elementenergy

**Rapid charging
network study**

Final report

for

Transport for London

26th June 2015

Executive Summary

Background and objectives

Electric vehicles are expected to play a major role in meeting London's CO_2 and air quality targets. Whilst uptake of private electric vehicles is now growing at a rapid pace, it is recognised that commercial fleet vehicles (taxis, private hire operators, logistics operators, service providers, car clubs, etc.) will also need to make a key contribution towards growing London's Ultra Low Emission Vehicle fleet. The establishment of an Ultra-Low Emission Zone in central London from September 2020 will also provide a further incentive for the mass uptake of ULEVs, as well as helping to meet CO_2 and local air quality targets.
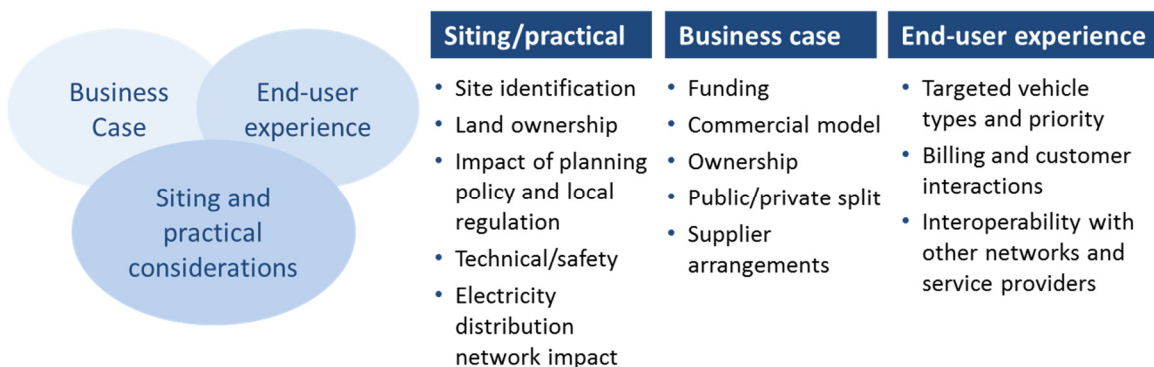
Whilst the 1,400 charging points (mostly 3 to 7kW) deployed as part of the Source London public network and other resident-focused programs are expected to provide sufficient charging capacity for private electric vehicles, many commercial fleet vehicles will require fast and/or rapid charging[1] in order to meet their more challenging duty cycles. This is particularly relevant in relation to the proposed requirement that all taxis and private hire vehicles presented for licensing for the first time in London from January 2018 need to be zero emission capable.

TfL recognises that it has a strong role to play in ensuring that this charging infrastructure need is met. In order to most effectively plan and optimise its role in any future fast/rapid charging network, TfL commissioned Element Energy to gather evidence of best practice in supporting and deploying fast or rapid charging infrastructure networks elsewhere. The study's main focus was to identify best practice and to highlight how this relates to the case of London.

Approach

This project has carried out a detailed desk-based assessment of over 25 rapid/fast charging networks across the UK, Europe and elsewhere, followed by a more in-depth bilateral consultation with 10 networks that were deemed most relevant to London (see Figure 1). Lastly, we conducted a workshop with several London Local Authorities that have deployed rapid charge points (or are considering it) and other key London stakeholders to present the findings from the consultation and discuss their relevance to the case of London.

The consultation was structured around three main themes:

Siting/practical	Business case	End-user experience
• Site identification	• Funding	• Targeted vehicle types and priority
• Land ownership	• Commercial model	• Billing and customer interactions
• Impact of planning policy and local regulation	• Ownership	
	• Public/private split	• Interoperability with other networks and service providers
• Technical/safety	• Supplier arrangements	
• Electricity distribution network impact		

Business Case — End-user experience — Siting and practical considerations

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[1] In this report, 'fast' charging refers to AC charging at 7 to 22kW (typically 22kW is meant when referring to fast charging). 'Rapid charging' rate is over 40kW (typically 43kW AC or 50kW DC). A 20kWh battery would take 6-7h to fully charge at 3kW but would be 80% charged up in c. 20min under a rapid charging rate.

Network	Description, extent, technology	Backing	Data source
ecotricity	• Free network covering majority of UK motorways • >220 rapid CP sites (mixture of CHAdeMO, AC, CCS) • Integrates the recent RCN (see below)	NISSAN, Office for Low Emission Vehicles	Ecotricity, CPS, APT, Nissan, ZCF
rcn rapid charge network	• Two road axes: North-South and East-West connecting major roads/ports in UK and Ireland • 74 CCS/ CHAdeMO /AC rapid CPs	BMW, RENAULT, VW, ESB, TEN-T EA	
source LONDON	• London-wide network, annual membership fee and access to Ecotricity network • C. 1,400 charge points (mostly 3-7kW)	Bolloré	Source London lessons learned guidance (TfL), Boroughs
CHARGE&DRIVE	• Largest Nordic rapid-charging network, covering Sweden, Finland and Norway with PAYG CP • 75 rapid CPs currently, aim for 145 rapid out of c. 500 overall by end of 2015	Fortum	Fortum, Renault Norway
FASTNED	• Netherlands-wide rapid charging network, based at services stations, PAYG and subscription options • Full highway coverage (>200) sought (currently 31, installing 1 per week), extension along highways in SE (35), DK (23), DE (67), NL (35) as well as in Dutch cities	TEN-T EA	Fastned
Auchan	• Planned France-wide charging network, offering free charging to Nissan users via a smart card • 130 rapid chargers to be installed at Auchan stores by end 2015, to add to 120 already at Nissan dealers	NISSAN, sodetrel	Nissan
WEST COAST ELECTRIC HIGHWAY	• Network running North-South across West-Coast US, linking with other local urban networks • Aiming to deploy rapid CP every 25 miles across California, Oregon and Washington states	Various EV-focused and other AQ federal funds	Drive Oregon
CHAdeMO	• Various rapid-charging networks, backed by OEMs, fuel retailers and Governments • >3,000 CHAdeMO chargers in Japan, Ministry of Economy, Trade & Industry long-term aim for 36,000	Various OEMs, municipalities, fuel retailers	Nissan
TRANSPORT SCOTLAND	• Local-Authority led rapid CP network across Scotland, coordinated by Transport Scotland • Aim to have one rapid CP every 35 miles along major roads, plus plans to deploy in urban areas	Office for Low Emission Vehicles, TRANSPORT SCOTLAND	Transport Scotland
ESB	• Government-backed and utility-led extensive fast and rapid charging network across Ireland • Number of DC chargers 75+, most of which are located on main motorways, currently free to use	Funding based on levy on electricity charges	ESB

Figure 1 – Networks investigated to understand best practice

Key findings

The number of fast and/or rapid charging networks is overall limited, and concentrated mainly in Japan, North America and Europe.

