overnight charging. Despite the improvement, this in combination with the feedback on intermediate charging highlights the essential role of wider charging infrastructure.

5.3.26. Participants were also invited to provide any other comments regarding the pilot scheme:

For me it works very well, and ensures that emissions in central London are kept to a minimum.

I have been allocated a dedicated charging space, which is great.

Very well-run scheme

The charge points are relatively basic when compared to fast charge points, and similar points available in public car parks. I would rather have a card to access the charge point than a simple key. I have also had a problem with the power supply to my designated charge point. However, in other respects the service is ideal.

My car is a plug-in hybrid that spends more time in oxford than London. Simplicity and flexibility (and not necessarily a dedicated own point) is needed.

My car is a PHEV, with an electric range of only about 10 miles in London. This is fine for many trips, but it is very inconvenient to take the car to another car park to charge each time it's used, the novelty wears off pretty quickly.

There have been problems with non-electric vehicles, especially contractors, using the bays for parking.

I have a plugin hybrid, so range is not a big issue. Most of my local journeys are in EV mode

Having to use my own type 2 charging cable makes charging cumbersome and time consuming, as I have to unlock my car, unwind the cable, plug in and the. Then repeat the reverse process to move the car. I have two children to load into car in most cases, and this process can be quite taxing.

I think it is a great project, even though I haven't recharged my car very often.

Key findings

- The majority of responses were positive, with 81% of responses describing the charge points as either straightforward or convenient
- Scheme well run, works well, enables more driving in EV mode for PHEVs
- Issues encountered generally not with charge points themselves, access issues
- Low usage - not used, or not used in electric mode (if hybrid)
- Charged elsewhere – opportunity charging, second homes
- Charging times unusual – equal split between daytime and evening
- Very inconvenient to take the car to another car park to charge
- Preference for tethered
- Basic chargers - rather have a card to access the charge point than a simple key

5.4. ONE TO ONE INTERVIEWS

One-to-one interviews with stakeholders

5.4.1. One-to-one interviews were undertaken with a sample of the participating residents, as well as a number of other stakeholders, including Barbican Estate officers. They also included a representative from ZipCar.

5.4.2. These enabled us to explore in further detail their experiences, and to understand some individual perspectives from each stakeholder group.

Table 5-10 – One-to-one Interviews – stakeholders and interview dates

Stakeholder	Interview Date
Resident 1	22nd August
Resident 2	23rd August
Resident 3	5th September
Resident 4	20th August
Barbican Estate Manager – Shaun Moore	17th August
Barbican Estate Head – Michael Bennet	21st August
Barbican Estate Car Park Management - Muhammed Muhid	29th August
ZipCar - Jonathan Hampson	4th September
Chargernaster – Kevin Howle	2nd November

Table 5-11 – Pilot Scheme Participant Interviews – Charge Point Users (Residents and Cars)

Interview Discussion Topics	Resident 1	Resident 2	Resident 3	Resident 4	Car Club
Electric Vehicle Type	BMW i3 (BEV)	BMW 225xe (PHEV)	Mercedes e-350e (PHEV)	BMW X5 (PHEV)	VW E-Golf x 2 (BEV)
Occupational Status	Full Time Employment	Retired	Retired	Full Time Employment Young Family	Car Club Operator
What is your mileage/ driving habits?	▪ 200 miles a week ▪ 10,600 miles annually	▪ 5,001 - 10,000 miles annually ▪ Main home in Oxfordshire, stays at Barbican 3 nights a week	▪ Typically, short journeys (10-15 miles) journeys around town in electric mode ▪ 4,500 miles annually	▪ 5,001 - 10,000 miles annually	▪ Vehicle available for booking by members ▪ No car club vehicles were operating from the Barbican at the time of the interviews
What are your charging habits?	▪ Commutes to the Barbican ▪ Live in Windsor, hardly use car at all from the Barbican – 25 miles door to door. ▪ Park and charge at Barbican and walk to office.	▪ EVCP at Oxfordshire home, charge overnight and daytime ▪ Doesn't use intermediate/ destination EVCPs often ▪ PHEV so don't need to. Not many and poor quality, often in use.	▪ Parks and leave the vehicle plugged in within their allocated Barbican bay charging over-night, could be plugged in for several days at a time.	▪ Vehicle only does around 10 miles on battery. Adequate for many trips. ▪ Charging point not available in my regular car park and inconvenient using allocated charge point after every journey. ▪ Novelty soon wore off, so haven't used it much.	▪ Elsewhere their E-Golf vehicles are parked and charged in on-street bays. ▪ The challenge is encouraging the users to plug them in rather than staff. ▪ They find user are more likely to plug it in if the car is plugged in when collected.

How did they charge before the scheme?	▪ Polar scheme member – used Rapid chargers near Heathrow. ▪ Never previously charged at Barbican via 3-pin plugs	▪ Prior to the scheme typically commuted back home using petrol engine ▪ Charged at second home. ▪ Previously the nearest EVCP were Smithfield NCP, but these had an issue with there being no signal, so could not see if available/ working remotely.	▪ No charging option at the Barbican prior to the pilot. ▪ First 9 months owned cars ran in petrol and charged up off that – did plug into ▪ Use EVCPs at Sainsburys or sometimes Park & Rides, but only if on route/ convenient as not essential.	▪ Previously charged elsewhere, and travelled more miles using petrol engine.	▪ Did not operate EVs at the Barbican prior to the scheme
What charge point are you using?	▪ 3kW Charger ▪ Lockable Key ▪ Breton Car Park	▪ 22kW Charger ▪ Lockable Key ▪ Cromwell Car Park	▪ 22kW Charger ▪ Lockable Key ▪ Cromwell Car Park	▪ 7kW Dual Charger ▪ RFID Access ▪ Bunyan Car Park	▪ 7kW Dual Charger ▪ RFID Access ▪ Willoughby Car Park
What has your experience been so far?	▪ Schemes been good and fit for purpose ▪ Experienced a malfunction with a point, contacted Barbican Estate Office. ▪ Appreciates that it provides free charging. ▪ Feels the charge points deployed are quite restrained – in terms of numbers and quality.	▪ Not many issues, works well ▪ Knows to get in touch with Estate team if issue ▪ A more general issue is the size of parking bays – too small for larger vehicles ▪ Issue with parts of the car park being wet and potentially unsuitable for EVCPs.	▪ Schemes worked fine, everyone's been responsive. Less likely to charge elsewhere now. ▪ Locking/ unlocking issues, but not too bad. Cable has jammed, then won't charge. ▪ Key operated, rather than connected so Chargemaster need to reset it rather than car park team.	▪ The equipment works fine ▪ Tethered cable would be preferable.	▪ N/A - at the time of the interviews no car club vehicles were operating from the Barbican ▪ Bays made available in Bunyan Car Park were too small – cars were only an inch apart, and car club members are occasional drivers, risks damaging expensive new EVs.

			▪ Process of dealing with issues needs to be refined. ▪ Allocated parking spaces in Cromwell tower are incredibly tight spaces.		
What are your charging preferences in terms of fast, rapid (destination or intermediate), overnight, during day, work etc?	▪ Slow chargers are fine for residential charging – 100% charge on slow gives 160 miles, 100% charge on rapid only 130 miles. ▪ Dislikes using on-street EVCPs, prefers rapids for on-street charging.	▪ Prefers charging via a dedicated charge point. ▪ Fair way down from flat so prefers dedicated bay to having to move the vehicle.	▪ Would be concerned if charge points were provided on a communal scheme – feels it wouldn't work well. ▪ Would prefer to charge via a dedicated charge point. ▪ Anticipates switching to a BEV at some point from a PHEV, though would still only need low charge rates.	▪ Would prefer to charge via a dedicated charge point. ▪ Car is a PHEV so even a regular 13A socket would be OK. ▪ Only use car when needing to cart around their young and their clobber so place a high premium on the car being easily accessible from the flat, not in a neighbouring car park.	▪ 7Kw chargers are fine, though less good over weekends
What's your view in terms of how barbican should deliver these charge points?	▪ Feels allocated slow chargers work well. ▪ Payments for electricity should on a per kWhr basis.	▪ Would be willing to pay capital cost for putting EVCP in. ▪ Anticipates metering to charge per kW would add lots of cost, so may be best to add costs into parking permits.	▪ Quite happy to pay for own point to have unfettered access, more convenient ▪ Would prefer to pay per kW hr, feels it would be fairer as power needs will differ	▪ Once charging points are put into Shakespeare I would expect to be an enthusiastic user	▪ Could operate on the basis of a fixed cost per hour, or on account, per kW. ▪ Would be a bulk user.

Other Comments / What else could be done to promote EV uptake?	▪ Other residents are well aware of pilot scheme EVCPs having been installed – well publicised. ▪ Feels take up of EVs will continue to be fairly slow however.	▪ Feels pilot scheme right thing to do. ▪ City is making right noises, but needs to work with the Mayors team. ▪ Notes that an increasing proportion of Barbican parking is utilised by non-residents	▪ Awareness raising - Feels continuing to promote that the future will be EVs is beneficial - lots of people still worry about range, whether tech still improving, many unaware of the grant. ▪ Feels increasing parking charges are driving people to not replace their car, and instead switch to Zipcar. ▪ Feels in the longer term the value of flats will fall if no EVCPS are available given it is in ULEZ, so now is a good time to prepare		▪ Would very much like to offer EV car club vehicles more widely in the City, but as it charges business rates on off-street parking bays, which in the City are very high, rates, more than the bay lease, they are not commercially viable. ▪ Feel the City need to take a joined approach across departments ▪ Interested in utilising any rapid chargers in central London in order to support their Zipcar Flex vehicles.