The operation of a charge point network typically involves **5 distinct roles** although not always filled by 5 distinct entities (see right).
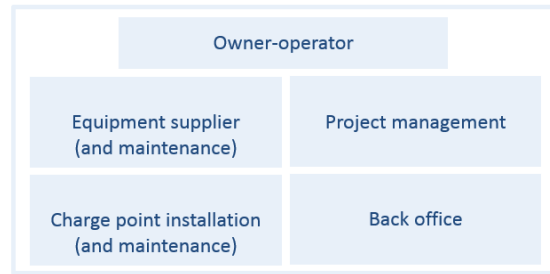
Most networks are fully or partly supported by public funds and/or by related stakeholders such as electric vehicles manufacturers or energy companies and are free to use. There are however some examples of commercially run – and privately funded – networks. There is

Figure 2 – Typical stakeholders involved in operating a charging network

also a variety of approaches to site layout (single post to 'forecourt style' station) and governance models – illustrated in the report through case studies.

The key findings in terms of best practice and key challenges are summarised below.

Siting and practical considerations

- Siting is reported to be the most important barrier for urban rapid charge point (CP) deployment, i.e. finding available land that meets criteria such as size requirements, attractive location for CP users, access to adequate power and, in some cases, non-competition with parking revenues.
- Related to this, **early engagement with the many stakeholders concerned** is key to minimising the overall network deployment time: this includes investors, land owners, DNOs, planning authorities, parking authorities, transportation /highways authorities.
- New developments can be the best opportunities to obtain new charge point sites, i.e. by making provision of sites, or the provision of adequate space and power, a condition for planning approval.
- Feedback from existing networks also suggests that a **well-funded and dedicated project management resource** is essential to a successful rollout, given the significant work required with external actors and the risk of delays and cost increases

Business Case and governance

Based on the expected payback period of over 5 years, **long-term contractual commitments** between network operators and landowners are typically needed to attract private sector investment, and investors usually seek commitment periods over 10 years. Ways to accommodate this include:

- Break clauses at regular intervals (e.g. every 5 or 8 years), with compensation agreements to pay for any losses incurred by the network operator up to that point;
- Sweeteners, such as profit-sharing agreements in the event that the rapid CP network breaks even earlier than initially planned (e.g. due to higher than predicted loading).

Separating the procurement of CP equipment from that of operating contracts is seen as best practice: CP equipment and long-term maintenance is a one-off purchase designed to

meet a technical specification, whereas CP management services are specifically tailored to the scheme and require greater flexibility (e.g. regular re-tendering).

Tender documentation must be carefully prepared, with **expert advice on equipment specification**, and it must take into account Local Authority/public sector procurement rules and the needs of land owners.

End-user experience

Catering for all plug-in vehicles currently on the market requires deploying charge points with **3 outlets** (Type 2 AC, CHAdeMO, DC and Combined Charging System DC).

Deploying **several charge points per location** has proven popular in existing networks. It reduces 'queuing anxiety', can have cost advantages (fewer planning processes, fixed cost effects) and increases the visibility of the network.

Many users are seen to **prefer rapid charging** to other slower facilities and like using WIFI and/or buying food and drink during their charging slot. However it should be noted that the experience of rapid charging in cities is limited, as networks have mostly been deployed for intercity use to date.

A booking system is not seen as essential by network operators in the early rollout phase, with a preference to install additional CPs rather than implement a booking system. However, in the case of urban areas where siting is challenging and/or in the case of commercial fleets, this approach might prove unpractical.

Different CPs are subject to varying electricity/capacity costs. However there is a strong preference amongst users for **consistent pricing**, so variations should be built into the business plan. Likewise, interoperable networks are more attractive, through allowing hassle-free charging across a wider geographic area. Interoperability can be relatively easily provided through the back-office system provider and Open Charge Point Protocol-compliant equipment.

Relevance to the case of London

Consulted London LAs agreed with the general findings, and their experience confirms that finding sites for fast/rapid charge points is often the greatest barrier to deployment. The London experience also highlights an opportunity to harmonise and streamline the planning permission process as well as improving the project management side by getting access to the relevant technical expertise – both among related stakeholders (e.g. local Distribution Network Operator) and among other Council teams.

Regarding the case of new developments providing an opportunity for siting, the London Plan already includes the provision of 'socket ready' car spaces, which was easily adopted by developers. It might therefore be possible to consider the inclusion of 'rapid charge point hubs' in new developments to address the challenge of finding space for such charge points, provided the evidence base is in place.

Contents

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Acknowledgments

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Acronyms

AC	Alternative Current
AQ	Air Quality
BEV	Battery Electric Vehicle
CCS	Combined Charging System
CP	Charge Point
DC	Direct Current
DE	Germany
DK	Denmark
DNO	Distribution Network Operator
DUoS	Distribution Use of System
EC	European Commission
ESB	Electricity Supply Board
EST	Energy Saving Trust
EV	Electric Vehicle
GLA	Greater London Authority
ICE	Internal Combustion Engine
LA	Local Authority
NL	Netherlands
NO	Norway
OEM	Original Equipment Manufacturer
OLEV	Office for Low Emission Vehicles
PAYG	Pay As You Go
PHEV	Plug-in Hybrid Electric Vehicle
RCN	Rapid Charge Network
RE-EV	Range Extended Electric Vehicle
SE	Sweden
TfL	Transport for London
TEN-T	Trans-European Transport Network
UK	United Kingdom
UKEVSE	UK EV Supply Equipment Association
ULEV	Ultra Low Emission Vehicle
ZCF	Zero Carbon Futures
ZE	Zero Emission
ZEC	Zero Emission Capable

1 Introduction

Electric vehicles are widely regarded as a key Ultra Low Emission Vehicle (ULEV) technology, and are expected to play a major role in meeting London's CO_2 and air quality targets. Whilst uptake of private electric vehicles is now growing at a rapid pace (with over 25,000 EVs now on the UK's roads), it is recognised that commercial fleet vehicles (taxis, private hire operators, logistics operators, service providers, car clubs, etc.) will also need to make a key contribution towards growing London's ULEV fleet. The establishment of an Ultra Low Emission Zone (ULEZ) in central London from September 2020 will also provide a further incentive for the mass uptake of ULEVs, as well as helping to meet CO_2 and local air quality targets.

Whilst the 1,400 charging points (mostly 3-7kW) deployed as part of the Source London public network (now owned and managed by Bluepoint London Ltd) and other resident-focused programs (e.g. in Westminster) are expected to provide sufficient charging capacity for private electric vehicles, many commercial fleet vehicles will require fast or rapid charging[2] in order to meet their more challenging duty cycles. This is particularly relevant in relation to the proposed requirement that all taxis and private hire vehicles (PHVs)[3] presented for licensing for the first time in London from January 2018 need to be zero emission capable (ZEC)[4].

TfL recognises that it has a strong role to play in ensuring that this charging infrastructure need is met. In order to most effectively plan and optimise its role in any future fast/rapid charging network, TfL commissioned Element Energy to gather evidence of best practice in supporting and deploying fast or rapid charging infrastructure networks elsewhere.

This project has carried out a detailed desk-based assessment of over 25 rapid/fast charging networks across the UK, Europe and elsewhere, followed by a more in-depth bilateral consultation with 10 networks that were deemed most relevant to London. The study's main focus was to identify best practice in deploying and running fast/rapid charging networks elsewhere and to highlight how this relates to the London-specific challenges and barriers identified as part of the study.

The outputs from the desk-based and consultation-based work are presented in this final report, which will support TfL in developing its strategy for meeting London's fast/rapid charging requirements in the coming years.

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[2] In this report, 'fast' charging refers to AC charging at 7 to 22kW (typically 22kW is meant when referring to fast charging). 'Rapid charging' rate is over 40kW (typically 43kW AC or 50kW DC). A 20kWh battery would take 6-7h to fully charge at 3kW but would be 80% charged up in c. 20min under a rapid charging rate.

[3] TfL is responsible for the licensing of taxis and private hire services in London. Taxis can be hailed on the street or at designated taxi ranks whilst private hire vehicles must be pre-booked with a licensed private hire operator. A wide range of vehicles can be licensed as a PHV. Only vehicles that meet the age, emissions, accessibility and manoeuvrability requirements of the London Conditions of Fitness can be licensed as taxis.

[4] A ZEC taxi is defined as having CO_2 emissions of ≤50gCO_2/km and minimum zero emission range of 30 miles. A ZEC Private Hire Vehicle is defined as having CO_2 emissions of ≤50gCO_2/km and minimum zero emission range of 10 miles or >50gCO_2/km and <75gCO_2/km and minimum zero emission range of 20 miles (aligned with OLEV plug-in car grant requirements, subject to consultation).

2   Technical background

2.1   Introduction to charging standards

The charging equipment landscape is somewhat complex and can be confusing to buyers of electric vehicles. This section aims to provide a very high level overview of the different charging standards and equipment, based on the three main categories described below.

- **Charging speed**: this is defined by the kW of electrical output and falls into three main categories, namely slow/standard charging (< 7kW), fast charging (7-22kW) and rapid charging (>43kW)

- **Connector type**: a wide range of connectors are available, including 3-pin AC, Type 1 AC (both a disappearing minority now), Type 2 AC, CHAdeMO DC and Combo CCS DC.

  The three charge point connectors relevant to rapid charging are Type 2 (43kW AC), CHAdeMO (50kW DC) and Combo CCS (50kW DC and AC). While Directive 2014/94/EU[5] requests that the Type 2 and CCS connectors are installed at AC and DC 'high power' charge point for interoperability purposes, it does not preclude the installation of the CHAdeMO outlets. The three outlets are therefore likely to continue to coexist, as the CHAdeMO protocol has been adopted by the bestselling (to date) EV manufacturer (Nissan).

- **Charging mode**: there are four main European charging mode standards, defined by the maximum current allowable, as well as the safety equipment incorporated and communications protocol used between the vehicle and the charging equipment. The two modes relevant to rapid charging are mode 3 AC charging and mode 4 DC charging, both with a smart data connection to allow vehicle-charger communications.

The interaction between these three variables for the typical charge points are displayed below.

	Slow/standard charge points <7 kW AC	Fast charge points 7 to 22kW AC	Rapid charge points 43 kW AC- 50kW DC
Outlet	3-pin AC / Type 1 AC / Type 2 AC	Type 2 AC	Type 2 AC / CHAdeMO DC / Combo CCS DC
Charging mode	▪ Single phase AC charging ▪ Typically mode 2 charging (32A max with residual current device, but no data connection)	▪ Single or 3-phase AC charging (22kW requires 3-phase) ▪ Typically mode 3 charging (32A max with data connection)	▪ Type 2 uses 43kW 3-phase AC mode 3 charging (32A max with data connection) ▪ CHADeMO or CCS Combo use 50kW DC mode 4 (125A max with data connection)
Cost	▪ c. £10k on-street (mainly due to cost of Traffic Order and other planning processes) ▪ <£2k off street	▪ Costs for 7kW similar/ close to 3kW ▪ Costs for 22kW: £12k-15k ▪ c. 80% installed are 7kW in the UK	▪ Indicative unit costs for 43kW-50kW: c. £38-45k ▪ Can be higher if electricity distribution network upgrade is needed

Source: Element Energy, OLEV, Zap-map.com. Costs are indicative production +installation, connection costs will vary across sites

CCS = Combined Charging System
AC = Alternative Current, DC = Direct Current

Figure 3 – Description of most common charging connector configurations

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[5] Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure, Official Journal of the European Union, L307/1

2.2 Vehicle compatibility with different charging standards

It was introduced earlier that several types of rapid charging connectors exist. The Figure 4 indicates the compatibility of plug-in cars on the market (represented through their brand logo) with each fast and rapid charging type. It shows that compatibility varies with electric vehicle brands.