Charge Point Hosts - Barbican Estate

5.4.3. In addition to the EV owner participating in the scheme, the hosts (the Barbican Estate team) are a key stakeholder, and must be content that the charge points can be managed and administered effectively, operationally and commercially, as a new function of the car parks they manage.

5.4.4. The Barbican Estate representatives interview as part of the study were:

- **Property Services Manager** – responsible for overseeing contractors including the electrical engineers who installed the charge points, and would install future charge points.
- **Head of the Barbican Estates** – responsible for heading the working parties with a strategic decision-making function, including investment plans infrastructure such as charge points, and pricing regimes.
- **Estate Services Officer** – responsible for providing administrative support as part of the car park team, including processing applications and payment for parking spaces and charge point maintenance.

5.4.5. The feedback provided by these staff is summarised below:

Charge point installations:

- Difficulties were encountered around the installations, particularly with UKPN regarding the installation of meters, resulting in delays to the project. The main problem was finding the right person to speak to push through the application, and the process took 5-6 months in total to complete.
- They also required UKPN to advise on the available electrical supply. Their experience was that the charge point supplier and their electrical engineers asked them what they wanted in terms of charge points, and then determined the resultant electrical supply demand. The Barbican Estate team then requested 100KVA from UKPN, with the cost of the upgrade paid by LEN project.
- They noted that a more joined up approach would have been preferable, whereby UKPN advised on the available capacity, and the charge point supplier then sought to advise what could be delivered within that, depending on the charge point types deployed. Otherwise, if all the charge points were on at same time, it would have meant needing to upgrade the transformer.

Observations on the scheme to date:

- The team felt the scheme was going well, and noted they had anticipated issues, but there had in fact been very low maintenance required generally.
- It was noted there was a slight lack of scheme participants, as not all of the EVCPs are being used.

Charge point maintenance/ responding to issues:

- Their experience was that generally the management and administration of the charge points had generally been fine so far. There had been some minor issues, some of which they noted was maybe their fault for not overseeing the installations more closely. Next time they would consider having an external commissioning engineer to oversee the works.
- When issues have arisen, generally residents have contacted the LEN project team, who have in turn re-direct residents to the car park team.
- Chargemaster have helped when needed, particularly with the installation, and when a resident got their cable stuck in a lockable charger. They have found Chargemaster can generally

remotely check and often fix issues. On another occasion they asked the Barbican Estate team to deactivate a point, but they were not initially sure how to, so it has been a learning curve.

Initial preferences in terms of charge point types and delivery models:

- It was noted that many residents leave their cars parked overnight, and are not heavily used, so felt lower powered units may be adequate, but were unsure and seeking guidance from this study.
- The team would prefer all points are RFID and connected, as they have found these units are much easier to administer, and Chargemaster can support these remotely.
- There were some concerns over how additional EVCPs might be funded and delivered beyond the LEN project.

Some mixed views on how best to levy charge point user charges:

- With some preferences for PAYG/ per kWh billing
- And others preferring for charges to be levied as quarterly surcharges on the existing permit charges for EV bays over a standard bay.

Charge point application process:

- The parking team anticipate that residents would be required to fill out a parking application as per the current process, but with additional sections for requesting an EVCP.

Other comments - use of car parks longer term, access arrangements

- Concerns were expressed over the long-term trend of falling car park occupancy (1-5% per year), which poses challenges in terms of covering the overheads associated with operating and maintaining the car parks.
- Staff advised of a reluctance from some residents to open up access to underutilised car park spaces for alternative uses and revenue generation opportunities.
- Suggestion that future EV charging bays would be the width of 2 normal parking bays so as to allow for access requirements to charging units and consideration of size of EVs. Follows the precedence being built into future planning car park policy this year where disabled bays will be the width of 2 car parking bays.

Key findings

- Scheme well received
- Low maintenance from host perspective
- Straight forwards for users
- Clear preference for dedicated bays
- Convenience is key – many of the residents EVs are PHEVs, so it may be a marginal decision to charge or simply use the petrol engine. Inconvenient charge point access may discourage uptake too in marginal cases where a prospective buyer is unsure on whether to commit to an EV.
- Satisfied with the charging rates (typically 3-7kW) of the existing charge points.
- Per kW hr charge preferred
- Price elastic, willing to pay for EVCP to install in order to secure dedicated unit
- Awareness raising need recognised to encourage further uptake
- Scheme well received, operated smoothly for the most part
- Issues where EVCPs not connected units, hard to remote manage

- Parking bay size to be reviewed – again, convenience is key, have spare capacity
- Car clubs offer potential for good revenue stream, bulk users
- Lessons learnt regarding the charge point installation, including establishing available capacity with UKPN and then work within that where possible
- Plan to oversee the EVCP installations more closely, would consider having an external commissioning engineer
- When issues have arisen, generally residents have contacted the LEN project team
- Parking team would prefer all points are RFID and connected
- Some concerns over how additional EVCPs might be funded and delivered beyond the LEN project

5.5. WORKSHOP

5.5.1. The workshop for participants in the pilot study near the end of the 6-month period provided an opportunity to feedback on the emerging findings, and invite feedback and capture any additional observations or suggestions to factor into the final reporting and recommendations.

5.5.2. A total of 12 attended the workshop, 4 of which were residents participating in the scheme.

5.5.3. A summary of the notes taken from the workshop is provided below:

General comments on the pilot scheme

- There was agreement amongst those participating that charge points provided had generally worked well and proven fit for purpose.
- Others attending who were in the process of purchasing an EV, or were considering doing so were interested to hear the experiences of existing EV owners.
- Discussion over the necessity of installing charge points rather than a series of 3-pin plugs.

Issues encountered by participating residents

- Some issues with charge point bays occasionally being blocked – including by the City Post Van,
- Some minor issues regarding faulty or unclear display screen instructions on the charge point units.
- A charging cable was jammed and stuck in one of the lock and key charge points.
- Discussion over issues with the size of car park bays being too small for many larger new vehicles.

Feedback received regarding additional considerations for future roll-out of charge points

- Some felt charge point users would benefit from a few more instructions initially
- There was interest from some residents in utilising the government grants for home chargers in installing future charge points. It was confirmed that the LEN project team have previously confirmed this is possible in the context of the Barbican.
- A City of London Corporation Wi-Fi programme that is currently being rolled out was discussed should it be helpful in enabling charge points in basements not currently accessible by mobile or Wi-Fi signals.
- Some would prefer tethered charge points for the added convenience they offer.

5.6. CHARGE POINT USAGE AND ELECTRICITY CONSUMPTION

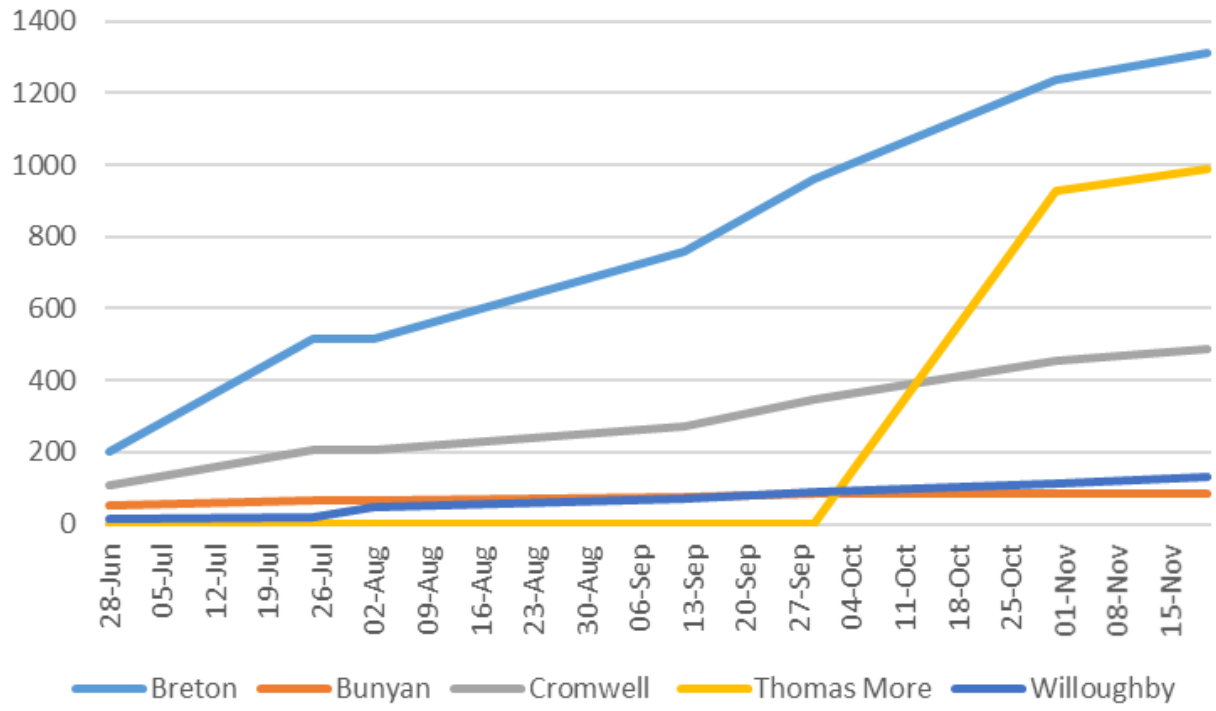
5.6.1. The total electricity consumption through the charge points by electric vehicles participating in the pilot was almost exactly 3 Megawatts (MW), or 3,003kW, over the 6-month pilot.