For the case of cars and hence Private Hire Vehicles, the table shows that:

- All but one of today's **PHEV**s are Type 2, but not compatible with any of the rapid charging standards (the exception being the Mitsubishi Outlander PHEV);
- All three rapid charging standards are needed to charge the full range of **BEV** models available from OEMs.

For the case of expected Zero Emission Capable Hackney Carriages, the number of models is much more limited but the charging compatibility is nonetheless varied too:

- For PHEV/RE-EV models, the LTC, Karsan and Metrocab Hackney Carriages are expected to compatible with rapid charging, but there is no clarity yet on the type of rapid charging they will operate with.
- The only pure EV model announced to date (Nissan model derived from the e-NV200) is compatible with CHAdeMO DC charging. It is however unclear when/if Nissan are taking the eNV200 forward to meet the London Conditions of Fitness.

PLUG-IN HYBRID/ RANGE EXTENDER EVs

Brand	Fast 7kW	Fast 22kW	Rapid >40kw
Audi			
BMW			
CHEVROLET			
Mercedes-Benz			
MITSUBISHI			CHAdeMO
Porsche			
TOYOTA			
VAUXHALL			
VOLVO			
VW			

Note: all vehicles are capable of charging at 3kW.

The capability to charge at 7 or 22kW is often offered as an option or for some variants only.

BATTERY EVs

Brand	Fast 7kW	Fast 22kW	Rapid >40kw
BMW	✓		Combo
BYD	✓	✓	Type 2
CITROËN			CHAdeMO
Ford	✓		
KIA	✓		CHAdeMO
Mercedes-Benz	✓	✓	
MITSUBISHI			CHAdeMO
NISSAN	✓		CHAdeMO
PEUGEOT			CHAdeMO
RENAULT	✓	✓	Type 2
smart	✓		
Tesla	✓	✓	CHAdeMO
VW	✓		Combo

Figure 4 – Compatibility of electric cars with fast and rapid charging[6]

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[6] Sources: Element Energy, UK Electric Vehicle Equipment Supply Association, OEM specifications. A more detailed list in provided in Appendix 5.2

3   Consultation outputs and best practice

3.1   Summary of approach to consultation

The number of fast and/or rapid charging networks is overall limited, and concentrated mainly in Japan, North America and Europe.

The map below shows the main European national and transnational networks of fast and rapid charge points. It shows the emergence of transnational networks, most of which are backed by either the European Commission and/or vehicle OEMs.

Figure 5 – Selection of national and transnational fast and rapid charging networks[7]

The study started with a detailed desk-based investigation of over 25 charging networks (mixed power rates, fast or rapid – not all shown in the map above) globally. It was followed by a consultation with a total of 10 charging networks that were deemed most relevant to London, spread across 7 countries, and covering a range of geographic extents, funding and operational structures (see Figure 6 next page for a full list of the networks consulted).

Pre-read material was circulated to all consultees in advance of the meeting/call, including an introduction to the study, technical background information on the technologies at play, as well as a list of pre-prepared questions that would be used to guide the discussion.

As well as consulting directly with network operators and owners, we also included discussions with equipment and service providers. The point of view of current and future rapid CP users was investigated through attendance to TfL-led workshops with London taxi and private hire drivers, as well as direct consultation in some cases.

Lastly, we conducted a workshop with several London Local Authorities that have deployed rapid charge points (or are considering it), UKPN (the Distribution Network Operator of London), OLEV, GLA and EST (who have conducted a feasibility study into a rapid charge point network for plug-in

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[7] Non exhaustive list. Source: EE consultation with network operators, TEN-T program press releases

taxis). The workshop was an opportunity to present the findings from the consultation and discuss their relevance to the case of London.

Network	Description, extent, technology	Backing	Data source
ecotricity	• Free network covering majority of UK motorways • >220 rapid CP sites (mixture of CHAdeMO, AC, CCS) • Integrates the recent RCN (see below)	NISSAN, Office for Low Emission Vehicles, BMW, RENAULT, VW, ESB, TEN-T EA	Ecotricity, CPS, APT, Nissan, ZCF
rcn rapid charge network	• Two road axes: North-South and East-West connecting major roads/ports in UK and Ireland • 74 CCS/ CHAdeMO /AC rapid CPs		
source LONDON	• London-wide network, annual membership fee and access to Ecotricity network • C. 1,400 charge points (mostly 3-7kW)	Bolloré	Source London lessons learned guidance (TfL), Boroughs
CHARGER DRIVE	• Largest Nordic rapid-charging network, covering Sweden, Finland and Norway with PAYG CP • 75 rapid CPs currently, aim for 145 rapid out of c. 500 overall by end of 2015	Fortum Next generation energy company	Fortum, Renault Norway
FASTNED	• Netherlands-wide rapid charging network, based at services stations, PAYG and subscription options • Full highway coverage (>200) sought (currently 31, installing 1 per week), extension along highways in SE (35), DK (23), DE (67), NL (35) as well as in Dutch cities	TEN-T EA Trans-European Transport Network Executive Agency	Fastned
Auchan	• Planned France-wide charging network, offering free charging to Nissan users via a smart card • 130 rapid chargers to be installed at Auchan stores by end 2015, to add to 120 already at Nissan dealers	NISSAN, sodetrel	Nissan
WEST COAST ELECTRIC HIGHWAY	• Network running North-South across West-Coast US, linking with other local urban networks • Aiming to deploy rapid CP every 25 miles across California, Oregon and Washington states	Various EV-focused and other AQ federal funds	Drive Oregon
CHAdeMO	• Various rapid-charging networks, backed by OEMs, fuel retailers and Governments • >3,000 CHAdeMO chargers in Japan, Ministry of Economy, Trade & Industry long-term aim for 36,000	Various OEMs, municipalities, fuel retailers	Nissan
TRANSPORT SCOTLAND	• Local-Authority led rapid CP network across Scotland, coordinated by Transport Scotland • Aim to have one rapid CP every 35 miles along major roads, plus plans to deploy in urban areas	Office for Low Emission Vehicles, TRANSPORT SCOTLAND	Transport Scotland
ESB	• Government-backed and utility-led extensive fast and rapid charging network across Ireland • Number of DC chargers 75+, most of which are located on main motorways, currently free to use	Funding based on levy on electricity charges	ESB

Figure 6 – Full list of networks consulted

3.2 Charging network case studies

The consultation revealed a wide variety of rapid CP network configurations in different locations, with each network operating under the geographic, political and commercial realities of their local markets. The key variables in describing a rapid CP network include:

- **CP suppliers and design**, in particular whether the CPs are to be deployed individually or as part of multi-CP recharging 'stations';

- **Commercial strategies**, with a wide range of options available to achieve semi- or fully-commercial propositions. This can include for example publically-funded networks run by the private sector, fully privately-funded and run networks, networks deployed and operated by multiple Local Authorities within a broader geographic area, etc.

- **Funding structure**, with a wide range of public/private funding splits depending on the commercial strategy selected. Funding can be sought from a range of sources, including dedicated EV infrastructure funds, but also non-specific funds such as air quality improvement funds, etc.

- **Network governance**, with some network owners choosing to take a more hands-on approach to back-office systems, operation and maintenance compared to others who rely on third parties to carry out the various tasks required to run a network.

Multiple stakeholders are involved in deploying and running CP networks:

- Owner/operator: responsible for developing the business model and operating the network

- Equipment provider: responsible for supplying and maintaining the equipment

- Project manager: manage the deployment of the network

- Installer: separate contractor responsible for deploying (and sometimes maintaining) CPs

- Back-office operators: responsible for ensuring the reliability of the network, availability of data to users, payment system, managing network interoperability, etc.
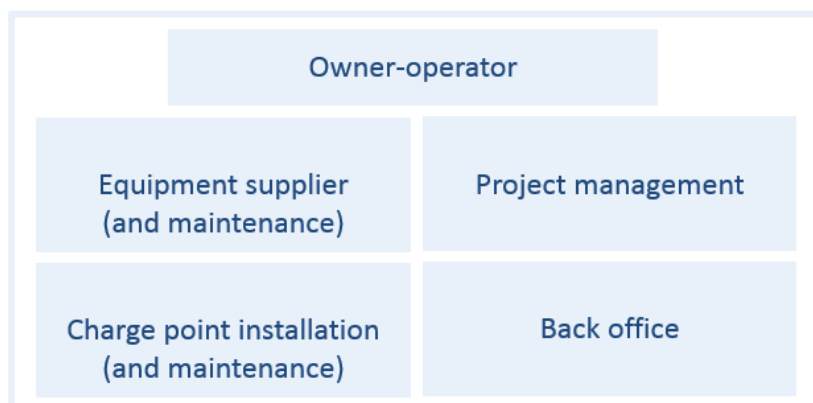
Figure 7 – Typical stakeholders involved in operating a charging network

In some cases, an organisation adopts several of these roles.

In order to illustrate the very distinct approaches that can be adopted, four rapid CP network case studies are presented succinctly in Figure 8, each describing a different type of network.

Electric Highway (UK)		Fastned network (Netherlands)	

Description (Electric Highway)
- Largest UK rapid CP network, covering all the major UK motorway service stations
- > 220 rapid CP sites already deployed, with more planned under the EC funded RCN project
- Currently free to use for all users, no immediate plans to start charging

Funding (Electric Highway)
- OLEV, Nissan (equipment and installation), Ecotricity (electricity and operation) and service station operators (providing land via a contract with Ecotricity). More OEMs, ESB and EC for RCN

Governance (Electric Highway)
- Owner-operator: ecotricity
- Equipment supplier: DBT
- Project management: Zero Carbon Futures, EC HARRIS BUILT ASSET CONSULTANCY
- CP installation: British Gas
- Back office: Charge Point

Description (Fastned network)
- Largest Dutch rapid CP network, with a deal to deploy rapid charging 'stations' (i.e. multiple units under a canopy) across all the Dutch motorways
- Target of > 200 rapid CP stations, 31 deployed to date, also looking to expand to urban areas
- Monthly billing of customers per kWh used

Funding (Fastned network)
- Entirely privately funded through selling share 'certificates', with minimum investment of €10
- Developed as commercial proposition, with breakeven at 15 charges per day, or c. 5 years

Governance (Fastned network)
- Owner-operator: FASTNED
- Equipment supplier: ABB
- Project management: FASTNED
- CP installation: ABB
- Back office: NOW! INNOVATIONS

RCN: Rapid Charge Network, EC funded project deploying c.74 rapid CP in the UK, backed by Nissan, Renault, VW, BMW and ESB

ESB network (Ireland)		Transport Scotland network	

Description (ESB network)
- National network (mixture of AC & DC urban, and DC inter-urban) covering the Republic of Ireland
- Number of DC chargers 75+, most of which are located on main motorways; currently free to use

Funding (ESB network)
- Network deployment (equipment, site search, civils, network upgrades [when required]) funded by ESB (a few posts funded by Nissan)
- Developed as a commercial proposition, with costs retrospectively recovered from Distribution Use of System charges

Governance (ESB network)
- Owner-operator: ESB
- Equipment supplier: Various (5 installed)
- Project management: ESB
- CP installation: ESB
- Back office (to 2015 Q3): pod POINT, IBM

Description (Transport Scotland)
- LA-led organically-grown network, aiming for national coverage (every 35 miles), with a focus on key routes connecting major towns and cities
- Initially free to use for all users

Funding (Transport Scotland)
- Funding from OLEV and Transport Scotland to cover all civils, equipment and network upgrades
- Individual LAs free to apply for funding to build the network, then operated by Charge Your Car
- Free to use until at least mid-2016

Governance (Transport Scotland)
- Owner-operator: Various LAs
- Equipment supplier: Various via framework
- Project management: Individual LAs
- CP installation: Various via framework
- Back office: charge your car

Figure 8 – Rapid CP network configuration case studies

9

The **Electric Highway**, the largest rapid charging network to date in Europe, has been mostly privately funded, until the EC backed Rapid Charge Network (RCN) project that started in 2014. The Electric Highway has been initiated, and is operated, by the clean electricity supplier Ecotricity.