5.6.2. This equates to an average of 1.33kW per participant per day.[8]

5.6.3. However, there was significant degree of variation in the electricity consumed across each of the five car parks, and in turn across each of the participants.

5.6.4. Figure 6.2 and Table 6.12 below demonstrate how, for example, electricity usage in Bretton Car Park was much higher (3.6kW per day on average per participant), as compared to Willoughby House Car Park, which was only (0.19kW per do on average).

Figure 5-2 – Charge Point Electricity Consumption by Car Park



[8] Average derived by dividing total electricity consumption by participants, then by the average number of days participants were engaged in the pilot.

Table 5-12 – Electricity Consumption per Car Park and Participant

Car Park	Charge Point Units	Sockets	Participants	Average per participant over period (kW)	Average per participant per day (kW)
Breton	9	9	2	657	3.60
Bunyan	3	6	3	27.9	0.20
Cromwell	3	3	2	244.5	1.34
Thomas More	2	4	3	329	2.32
Willoughby	5	8	5	25.86	0.19
Total	**22**	**30**	**15**	**200.2**	**1.33**

5.6.5. Interestingly, Breton House Car Park features one of only 4 BEVs to feature in the pilot, and the only BEV to have featured throughout the full 6-months of the pilot, as the others joined the programme later.

5.6.6. The other car park to sustain higher levels of electricity consumption per EV was Thomas More – which featured PHEVs, but also the Royal Mail E-Crafter (BEV).

5.6.7. It is less clear why usage in Willoughby is so low, although of the vehicles listed are the ZipCar car club vehicles, which were late being deployed and so were only active for the latter period of the trial.

How does this compare?

5.6.8. An average electricity consumption of 1.33kW per day is a very low figure (15-20%) when compared to other more mature EV markets, such as Norway, where their experience is that 7-10kW per day is a typical usage rate, including central urban locations.

5.6.9. 7-10kW per day equates to 30-50 electric miles per day. The Barbicans 1.5-2kW per day figure equates to around 7-10 miles per day.

5.6.10. Whilst this is a helpful benchmark against which to compare these usage levels, it is an imperfect comparison for a number of reasons.

5.6.11. In Norway the ratio of BEVs to PHEV (approximately 60/40%[9]) is far higher than in the UK (approximately 30/70%), where the PHEV is more dominant amongst the existing fleet and sales. BEVs have large batteries and no alternative means of propulsion, so would be expected to consume more electricity.

[9] https://insideevs.com/norway-experienced-minor-decrease-of-plug-in-car-sales-in-july/

5.6.12. Furthermore, in Norway, the average daily mileage of EV drivers is around 30-40 miles, in the UK the average daily mileage is 21.4 miles. This figure will be considerably lower for Barbican residents, as seen in section 5.6.

5.6.13. The electricity consumption and charge point usage figures are significant because they can provide a source of revenues against which the high initial capital costs of installing the charge points can be paid down over time. But delivery models such as this are typically reliant on a reasonably reliable base level of charging activity. Business models and funding options are continually evolving in this regard, but at the time of writing we would anticipate many such models requiring at least 4kW per day.

5.6.14. The reasons for the low levels of charge point usage evidenced in these figures can be explained through the survey and interview findings reported in sections 5.2-5.5, including:

- Low Mileage, due to the very central location of the Barbican.
- High proportion of PHEVs amongst the participating vehicles (though this is reflective of the UK average), and lesser reliance on electricity as a means of propulsion.
- Alternative charging locations – particularly at second homes
- Some residents charge points are inconveniently located, and so they are less inclined to use it, particularly if it is not essential (PHEV or alternative charging options).

5.6.15. A further consideration is that across the individual use cases of each participant there is a significant degree of variation, and the small sample size means that the particular traits of each has a larger bearing on the average per kW figure derived. Additionally, as the charge points and the electricity have been made freely available to the participants for at least the duration of the pilot, the individuals are not invested in the same way in getting their money's worth from the charge point, in the same way that they would be if they had invested in a charge point and it fulfilled all their specifications.

5.6.16. The table below illustrates the variance in electricity usage across 3 participating residents.

Table 5-13 - Electricity Consumption – Barbican Reference Cases

Electricity Consumption	Vehicle	Daily electricity consumption	EV miles per day	EV miles per week	EV miles per year
Higher (Resident 1)	BMW i3 (BEV)	3.60 kW	13.7	95.8	4,980
Average (Resident 2)	BMW 225XE (PHEV)	1.34 kW	5.1	35.6	1,853
Lower (Resident 3)	BMW X5 (PHEV)	0.11 kW	0.4	3.0	156

Key Findings

- Low levels of electricity usage
- Most have PHEVs so are not critically reliant on it them
- Low mileage
- Several participants have second homes - commute in, park and charge
- Emerging theme is a preference for convenience over speed, rather not have to move car

- Preferences for pricing mixed but generally per kW hr
- A key driver for purchasing EVs is the ULEZ
- Some preference for tethered units
- RFID access cards preferred to key operated
- Concerns around bay dimensions
- Barbican is a special use case - central London location
- Small sample size means that the particular traits of each has a larger bearing on the average per kW figure derived.
- Charge points and the electricity have been made freely available to the participants for at least the duration of the pilot, the individuals are not invested in the same way in getting their money's worth from the charge point, in the same way that they would be if they had invested in a charge point and it fulfilled all their specifications.

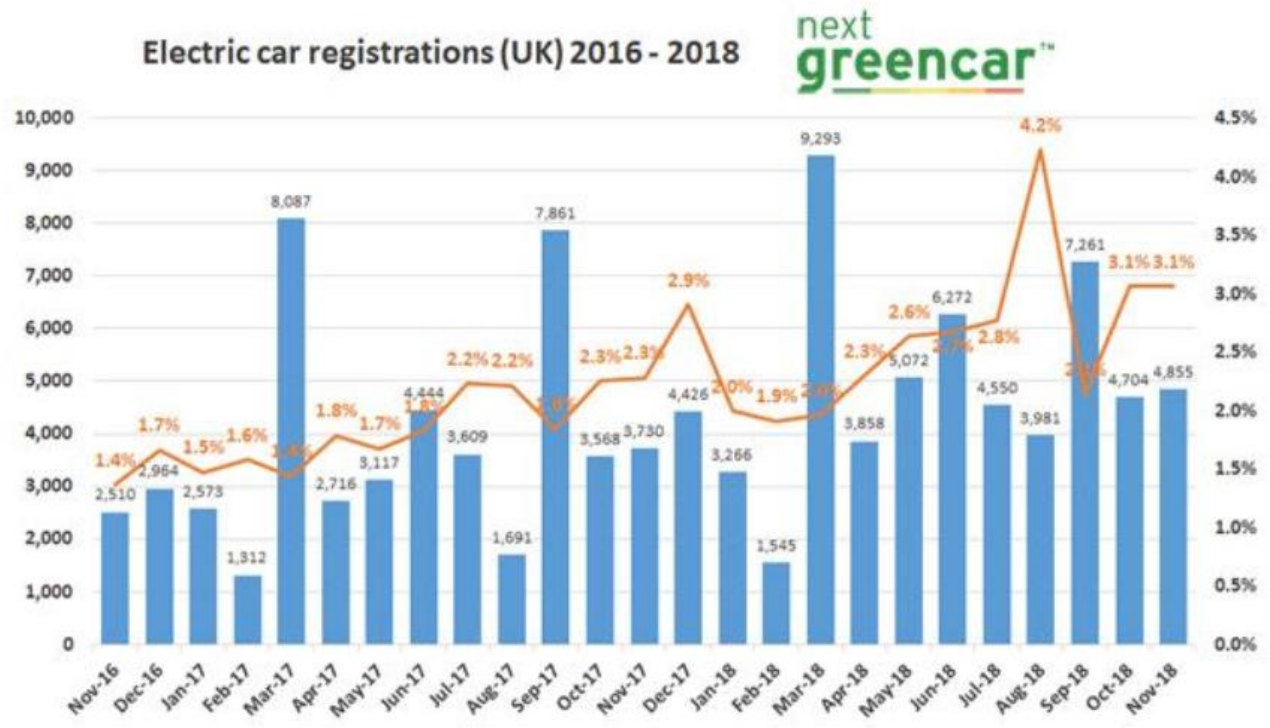
6. FORECASTING DEMAND FOR ELECTRIC VEHICLES AT THE BARBICAN

6.1.1. In order to plan how the Barbican can most effectively deliver charging infrastructure to support a transition to electric vehicles, it is important to understand the likely extent of demand and the timescales over which this unfolds, to determine a requirement for charge points.

The Macro Picture of UK EV Uptake

6.1.2. From a low base, electric vehicles sales have grown rapidly in the UK. There are an increasing number of models on the market (120), with improving battery range (over 200 miles in mid-price range), falling purchase costs, a new pre-owned market, and a fast-developing public charging ecosystem (18,685 charge points)[10].