It will grow to c. 300 sites by the end of 2015, 4 years after the first installation. The free to use network is an example where each role is fulfilled by a different stakeholder:

- Ecotricity owns the units, provides the electricity, covers the running costs and leads on site finding & negotiation;

- Zero Carbon Futures are in charge of the day to day project management with support from EC Harris. ZCF is also the transitory owner of most of the RCN units, until 2018;

- Charge Point Services, British Gas and DBT are the contracted for, respectively, running the back office, the installation and supply of units;

The network stakeholders work closely together and hold monthly steering committee meetings.

The Electric Highway has received crucial financial support from the Nissan Business Incubator scheme in the early years, a project that set out to reduce the then high capital costs of charging posts through standardisation and higher production volumes.

More vehicles OEMs have since joined in the effort to provide the UK with a national network of rapid charge points – a condition seen by OEMs as key to the mass rollout of EVs. Figure 10 details the rollout phases of the Electric Highway and the many contributors.

Figure 9 – A charge point of the Electric Highway

The latest phase, the Rapid Charge Network, is a project initiated by Nissan that is co-funded by the European Commission as part of the TEN-T program[8]; it will extend the Electric Highway to Ireland.
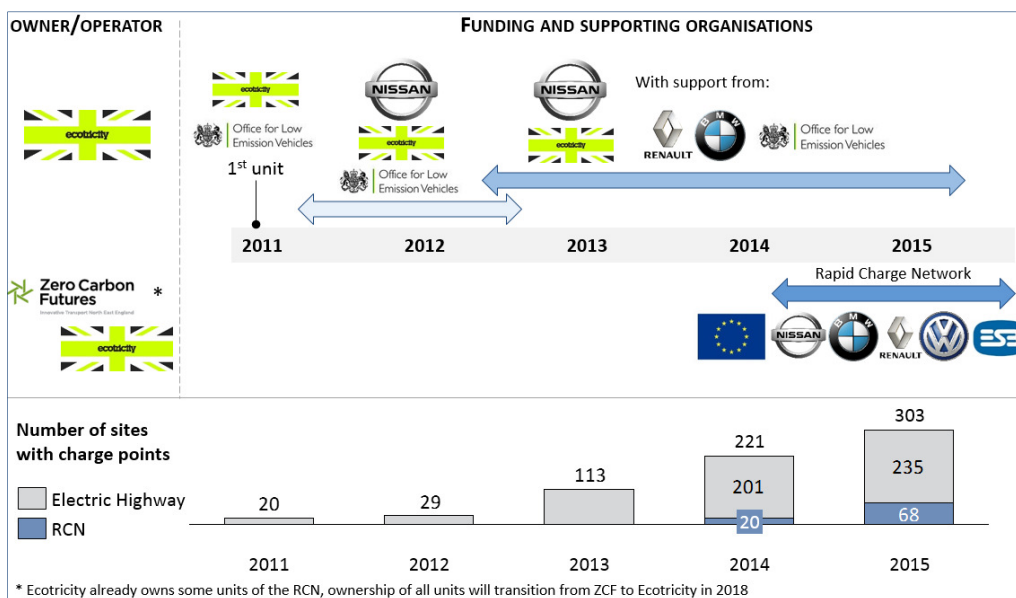
Figure 10 – Ownership and funding structure of the Electric Highway[9]

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[8] The TEN-T corridors are a planned set of transport networks (road, rail, air and water) identified as key for trans-European passengers and freight movements. See map and information on other TENT-T projects in Appendix.

The Dutch **Fastned network** is unique in its funding structure and charging site layout: it is a **privately run and funded network of 'forecourt style' rapid charging stations** (see picture on the right). The first station was opened in November 2013 and there are 31 open as of May 2015 – with the current installation rate at around 1 new station per week. The company has already secured sites along highways for the next installations, with a plan to cover Dutch motorways by 2017 – see Figure 12.

Figure 11 – Fastned station

The company estimates the commercial break even is reached at 15 charges per station of 2 posts (7.5 charges a day per outlet) and has raised capital through sales of share 'certificates'.

Figure 12 – Fastned planned network of stations (yellow dots) along highways (grey lines).[10]

The **ESB network** covers the Republic of Ireland, having been deployed by, and now owned and operated by the Irish semi state utility ESB. It is aiming at deploying up to 100 rapid CPs along Irish main roads, an increase of up to an additional 25 rapid CPs on the already installed and operational 75, which will take place in line with additional EV uptake and rapid charging needs. The ESB CP network provides an example where **governance is comprehensively integrated**: as well as being the network owner and operator, ESB also takes on the role of project management and all aspects of installation. ESB conducted all negotiations with the grid company and land owners in site selection for all of the network installations, as well as ensuring network design optimisation was in line with grid capacity and specific site requirements and constraints. The back office services and equipment supply were both tendered (separately), in a process managed by ESB. A new tender process is currently underway, again led and managed by ESB, for a new, next generation backend, the upgrade of which will be completed by 2015. Like many other networks, it is currently free to use to all users. However, fees for use of the national charging network will be in introduced in 2016.

The **Transport Scotland network** is a publically funded network aiming at covering the entire country, with the focus being to locate the rapid charge points as close as possible to key routes connecting Scotland's major towns and cities. It provides an example of a **multi-owners network**, allowing for variations across the network in terms of speed of deployment and suppliers (electricity, hardware, installation).The 32 Scottish Local Authorities can apply for funding and subsequently own the units, which are installed on public land. Consistency across the network is ensured through procurement frameworks for hardware and installation and a single back office operator (Charge Your Car). Each LA engage with local stakeholders (e.g. DNOs) but receive some guidance from Transport Scotland regarding appropriate siting. Transport Scotland also engage with LAs on other aspects affecting the end users, such as future pricing, to ensure a

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[9] Source: Ecotricity, Nissan, ZCF
[10] Source: Fastned

balanced approach is taken across the network. The network is expected to grow to approximately 450 units, including c.75 rapid charge points.

3.3 Challenges and barriers themes

In order to guide the consultation and structure the discussions with consultees, the challenges and barriers to rapid CP deployment were split into three main 'themes', namely 'business case', 'end-user experience' and 'siting and practicalities'.

For each of these overarching themes, a series of sub-themes were developed to describe the challenges and barriers that were deemed most relevant to London. Some of the most relevant sub-themes are listed in Figure 13 below.

Siting/practical
- Site identification
- Land ownership
- Impact of planning policy and local regulation
- Technical/safety
- Electricity distribution network impact

Business case
- Funding
- Commercial model
- Ownership
- Public/private split
- Supplier arrangements

End-user experience
- Targeted vehicle types and priority
- Billing and customer interactions
- Interoperability with other networks and service providers

Figure 13 – Main themes and sub-themes used for guiding the consultation discussions

For each specific sub-theme, targeted questions were prepared for consultees on how the specific challenges and barriers relevant to their network were approached. These were circulated to consultees as part of a pre-read pack, in advance of the meeting/call.

The consultation was used to refine the sub-themes identified, whilst key outputs from the discussions were grouped into additional relevant sub-themes where necessary, in order to present a well-structured summary of best practice in rapid CP network deployment. These sub-themes are discussed in more detail in the next section.

3.4 Charging network deployment best practice

This section includes a discussion of how other networks have approached the challenges and barriers identified for deploying a rapid CP network. Individual consultation responses have been anonymised and wherever possible, responses have been grouped into the relevant sub-themes to provide a well-structured and useful guidance document for TfL and other key stakeholders.

3.4.1 Siting and practicalities

The vast majority of rapid CP network operators/owners highlighted site identification as being the number one barrier to deploying a network, particularly in urban areas. A number of key issues must be dealt with when deploying a rapid CP network, with the most prominent described below.

Focus on London

At least two boroughs installed a reduced number of rapid CPs compared to funding obtained because of difficulties in finding sites.

Size of equipment

The size of equipment and the associated parking spaces results in a total site footprint that makes it difficult to accommodate rapid CPs on-street from a practical point of view. Restrictions

on the minimum width of pavement or on siting in front of residential buildings/shops, heritage or conservation areas, the additional space required for queuing and the impact on traffic flows must all be taken into account when identifying rapid CP sites.

For on-street sites, there is an additional challenge from the fact that parking revenue is one of the main sources of income for many Local Authorities and there is a need to convince Local Authorities of the value of providing on-street rapid CP sites, in order for them to accept this impact on their revenues.

Identifying sufficient free space for off-street parking (often from private-sector land owners) is also seen as challenging, due to the high value of real-estate and significant footprint for equipment and access requirements.

Some stakeholders have reported approaching conventional forecourts but found operators were not interested in charging points, either because of the low spare electricity capacity (car washes being common and power hungry) and/or because of concerns over traffic flow to and in the forecourt.

Planning process

Despite the existence of a Statutory Instrument dedicated to charge points (number 2056, see Appendix), consultees reported there is currently no clear guidance on the planning process for rapid CPs in urban areas and network operators/owners tend to deal with each application on a stand-alone basis. This can pose a significant barrier to deployment, given uncertainty around the timescales involved and restrictions in different local areas (e.g. maximum height

> ***Focus on London***
>
> *Several London Boroughs have deployed rapid CPs and each has so far used a different process to obtain planning permission.*

of posts, restrictions on lengthy cabling, conservation areas, etc.). Many sites have to-date used 'work-arounds' to avoid delays in obtaining planning permission, but there is a risk of retroactive enforcement.

Electricity network upgrades

The view from many urban network operators/owners is that there are a large number of suitable substations in most urban areas and that access to electricity supply should not, on its own, prevent the deployment of a rapid CP network. However, all network operators/owners highlighted the essential need to map the electricity distribution network early during the site selection process in order minimise the complexity and cost of network connections/upgrades and provide an early filter to sites selected based on other criteria.

In terms of minimum requirements, there is a need to be within c. 50m of a substation, as well as having a 3-phase mains supply on the right side of the street, in order to avoid excessive additional network upgrade costs. The supply required for a single CP is often 100kW (dual charging), rather than 50kW, and this must be taken into account when identifying substations with sufficient spare capacity.

Non-technical siting requirements

Consultees reported other non-technical siting criteria, the key ones being:

- Relevance to commercial fleets, based on typical routes, proximity to busy thoroughfares, etc.

- Proximity to CCTV and street lighting

- Access to nearby amenities (e.g.: shops, cafes, rest areas, etc.)

Project management and stakeholder engagement

Many of the network operators/owners consulted highlighted the needed for a more coordinated and formalised approach to project management for future deployments. This would ensure that clear responsibilities are assigned to specific stakeholders and that networks can be deployed in a more efficient and timely manner. Key elements of this approach could include:

- A well-funded and dedicated project management resource to formally guide the project

- A dedicated site identification task force, taking responsibility for all site-selection interactions and tasks and interacting regularly with all the key stakeholders, e.g. DNOs, land owners, equipment providers, Local Authorities, etc.

- A project board with all the key stakeholders, set up from the start to provide high-level guidance to the project and site selection

Ideally these fora would be established on a city-wide basis, incorporating all the relevant players and Local Authorities, to avoid major differences between local areas.