6.1.3. The latest sales data at the time of writing (November 2018) shows electric vehicles registrations increased by 30% in November 2018 compared with last year – and there are now 187,000 ULEVs registered in the UK. The average annual market share of ULEVs in new vehicles sales is now 2.5%, compared to 1.9% in 2017.



[10] https://www.nextgreencar.com/electric-cars/statistics/

6.1.4. This is despite the market turbulence and uncertainty in the wider economy. The Government announced changes to OLEVs Plug-in Car Grant in October 2018, which saw grants for PHEVs (previously £2.5k) removed entirely, and grants for BEVs reduced from £4.5k to £3.5k. Many in the industry have felt this was a premature withdrawal of funding, and whilst time will tell, this initial sales data is encouraging. There is also the economic uncertainty posed by Brexit, and due to concerns about further restrictions and charges being levied on diesel vehicles. These factors in combination have contributed to an overall fall in vehicles sales by 3%, with diesel vehicles continuing to see significant falls in sales, down 30% in 2018. All of which only serves to underline the relative robustness of demand for EVs in the face of market turbulence.

6.1.5. However, one of the biggest challenges to more rapid EV sales growth now increasingly stems from a lack of availability of the models available to buy in the UK, which is constraining the market.

6.1.6. The 2018 National Grid forecasts for national EV growth estimate up to 70% of vehicles in the UK (25m) could be EVs by 2035, and 100% (36m) by 2040.

Localised Demand

6.1.7. It is important to note that EV growth is likely to continue to vary considerably spatially. The proportion of ULEVs amongst registered private cars in City of London (3.2% of fleet in 2016) is significantly higher than the London average (0.4%), which is in turn higher than the UK average (0.34%), reflecting the unique nature of the City, which must be factored into planning infrastructure planning for the Barbican.

6.1.8. There is also known to be a high level of demand and interest in EVs amongst Barbican residents, as reported in section 5.2, with 91% of respondents who were considering buying/ replacing a vehicle saying they would consider purchasing a ULEV, and a survey of residents undertaken in 2014 finding that that 150 residents would consider buying an EV, with 22 actively planning to do so.

6.1.9. For the purposes of establishing a baseline figure, it is estimated that there are currently 20 ULEVs amongst the vehicles permitted to park within the Barbican. 15 of which participated in the pilot or baseline surveys.

6.1.10. The plans to potentially introduce a pricing mechanism based in part on vehicle emissions would serve to further incentivised a switch to ULEVs amongst vehicle owners, in addition to schemes like the Ultra-low Emission Zone, and ULEV only streets such as the scheme being consulted on for nearby Moor Lane.

Declining car park usage and car ownership

6.1.11. A further notable trend to account for is the steady decline in car ownership and car park utilisation by Barbican residents, with 332 (34%) fewer residents parking compared to 1998. Over this period this equates an average annual reduction in resident parking of 1.9%. This has though been partly off-set by a growing number of "sold bays", which are sold as long-term car bay agreements as opposed to regular short-term permit renewals - increasing by 201 (264%) since 1998, mainly due to new Heron development with over 180 car bays as part of the agreement with Planning and the City.

6.1.12. The following assumptions have therefore been applied to forecast EV growth:

- Residential Parking Bay Lets will continue to decline by 1.9% per annum
- Commercial Parking Bay Lets will remain unchanged, due to advice from City Planning regarding commercial car parking.
- Sold Parking Bays (Long Term car bay agreements) will continue to decline by 2.1% per annum
- Overall this equates to an annual average decline of 1.8% in vehicles parking at the Barbican

6.1.13. The Future of City Car Parks reports 25-year strategy will considers potential decreases in volume of traffic, and the demands from other users, delivery hubs and cargo bicycles, indicative of the broader trend for roadspace reallocation away for the private car in the centres of major urban areas.

Forecast EV growth at the Barbican

6.1.14. The table below includes projections for EV growth at the Barbican.

Table 6-1 – Forecast EV uptake scenarios in the Barbican

Total Vehicles Parked		Number of EVs			Share of EVs		
		Low	Mid	High	Low	Mid	High
2018	926	20			2.2%		
2019	908	23	24	25	2.6%	2.6%	2.7%
2020	891	27	29	31	3.0%	3.2%	3.5%
2021	874	32	35	40	3.6%	4.0%	4.5%
2022	858	37	42	51	4.3%	4.9%	5.9%
2023	841	44	51	66	5.2%	6.1%	7.8%
2024	825	52	63	86	6.3%	7.6%	10.4%
2025	810	62	78	112	7.7%	9.6%	13.9%
2026	794	74	96	148	9.3%	12.1%	18.6%
2027	779	89	119	195	11.4%	15.2%	25.0%
2028	765	106	147	248	13.9%	19.3%	32.4%
2029	750	127	183	300	17.0%	24.4%	40.0%
2030	736	153	228	351	20.8%	31.0%	47.7%

6.1.15. In addition to the assumptions set out earlier regarding the number of vehicles likely to be parking at the Barbican in future years, these figures assume the following EV uptake rates:

- Average renewal/ replacement rate of vehicle fleet – 7% per annum
- Between 5-7.5% of new sales are ULEVs in 2019, rising incrementally to between 50-100% by 2030.

6.1.16. These are high level forecasts and do not account for variables such as the nature of charge point provision at the Barbican.

Key Findings

- Forecast EV numbers parking in the Barbican are anticipated to grow from 20 in 2018 to:
- between 27-31 (3 to 3.5%) by 2020;
- 62-112 by 2025 (7.7 to 13.9%); and
- 153-351 (20.8 to 47.7%) by 2030.

7. REVIEW OF CHARGING TECHNOLOGIES AND TRENDS

7.1. CHARGE POINT TYPES

7.1.1. There are range of charge point technologies, with a number of variants and options with each subset. The charge point types for consideration in the context of residents parking at the Barbican are:

Slow Chargers

7.1.2. Domestic three-pin sockets – the power output is therefore limited to the rating of the plug at around 3kW. EV charging from a 3-pin socket is typically down-rated to only draw 10 Amps from a standard garage radial circuit which equates to about 2.4kW.

7.1.3. The typical charging cable for standard charging possesses a three-pin plug at the infrastructure end with a Mode 2 device, which communicates the requirement to initiate charging the EV. The other end of the cable possesses the correct plug to connect to the vehicle. This is usually one of either the five pin J1772 or seven pin Type 2 plugs.

7.1.4. The typical standard charging time for replenishing a 24kWh EV battery from 0-100% State of Charge (SOC) is eight to twelve hours. This depends on the efficiency of the conversion of AC to DC power by the vehicle onboard converter (the battery is DC) and the power down-rating of the Mode 2 device. For example; a vehicle onboard AC to DC converter with 85% efficiency and a power input of 2.4kW will take approximately twelve hours to charge a 24kWh battery.

Standard Chargers

7.1.5. A standard charging unit typically found in an apartment block like the Barbican will possess Type 2 seven pin sockets and provide 3.6kW or 7kW power output, at 16 or 32 Amps, single or three phase AC.

7.1.6. 3.6kW or 7kW chargers will usually fully charge a 24kWh battery in six or four hours, respectively. The actual time charging will depend on the efficiency of the vehicle AC to DC converter. The charger communicates with the EV via the charging cable to initiate charging. This is termed Mode 3 charging. There is no Mode 2 device in the cable assembly.

7.1.7. Fast charging from a 7kW, 11kW or 22kW socket to a vehicle with a 24kWh battery that has a suitably rated 7kWor 22kW onboard charger AC to DC converter will take approximately four hours. The actual time charging will depend upon the efficiency of the onboard AC to DC converter. Please note that cables with a lower power rating than the charge point and the EV will cause charging to take place at the cable's rated current carrying capacity and will increase the time charging.

Fast Chargers

7.1.8. A typical fast charging unit will possess Type 2 seven pin sockets and provide 11kW or 22kW power output at 16 or 32 Amps three phase AC.

7.1.9. Fast charging from a 11kW or 22kW socket to a vehicle with a 24kWh battery that has a suitably rated 22kW onboard charger AC to DC converter will take approximately one to two hours.

Rapid Chargers

7.1.10. Rapid charging is typically from a charge point with tethered plugs that can provide a significantly higher power output than both fast and standard charging and can generally charge an EV to 100% state-of-charge (SOC, i.e. a fully charged battery) in an hour or less.

7.1.11. AC three phase rapid charging is typically at 43kW power output (at 63 Amps per phase from a three phase AC supply) utilising a tethered Type 2 plug attached to a charge point that resembles a forecourt petrol pump.

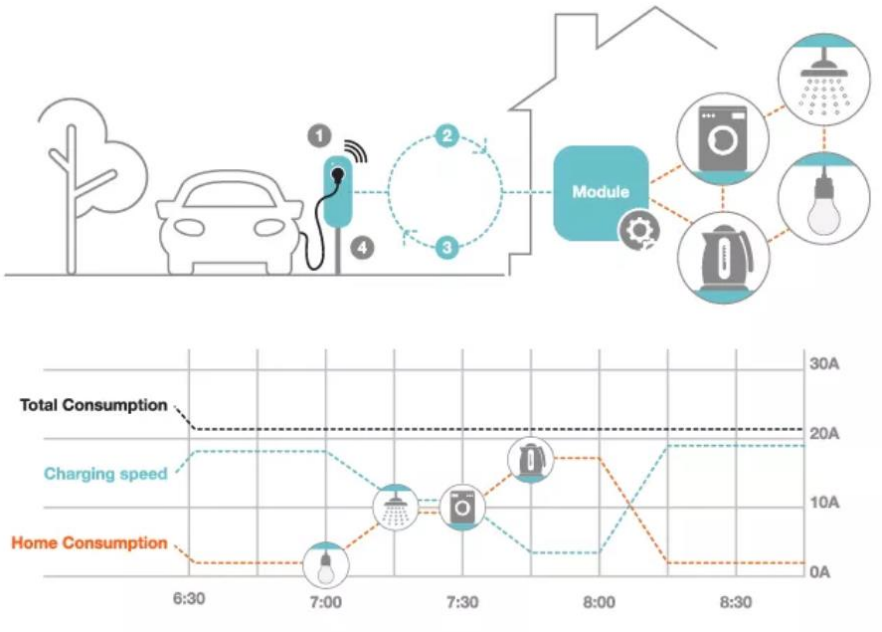
7.1.12. DC rapid charging currently provides 20kW, 44kW, 48kW or 50kW power output. The charging unit possesses the power electronics to convert AC to DC current at the correct level for the vehicle traction battery (as opposed to the vehicle onboard AC to DC converter used in AC standard, AC fast or AC rapid charging).

Charge point features and additional considerations

7.1.13. Charge points include a number of sub-component parts and features to be considered, including:

- **Socket or Tethered** – a tethered charge point refers to the charging cable being integrated into the unit, rather than featuring a socket for the user to plug a cable into. This can be preferable for home charging, to save the user having to remove their cable and plug-in each end every time they park.
- **Single or Dual chargers –** some suppliers offer dual chargers, whereby a single unit includes two sockets that can be used simultaneously. This can be a cost-effective approach for multi-occupancy dwellings, when positioned between each bay.
- **Smart chargers** –from July 2019 all newly installed home EV charge points must feature 'smart' (communication enabled) technology to receive government grant funding. Dumb chargers (non-communicating) will no longer be supported by the grant. The move is part of the UK Government's Road to Zero strategy, to enable home units to be remotely accessed, and capable of both sending and receiving signals, with the potential to dramatically reduce the load during peak times on the National Grid as EV uptake increases, minimising the cost of charging for users, and the price of infrastructure upgrades for network operator. Smart chargers also enable charge scheduling.
- **Scalability** – a key consideration is ensuring that beyond the initial tranche of charge points installed, additional points can be added later, in line with demand. It is advisable to at least plan for 2-3 years ahead, and 5 years or more if the host is being more ambitious. If the first units that are installed are dumb sockets rather than smart chargers, and not able to optimise their use of the available electricity supply (i.e. are reliant on static load management, which divides available supply on the basis all units may be charging), this will significantly limit the number of additional charge points that can be added, before a costly upgrade will be required to the grid connection.

- **Load Balancing** – related to the previous point around scalability is the critical function of load balancing, whereby the charging station automatically divides the available power over the vehicles that are charging. The charger analyses the available capacity and how much power the vehicles require. Subsequently, the smart charger distributes the power based on the maximum capacity of the connection. This enables a faster charging when fewer points are in use, but enables the available power to be rationed out more widely when more vehicles are plugged-in, potentially delaying the requirement to make expensive investments to upgrade the grid connection. Load balancing the power usage can reduce the load by around two-thirds relative to a static load managed installation. Typically charge points would not lower the power any further than 2.2kW. It should be noted some operators charge additional operating fees for this function. Dynamic load balancing/ active load management effectively enables charge points to account for the power supply of the whole building, and utilise the available spare power



NewMotion Dynamic Load Balancing - https://newmotion.com/en_GB/Dynamic-Power-Solutions-for-Home

- **Passive cabling and back plates** – for multi-occupancy dwelling like the Barbican, it may be desirable to pre-install the cabling/ducting/tray to an isolator, MCB board[11] and RCD board[12] for a number of additional parking spaces. The space is then ready to simply have a charge point installed and activated. A number of the charge point suppliers also offer back plates for the chargers to be slotted onto, and include a cap to protect the supply.

[11] Miniature circuit breaker (MCB) - An overcurrent-protection circuit breaker with standardised current ratings and tripping characteristics, which can be installed in close proximity in consumer units and distribution boards.

[12] Residual current device (RCD), also residual current circuit breaker (RCCB) - A circuit breaker triggered by non-matching currents in line and neutral wires (i.e., electrical power is passing to earth). Mandatory for most circuits as of 17th Edition regulations.

- **Electricity supply** – in order to be scalable such that the number of charge points can be increased in line with demand, in a site the size of the Barbican a 68kVA 3-Phase 100A supply will be required in each of the car parks.
- **Charge Point Access** – a number of options are available for accessing and locking the charge points, including RFID cards/ fobs/ lock and key and via Apps. Some suppliers offer Apps with NFC (Near Field Communication), enabling a phone or a registered payment card to function as a key, rather than carrying an additional card. Others offer features whereby if no signal is available the user can still plug-in and activate once they have signal.
- **Single phase or 3-phase** - Most UK homes have a single-phase supply, unlike much of northern and central continental Europe, limiting the scope for domestic charging to 7.4kw single phase charging. Domestic connections can be upgraded to three-phase but this can be costly. Larger flats or commercial buildings like the Barbican need more electricity, so will have a three-phase supply. At present there are relatively few vehicles that charge 11-22kW (Renault Zoe, and LEVC TX (black cab) and Tesla's). Beyond enabling higher A/C power outputs, 3-phase supply also supports phase balancing.
- **Communications** – for charge points to be smart they must enable communications, as EVCPs communicate frequently (every 3 seconds in some cases). This is typically achieved using Wi-Fi connections. Alternative options include GSM (Sim Card) 3G to Wi-Fi routers, though as the number of charge points increases the data costs of this approach make it more costly option. A further option is to run a LAN/ Cat-5/ Cat-5e cable to the Wi-Fi router. Effective communication over Cat5 cable is limited to 80m. Power Line Communication (PLC) are another option, and useful for connecting to a small number of units out of Wi-Fi range, though there are limitations to this approach for more than around 20 units.
- **Communications back-up contingency protocol** – it is important that the charge points have a backstop measure and continue to function if their communications systems fails, in most cases they simply revert to dumb chargers and deploy static load management. Some charger points maintain a downloaded list of enabled users locally.
- **Phase balancing** – in some case a charge point can offer a phase balancing feature, whereby single and three phase supplies can be used at the same time via a balancing algorithm, which determines whether a vehicle can support an 11kW charge, or whether it only support single phase A/C charges, in which case it will switch supply to that. These units select which of 3-phases to use, and use the one with most capacity.
- **Priority charging** - few chargers currently offer this feature as there is currently low market demand, but several are developing this to future proof their units. This function would allow users to opt to perhaps pay a slight premium for a faster charge, or conversely to select an eco-charge, at a discounted rate, if they know they don't urgently require an additional charge. Other options for achieving a similar outcome can be to differentiate the charge point usage and charge rate with differential pricing.
- **Warranties** – typical warranties on charge points are 3-5 years. There is limited data on expected life spans of charge point units due to the relatively recent emergence of the technologies, but provided they are well maintained would be expected to last 10 years.
- **Maintenance** – most charge points are offered with managed maintenance, and are self-monitoring, notifying the supplier if there is a fault. The ability for suppliers to conduct remote checking and proactive maintenance is an important consideration, including a remote reset option, which can often resolve minor issues. Installation faults would be the responsibility of the installer to remedy. It is also important to establish whether 24/7 customer support is provided.

- **Operating costs** – charge point suppliers typically levy a modest service charge for managing the back-office systems, rolling out software updates, and fulfilling maintenance and support functions. These costs can either be included with the usage charges to users, or picked up on a rolling basis by the host. These costs range from 1.5 pence per kW of charge, or a monthly fee per charger of £3-10 a month.
- **Management controls and data access** – the charge point platforms can offer the host access to all EVCPs via portal, to see real-time usage, and offer controls to restrict access, i.e. to residents only, or approved visitors, or to manage price setting. Some systems also allow the host to set a grace period to sign in, i.e. if residents can't log in in basement due to Wi-Fi their charge commences for a time limited period.
- **Government Grants** – The Governments Electric Vehicle Homecharge Scheme (EVHS) provides £500 off the cost of purchasing and installing a home charging point, with funding committed until March 2020, or until 30,000 installations in 2019/20 have been supported, whichever is sooner. OLEV require applicants to prove they own their space. Residents at the Barbican do not own their parking bays so this funding would not be available.
- **Falling charge point costs** - the EV charging infrastructure market is increasingly competitive, with significant investments and a series of new entrants to the UK market each wanting to grow or establish market share, and it is expected charge point costs will fall significantly in view of the increasing economies of scale and market competitiveness. Though in the short term as chargers shift from predominantly dumb sockets to smart chargers with added functionality unit costs are likely to increase relative to previous installations.

7.2. FUTURE CHARGING DEVELOPMENTS

Ultra-rapid public charge points

7.2.1. Ultra-rapid public charge points are expected to be rolled out in greater numbers from 2019.

7.2.2. 100 kW units are already being installed, and there are also plans for 150 kW ultra-rapids, which are effectively expected to become the new ‘standard’ rapid charge point. A number of the newest generation of EVs can all charge at between 100 kW and 150 kW.

7.2.3. In addition to which the pan-Europe “Ionity[13]” network of 350 kW CCS chargers is due to begin being deployed in the UK in 2019. Though at present, only the Porsche Taycan (due to be launched in 2019) has 350 kW charging capability.

Vehicle to Grid (V2G)

7.2.4. V2G enables certain EVs to feed electricity back into a home, workplace, or grid, when demand is at its highest, before then charging at off-peak times during the day or night. In effect using an EV as a portable energy storage system, enabling the user to generate revenues through energy arbitrage and peak shaving. Whilst many consider V2G charging

[13] https://ionity.eu/

is still a few years away from being commercially viable, it may only be a matter of a year or two years before this technology begins to be deployed.

Inductive charging

7.2.5. The wireless system uses the principle of electromagnetic induction. A magnetic field generated by an alternating current in a primary coil (the charging pad) induces a current in a nearby secondary coil (the EV). The charging pads can be embedded within parking bays.

7.2.6. Inductive charging technologies have been around for a number of years, and the issue has always been cost, due a lack of standardisation and interoperability. Meaning a bespoke kit is required for each vehicle type, which does not come as standard on vehicles.

7.2.7. The market is beginning to catch up with the technology in this area however, and in the medium term they may begin to be more prevalent for off-street charging.

7.2.8. A US supplier called Plugless sells wireless chargers for the Tesla Model S, BMW i3, Nissan Leaf and first-generation Chevrolet Volt. These cost between £880-£2,100 and deliver a 7.2kW charge. The Plugless system includes two parts; the charger placed on the floor, and a power receiver which attaches to the car - and requires professional installation.

7.2.9. BMW began selling a wireless charging pad as an optional extra for its 530e iPerformance hybrid in late 2018. This system connects to a regular power outlet and feeds the car with electricity when it is parked in the right position (as directed by instructions on the infotainment display). The vehicles 9.5kWh battery can be charged in 3.5 hours.

7.2.10. The Qualcomm Halo has been available since 2012, and is now able to charge at up to 22kW with 90% efficiency, meaning just 10% is lost across the air gap.

Battery Swap

7.2.11. Battery swap technology attracted a lot of attention and investment earlier in the 2010s, with BetterPlace investing significant sums launching trial networks in a handful of countries globally. However, the operation filed for bankruptcy in 2013, and ever since has been widely regarded as a technological dead end.

7.2.12. Nonetheless, a number of innovative companies, including Tesla and NIO, are still exploring battery swap technologies ecosystems. In part because as EV ranges increase and batteries get larger, ultra-rapid charging becomes more challenging.

7.2.13. The key challenges are likely to continue to be the significant cost of battery swap stations, and of establishing a sufficiently standardised and readily removable battery across enough

models to sustain the business model. The battery is a very high value component of the EV, so would necessitate careful safeguarding and quality assurance.

Mobile Charging

7.2.14. In 2018 BP invested in US-based manufacturer FreeWire Technologie, the founder of the Mobi mobile charger units. The units are pre-charged, then wheeled over to the vehicle in need of charging. Their models include a 15kW and 50kW DC model.

7.2.15. The most likely application for these units are as part of a concierge service, and in workplaces

7.3. FUTURE VEHICLE DEVELOPMENTS

7.3.1. The number of electric vehicles available has expanded significantly in recent years, and most mainstream car makers now offer an EV model, with 100 fully- or part-electric vehicles available to buy or lease in the UK. This includes all vehicle classes from superminis to SUVs, and sports cars to people carriers.

7.3.2. The notable trends amongst the new models coming to market and upcoming launches are the increasing batteries capacities and capabilities to support faster charger rates.

7.3.3. The average battery size of planned BEV releases has risen to 68kW, relative to the current average of 25kW.

7.3.4. Based on our reviews of planned new EV model launches over the coming years, the majority of future models facilitate a maximum A/C charge of 11kW, and many post 2019 launches support ultra rapid charging.

Key Findings

- 7kW dedicated charges are most suitable based no stakeholder preferences, dwell times and mileage. Convenience of not needing to move the car.
- Rapid chargers would require resident to move vehicles - risk that someone may use the EVCP when it's not their turn, block it, resulting in neighbourly disputes and potentially requiring intervention by the host. The anxiety of this scenario potentially unfolding may discourage them from switching to EV.
- Fast Chargers are not necessary given the dwell times, and few vehicles currently support them.
- 3.5kW likely to be adequate for long time based on low mileage, but pending findings of available supply, it is worthwhile future proofing with 7kW. The notable trends amongst the new models coming to market and upcoming launches are the increasing batteries capacities and capabilities to support faster charger rates.
- Residents would value being provided the option of tethered cables or sockets
- Chargers must be Smart, with RFID access or alike, and have the capability to support load balancing, essential for scaling.
- New charging innovations should be monitored but are not currently mainstream options.

7.4. CHARGE POINT COSTINGS AND DELIVERY OPTIONS

7.4.1. The emerging user requirements and preferences from the pilot study were taken forward to inform a market engagement exercise with 5 charge point suppliers. The table below summarises the indicative capital and operating cost ranges at the time of writing.

Table -7.1 Charge point cost ranges (November 2018)

Indicative Capex and Opex Costs	Low	Average	High
Capital Costs			
Charging unit and installation cost	£1,500	£2,000	£3,000
Operating Costs			
Annual maintenance	£0	£25	£50
Back office, data connection/collection fee	£0	£36	£150
Passive Cabling			
Cabling, ducting etc cost per parking bay	£150	£300	£1,000
Installation of new/ upgraded power supplies			
Installation of sub-main cable to car park from the main UKPN distribution board with sub-distribution board, metering, MPAN registration.	£0[14]	£9,490[15]	£10,900[16]

7.4.2. There are a number of payment models available for delivering charge point infrastructure, which can be broadly summarised as:

- **Charge points purchased by the Barbican Estate** - with costs recouped to a greater or lesser degree from the resident. Potentially delivered in batches on an ad-hoc basis when funding grants like the LEN are available.
- **Enabling works/ cabling funded by the Barbican Estate, charge points purchased by the Barbican Estate with costs recovered from residents** – which can be installed rapidly, with the resident's permit cost including a surcharge to pay down the cost of the installation over an agreed period (i.e. 3 years).

[14] Based on a supply already being in place and no requirement to upgrade (i.e. as in the 5 car parks in the Barbican with charge points already installed).

[15] Based on average costs when installing the charge points across the 5 Barbican car parks

[16] Based on highest cost when installing the charge points across the 5 Barbican car parks

- **Fully funded options** – with initial capital costs borne by the supplier, and the resident enters into a contract and pays down the capital costs over time.
- **Supplier Offers/ Bulk Discounting** – as part of wider commercial agreement with the City, some suppliers would offer to deploy an initial tranche of charge points at their own cost, and/ or offer discounts on additional charge point purchases, but would likely entail exclusivity agreements, additional sites for charge points beyond the Barbican.

Charge points purchased by the Barbican Estate

7.4.3. This approach is the most common approach to date, as installations at multi-occupancy dwellings are generally fairly small scale, and led by the estate management/ facilities team. In the case of the Barbican, this approach has been taken to date, utilising specific funding made available through the LEN programme.

7.4.4. In order to roll out additional charge points in this manner the Barbican would either have to:

- Secure additional funding (i.e. via funds such as the Mayor's Air Quality Fund);
- Fund them directly as investment programme in the asset; or
- Recoup some or all of the costs from the resident.

7.4.5. If we take the average cost of around £2,000 per charge point installation, this could for example be paid down by the resident as:

- A surcharge on the parking permit - for example the resident would enter into a 3-year contract and pay £83.33 per quarter if they sought to recoup 50% of the cost.
- A surcharge on electricity usage of, for example, 5 pence per kW (on top of the 14p per kW domestic rate) would entail a long pay-back period. It would also be subject to the usage levels of the user, which as we have seen in the monitoring study for the Barbican are generally very low.

7.4.6. This option would appear to be best suited to initial smaller scale installations, such as the Barbican pilot, but in the medium term as the number of charge points required increases, would saddle the Barbican Estate with high upfront capital costs. The exception to this being when funding awards such as the LEN become available, and can be used to deliver a further tranche of charge points.

Positives	Negatives
▪ Potentially a simple process to administer, working within existing payment processes for permits. ▪ Potential to secure bulk discounts	▪ High upfront costs borne by Barbican Estate, with long payback periods

Enabling works/ cabling funded by the Barbican Estate, charge points purchased by the Barbican Estate with costs recovered from residents

7.4.7. The Barbican Estate could invest in preparing a number of bays within each car with the necessary cabling/ducting/tray to an isolator, MCB board and RCD board for a number of additional parking spaces, such that they are ready for a charge point unit to be quickly and conveniently installed. This is known as a passive charging provision. A number of the

charge point suppliers also offer back plates for the chargers to be slotted onto, and include a cap to protect the supply.

7.4.8. The benefit of this approach is that enables the Barbican Estate to gradually expand the provision of passive bays at relatively low cost, whilst providing a readily scalable platform for adding additional charge points that can function intelligently to load balance the available electrical supply. The provision of EV ready bays then provides a clear and legible process for residents, who can the request a charge point, which the Barbican can procure from the approved supplier, and can then be quickly installed onto the existing cabling. This may also offer scope for a choice between different models (i.e. tethered or a socket).

7.4.9. If we take the average cost of around £2,000 per charge point installation, this could for example be paid down by the resident as a surcharge on the parking permit, at around £141.67 per quarter if the resident entered into a 3-year contract, and the Barbican covered the cost of the initial passive cabling (approximately £300 per bay).

7.4.10. This approach is the common model for housing associations in Norway, where their experience has been that users typically prefer to purchase their own charge point.

Positives	Negatives
▪ Passive cabling helps foster a legible process for residents. ▪ Manageable costs to Barbican Estate	▪ High cost to residents, but benefit from enabling works being completed. ▪ Barbican Estate incurs some costs

Fully funded options

7.4.11. A number of charge point suppliers offer ‘fully funded’ models, whereby they will cover the initial capital costs, and the resident via the Barbican would enter into a contract and pay down the investment over time, either in the form of a surcharge on electricity usage, or fixed repayment programme model.

7.4.12. Operators would typically require long term licenses to enable residents to pay down the charge point via a surcharge on electricity usage, to ensure they pay down their investment, though this model is more with a view to ‘right to park’ car parks, rather than allocated bays and dedicated charge points. Under this model suppliers typically look for a minimum electric usage per day on average, which would exceed the current average of Barbican residents, though this may change over time as more BEVs are purchased.

7.4.13. Alternatively, a fixed fee payment can be agreed to enable the resident to pay down the cost of the charge point over time, as part of a package that includes electricity, though at the time of the interviews such a model was yet to be launched.

7.4.14. The Barbican Estate could pick up a modest proportion of the costs of the enabling works (cabling etc.) to establish passive provision, lessening the overall cost to resident.

7.4.15. Some suppliers will only offer fully funded charge points if they can be accessible as part of a public charging network, which would not be in line with clear preferences of residents for their own dedicated bays.

Positives	Negatives
▪ Minimises cost burden on the Barbican Estate ▪ Removes high initial cost burden on residents, allows them to pay down over time.	▪ Limitations to some models in either requiring minimum electricity consumption which exceed current levels, or public access. Other models are new to the market.
▪ Rapid delivery of charge points on request	▪ Long terms licences required over which operators can recoup investment. ▪ High overall; cost to residents

Supplier Offers/ Bulk Discounting

7.4.16. In some cases, suppliers/ operators can offer an initial tranche of charge points at their own cost, as part of wider commercial agreement with the City, which may include exclusivity, wider deployment in other City Car Parks and Rapid Chargers. The City of London is a prestigious territory for a charge point supplier to be present in, and this is to the benefit of the City when it comes to attracting investment.

7.4.17. Suppliers may also offer a discount to the City on additional charge point purchases as part of such an arrangement.

7.4.18. This is reflective of the increasingly competitive EV charging infrastructure market, with significant investments and a series of new entrants to the UK market each wanting to grow or establish market share. The main considerations when assessing such details should be the strategic fit with the City's wider plans with regards EV charging. Larger scale and longer terms agreements require due diligence to be undertaken on the long term financial viability of the potential partner. If the deal entails an exclusivity agreement of future EV charging purchases it will be important to ensure prices for charge points in future year fall in line with the market prices. As it is expected charge point costs will fall significantly in view of the increasing economies of scale and market competitiveness.

Positives	Negatives
▪ Free charge points initially, and a minimised cost burden on the Barbican Estate for additional units. ▪ Discounts passed onto residents.	▪ High cost to residents, but benefit from enabling works being completed.
▪ Rapid delivery of charge points on request	▪ Barbican Estate incurs some costs

8. RECOMMENDATIONS

8.1.1. Based on the preceding analysis of current and forecast future demand for EVCPs, a review of technologies, costs and stakeholder feedback, a series of recommendations have been developed. The objective being to strike a balance between being self-sustaining and cost neutral to the Barbican Estate Office, whilst also providing a fair and attractive service to residents.

User Requirements / trends

8.1.2. A charge point specification has been developed based on the feedback and of residents and the hosts throughout the pilot study. feedback and experiences and usage. This can be used to inform future procurement and requests for quotations, to ensure the necessary functionalities are included within the charge points supplied.

Table 8-1 - Charge point specification

Charge Point Specification
7kW power output - 32 Amps, single or three phase AC
Smart chargers with Wi-Fi/ LAN/ CAT-5E/PLC communications, back-up contingency protocols
Dynamic load balancing capability
Preferably the option of models with Sockets or Tethered cables
Secured unit accessible by RFID/ Fob/ App/ NFC.
Passive cabling and back plate pre-installed in phases
Full management control platform and real-time usage data
Warranties for at least 3 years, preferably 5 years.
Comprehensive maintenance package including remote checking and reset functionality
Customer support available 24/7

8.1.3. Key determinants in specifying the charge point have included:

- Dwell time - vehicles are parked for extended periods
- Low mileage due to central London location.
- High proportion of PHEVs, and whilst it is anticipated in the medium term this profile will shift to EVs, mileage is expected to remain low.
- Alternative charging options – a number of resident's charge at other properties homes with charge points.
- Prioritising user convenience and preferences for dedicated charge points.

8.1.4. There was a clear preference for dedicated charge points in the feedback from residents and pilot scheme participants. Convenience is key, and this message came across

consistently. It is recommended therefore to ensure charge points are made available within each car park, as a number of EV owners were unwilling to even use the charge points when made available for free and with no charge for the electricity during the pilot, so will undoubtedly stifle EV uptake otherwise. In some cases, even the assigned car park is a relatively long distance away from the resident's flat, and using alternative car parks was often found to be very inconvenient.

8.1.5. The charge point must also be accessible by quickly and conveniently via RFID / Fob or Apps. NFC protocols are likely to prove a popular mechanism as they do not necessitate the user carrying another card, but rather enable a smart phone or credit card to double as the key card.

8.1.6. Additionally, where possible the Barbicans approach should be to endeavour to provide residents with choices around personal preferences for things like whether a charge point comes with a tethered cable or only a socket.

8.1.7. A moderate charge rate (7Kw) was found to be widely acceptable. In the short to medium term 3.5Kw chargers would be adequate, but it would be advisable to provide an element of future proofing by ensuring a capability to charge at 7Kw, recognising the trend towards larger batteries amongst new vehicles coming to market.

8.1.8. It is key to take a longer-term approach, and accounting for both current and future demand when planning the deployment strategy. This entails specifying chargers capable of making intelligent and optimal use of the available electricity supply to the Barbican Estate. The largest costs associated with charge point deployments are inevitably triggered by requirements to upgrade grid connections. Examples of which may include redistribution of loads between different feeders or substations, or reinforcement of individual feeders. This may entail mitigation costs of up to £1k to 50k. Areas of concentrated demand where the additional load increase from EVs triggers more significant medium to high level enhancement works, such as upgrades to secondary or, in extreme cases, primary substations, could cost anywhere from £50k to £1m, and take between 4 months to over 18 months to deliver.

8.1.9. As such it is advisable to forward plan an installation so as to manage with the available power supply as far as possible. This will often entail higher costs in the short term, and investing in more robust smart charging units over cheaper dumb sockets, but in the medium to longer term is the only way to effectively scale a network. The consequences of more piecemeal or unplanned installations is that the units unable to perform smart functions such as load balancing will have to be swapped out.

Electrical Supply

8.1.10. The car parks with charge points already installed (5 of 10) currently have supplies with 68kVA of available electrical capacity agreed with UKPN, or 3 Phase 98A per phase, which should prove adequate to cater for the forecast demand up to 2030. It will be necessary to install an equivalent sub-main cable for each of the remaining car parks (5), to provide the same platform from which charge points can be installed in a phased manner in line with resident requests.

8.1.11. The cost for a new installation is approximately £9,490 which includes the sub-main cable to the car park, the main UKPN distribution board and infrastructure (in the switch room),

installation of a sub-distribution board, UKPN and metering costs, the temporary shutdown of supply and the MPAN registration.

Delivery Mechanisms.

8.1.12. It is not viable for the Barbican Estate to fund the full installation of charge points for residents. The cost of doing so are significant and as the volume of demand ad-hoc funding awards will not be sufficient, and are unlikely to be sustained in any case as the market matures. The Barbican's role instead, in our view, should be to ensure it provides a supportive platform and the mechanisms required to enable residents to request and fund the installation of a charge point.

8.1.13. A proactive approach the Barbican can take at relatively modest cost would be to pre-install the cabling and associated hardware to convert a number of bays to passive bays, ready to be activated with the simple addition of pre-determined charge point model/ range of models.

8.1.14. The benefit of this approach is that enables the Barbican Estate to gradually expand the provision of passive bays at relatively low cost (£2.5-£5k per annum to cater for total forecast demand in mid-range uptake scenario), whilst providing a readily scalable platform for adding additional charge points that can function intelligently to load balance the available electrical supply.

8.1.15. The provision of EV ready bays then provides a clear and legible process for residents, who can the request a charge point, which the Barbican can procure from the approved supplier, and can then be quickly installed onto the existing cabling. This may also offer scope for a choice between different models (i.e. tethered or a socket).

8.1.16. A further benefit of this incremental approach is that is avoids overcommitting given the uncertainties around demand, particularly given the trend to declining vehicle ownership and car park usage at the Barbican.

8.1.17. A positive to the available spare capacity may be there is reasonable scope to identify blocks of available parking bays to be converted to passive charging bays, without needing to disrupt existing bay allocations, and ideally in reasonable proximity (up to 120m) of a fuse box and distribution board to reduce installation costs. There may be also be opportunities to investigate re-sizing the smaller parking bays to overcome some of the issues encountered by residents. A premium could be levied for larger bays if required. An additional factor in proceeding with caution in terms of the scale of the installations is that EVCP costs are expected to fall significantly.

8.1.18. The City of London is a prestigious territory for a charge point supplier to be present in, and this is to the benefit of the City when it comes to attracting investment. The Barbican Estate should engage with the market, and explore the potential for securing some of the potentially very appealing offers from the private sector to deliver a large number of free high good quality chargers, and discounts on further purchases, where the savings could be passed onto residents. These models require strategic level decisions to be taken a City-wide level. A note of caution, would be that there is a balance to be struck in making the most of offers, whilst not being a hostage to them. Being aware of your objectives and desired outcomes at the outset is essential in this arrangement. For example, does the City wish to support rapid and ultra-rapid chargers as part of the deal. These could serve to

invite in additional transport, but conversely could accelerate a take up of low emission taxis and delivery vehicles. So, there is a wider strategic element to consider.

8.1.19. It should also explore other options for leveraging private sector investment, including fully funded models. In their current form these may prove to not be ideally configured for Barbican, due to the low electricity usage – a key mechanism by which the investors recoup their investment. A fixed fee payment can also be, removing the high initial cost burden on the Barbican, and allowing them to pay down over time.

Pricing

8.1.20. Home charging was found to be a prerequisite amongst residents in promoting EV uptake – and the industry consensus is that home charging must be reasonably priced, given savings in fuel costs are one of the major selling points of EV. As such electricity should set only a few pence beyond the domestic rates for electricity (14 pence per kW). We would recommend not exceeding 20-25 pence per kW.

8.1.21. Operating costs such as maintenance, data connection/ collection fees and back office costs would typically best be incorporated as a small surcharge on the per kW charges. 4-5 pence is usually adequate, but depends on usage, and within the recommend charges outlined above.

8.1.22. The cost to the residents in ultimately paying for the majority of the charge point is significant, though can be lessened through the Barbican taking a co-ordinated and proactive approach in competing the passive charging provision, and potentially securing discounts or access to fully funded models. This is a standard approach in mature EV markets like Norway. Additionally, the cost of the charge points will come down over time, and in our view the key role of the Barbican is to ensure the enabling works are provided and readied for the charge points to be added in line with demand.

Management Platforms

8.1.23. The Barbican should ensure the preferred suppliers hardware and software facilitates full management controls and access to data. It should offer the host access to all EVCPs via a portal, and the ability to see real-time charge point usage, and offer controls to restrict access, i.e. to residents only, or approved visitors, or to manage price setting.

8.1.24. To maximise convenience to users if possible a grace period should be enabled, to allow residents who are unable to log in due to a communications issues, forgetting a card etc, to plug-in and charge for a time limited period.

8.1.25. Additionally, having established a route by which residents can apply for a charge point, the City should establish a clear and transparent process the can follow to register their interest. We would suggest this takes the form of a page on the Councils website, as well as in the existing car park application forms.

8.1.26. It will be important that the page is clear in listing what models are available, the costs, contractual terms, supply and activation timescales. It could also serve to provide user instructions and links to helpful tutorials, help lines etc.

8.2. FORECAST EVS AND CHARGE POINT REQUIREMENTS

8.2.1. Table 8.2 on the following page draws together and summarise the existing charge point provision across the Barbican car parks.

8.2.2. Below this it includes the mid-range forecast growth scenarios for EV uptake amongst Barbican residents in each car park in the short (2020), medium (2025) and longer term (2030).

8.2.3. These are then translated into the number of additional charge points required in the short, medium and longer term.

Table 8-2 – Forecast EVs and Charge Point Requirements

Barbican Residents Car Parks	Andrewes House	Breton House	Bunyan Court	Cromwell Tower	Defoe House	Speed House	Lauderdale House	Thomas More	Willoughby House (Level 01)	Willoughby House (Level 03)	Total
Existing Charge Points	0	9	6	3	0	0	0	4	8	0	30
	-	*3Kw Dumb chargers*	*3Kw & 7Kw Connected chargers*	*22Kw Dumb chargers*	-	-	-	*7Kw & 22Kw Connected chargers*	*7Kw Connected chargers*	-	*18 Connected chargers* *12 Dumb chargers*
Forecast EVs (mid-range scenario)											
2020	3	2	3	2	4	4	3	3	3	2	29
2025	8	5	7	5	11	12	7	8	8	7	78
2030	23	16	22	14	31	35	21	22	24	19	228
Forecast Additional EV Charge Points Required (mid-range scenario)											
2020	3	0	0	0	4	4	3	0	0	2	16
2025	8	0	1	2	11	12	7	4	0	7	51
2030	23	7	16	11	31	35	21	18	16	19	198

Short term

8.2.4. In the short term we would advise that existing bays are reviewed and charges for the electricity are introduce on a per kW basis, of 20-25 pence, subject to operating costs incurred.

8.2.5. Review the scope for establishing blocks to be converted incrementally over time to passive charging bays in each car park, based in the forecast additional charge point requirement for each charge point identified in Table 9.2. As can be seen these are relatively modest numbers (16), and at an average cost of £300 per bay to complete the passive cabling should amount to approximately £5.3k, or £2.65k in 2019 and a further £2.65k in 2020.

8.2.6. This process should include a review of leaseholder bays, and the location of fuse boxes/ distribution boards, and focus on bays within 120m of these.

8.2.7. A key action in the short term will be to investigate the different funding options outlined, and ultimately identify and procure a long-term supplier from which additional charge points could be purchased on the request of residents. The specification and requirements derived through this study can form the basis of the request for quotation (RfQ).

8.2.8. Following which, passive charging provision should be introduced at the car parks not currently served by the existing EVCPs, as this is likely to stifle demand. These include: Andrewes House, Defoe House, Speed House, Lauderdale House and Willoughby (Level 03). This will entail a relatively high one-off cost to install a sub-main cable into each car park (£9,490 average cost) to provide the same platform from which charge points can be installed in a phased manner in line with resident requests. In order to confirm the availability of new connections an application must be submitted to UKPN before any dialog can take place. Given the high cost of these initial connections, the Barbican may wish to stagger their installation, prioritising those with the greatest forecast demand or requests from residents. Subject to the outcome of the market engagements, and whether any discounts or free installations can be secured, it may be necessary to levy a charge on the charge points already installed. This could be administered in a similar manner as proposed for residents requesting new charge points (i.e. £141.67 per quarter), to be reinvested in completing the remaining connections.

8.2.9. At some point it will be necessary to swap out the existing non-communicating charge point units (14), and replace these with smart chargers, supported by a fixed data connection, with the capability to support load management functions at a later date. This is likely to cost around £10k, subject to whether they could be exchanged. A key element of the market engagement would relate to how the existing supplier, and other prospective suppliers, would approach upgrading this equipment, with some having suggested they would swap them out at their own cost.

8.2.10. It may also be necessary to swap out the connected dual 22kW charger in Thomas More car park, to enable the available electrical supply to be distributed more widely, subject to whether these could be managed with phase balancing and load balancing.

8.2.11. To understand the scope for scaling up the charge points in line with the longer-term requirements for charge points, distribution boards should be assessed and what we can work with.

8.2.12. Beyond these actions, there is not an immediate requirement for further investment, as for the most part there should be adequate capacity till 2020. The exception being if the offers of fully funded models can be agreed, but if so this would still not require significant investment by the Barbican as the costs would be picked up by the private sector.

- Forecast EVs in the Barbican (2020) - 29
- Additional EVCPs required (2020) – 16

Medium term

8.2.13. In the medium-term dynamic load balancing may begin to become a requirement, though in the mid-range forecasts the highest number of charge points in a single car park is 12 in Speed House.

8.2.14. At an average cost of £300 per bay to complete the passive cabling should amount to approximately £2.5k per annum to 2025.

- Forecast EVs in the Barbican (2025) 78
- Additional EVCPs required (2025) - 51

8.2.15. In the high uptake forecast, this increases to:

- Forecast EVs in the Barbican (2025) 112
- Additional EVCPs required (2025) - 83

Long term

8.2.16. In the longer term, when the number of EVs is likely to begin posing greater challenges in terms of the available electrical supply, further developments in battery storage, V2G and energy arbitrage, amongst other innovations have the potential to completely revolutionise the energy market. For the time being, the Barbican just needs to ensure that it adopts charge point technologies that can evolve with these developments. The revenue potential of systems like V2G and energy arbitrage would have the potential to offset (and more) the growing cost of passive charging provision at this stage. For example, passive provision for 200 bays would cost £59.9k, or £4.9k per year until 2030.

8.2.17. A further longer-term consideration is the potential to by this time open up areas of the car parks, which by this point may be well under capacity, to car clubs, future mobility models and autonomous vehicles cycle freight, taxis, low emission freight, which would offer further potential revenue streams.

- Forecast EVs in the Barbican (2030)- 228
- Additional EVCPs required (2030) – 198

8.2.18. In the high uptake forecast, this increases to:

- Forecast EVs in the Barbican (2030) - 351
- Additional EVCPs required (2030) - 321

WSP House
70 Chancery Lane
London
WC2A 1AF

wsp.com