In addition to a more formalised approach to project management, many urban networks are moving towards a system of early engagement with the key stakeholders required for a successful deployment. These include investors, local DNOs, planning authorities, parking authorities, transportation/highways authorities, Local Authorities, etc. In particular, two main types of stakeholders are highlighted as needing to be engaged with at least 6-12 months prior to commissioning:

- Both public and private sector land owners, to allow sufficient time for contracts to be agreed;

- Local DNOs, in order to work with them from an early stage in the siting process, to help constrain siting and evaluate the overall cost of each CP deployment. Here, it has been suggested that a dedicated rapid CP team should be established within local DNOs, to provide a direct point of contact, and expert advice, for rapid CP network siting teams.

__Focus on London__

The London's cycle hire scheme sets a good example as to how a top-down approach can work, with centralised project management working with local partners where appropriate:

- *TfL with high-level location suggestions*
- *LAs do detailed siting and provide support on civils and planning processes*
- *TfL provides hardware, installation and software*

__Focus on London__

Consulted boroughs reported a high level of satisfaction with the services provided by the local DNO (UK Power Networks). However, in some instances, establishing contact with the relevant person in the organisation proved lengthy.

UK Power Networks indicated that with increased uptake of EVs on the network, eventually there could be a dedicated EV team/contact or portal. This would be incorporated into UKPN's connection process and would address the reported difficulties in finding relevant experts.

The role of regulation and a top-down approach

The role of regulation and a more coordinated approach to project deployment is seen as key to the success of future rapid CP network deployments. In particular, there is a perceived need to instil confidence in private land-owners through top-down regulation, or incentives. Public-funded pilots may be necessary to convince land owners of increased footfall.

Longer-term, network operators/owners recommend that efforts should be made by public authorities to integrate CP deployment with other infrastructure needs, e.g. street lighting upgrades, road upgrades, etc.

There is also a desire for planning policy to be altered to easily enable the deployment of rapid CPs, in a similar way to other successfully streamlined planning schemes, such as bike safety schemes in a number of European cities.

> *Focus on London*
>
> *The London Plan already includes the provision of 'socket ready' car spaces, which was easily adopted by developers. The inclusion of 'rapid charge point hubs' in new developments might have to be considered in the future to address the challenge of finding space for charge points.*

3.4.2 Business case

Contractual commitments

Whilst payback periods vary significantly across individual CPs, typical network-wide payback periods for network operators lie in the 5-8 year range, depending on network loading. As a result, most network operators with a commercial business plan require 10-15 year minimum contracts for individual charge points deployed across their network, in order to attract private sector investment.

Whilst achieving such long-term commitments from public or private sector land-owners can be challenging, a number of solutions can be used to de-risk the inability of certain land owners to commit to such long-term contracts, including:

> *Focus on London*
>
> *Several London Boroughs have now agreed long-term contracts for the future of the Source London network.*
>
> *These are based on long-term leases with 4 or 8 year break clauses, offering compensation in the event of removal of the CPs.*

- Break clauses at regular intervals (e.g. every 5 or 8 years), with compensation agreements to pay for any losses incurred by the network operator up to that point;

- Sweeteners, such as profit-sharing agreements in the event that the rapid CP network breaks even earlier than initially planned (e.g. due to higher than predicted loading).

Procurement arrangements

Procurement of equipment and services for a rapid CP network can be a significant and challenging endeavour to any prospective charging network owner/operator. Whilst the equipment supply and maintenance contracts must be robust, provide assurances on reliability and ensure the long-term availability of equipment purchased (in order to operate throughout the minimum contract period), procurement for the back-office and management systems must be significantly more flexible, ensuring regular software updates and new features as the technology evolves, whilst also

> *Focus on London*
>
> *Several approaches have been used across London, including: the use of the procurement frameworks (generally Source London or Birmingham Buy for Good), tender drawn with expert advice and procurement outsourced to private sector.*

incorporating regular reviews to allow new, more desirable suppliers to be selected in the future.

Many networks (particularly those that are publically run) have benefited from external input to support their procurement. This could take the form of:

- Expert technical advice when drafting tender documentation, or the use of 'template' tender documents;

- The use of a framework or call-off agreement used by a number of public bodies, and drafted with the help of technical experts;

- Outsourcing the procurement and deployment entirely to a trusted third party.

Commercial model

As discussed above, a range of commercial models are relevant to the deployment of rapid CP networks, with varying levels of public and/or private involvement, each with their specific break-even requirements and payback periods.

The main source of revenue for most rapid CP networks is income from selling electricity. Here, the majority of rapid CP network operators/owners agree that, whilst an introductory 'free' charging offer can be attractive, moving towards a charging model will not deter customers, if cheaper than diesel/petrol on a per km basis. Whilst invoicing customers on a time-charge basis is currently most widely used, many networks are moving towards a kWh-based invoicing system in order to improve fairness to the customer (given the many factors that determine the number of kWhs delivered to a battery in a set time period). A number of challenges exist to this transition however, including:

- Lack of clarity over regulation: in theory only licensed energy suppliers are allowed to sell kWh of electricity to consumers. Ofgem guidance is open to interpretation and does not clarify if CP network operators/owners are 'automatically' exempted from that rule, i.e. if they are allowed to sell energy on a per unit basis.

- Due to the charging curves for batteries dropping off as the batteries approach full charge, there is an incentive for users to remain parked at the charge point for as long as possible, thereby preventing other users from using the rapid CPs. Maximum parking times are considered an effective solution to this problem.

From the point of view of costs, a number of key cost components must be taken into account over and above the obvious equipment and operating costs for rapid CP networks, including:

- Civil works: In some cases the civil works are paid for by the land owner, but if not, it can be a significant cost component and these are generally incorporated into any funding application or commercial business plan.

- Electricity network upgrade costs: Network upgrade requirements for rapid CPs and associated costs differ significantly by location, due to the varying robustness of local electricity networks. The most widely-adopted approach involves an early filtering of sites based on the strength of the local distribution grid. The eventual cost can be significant (e.g. over capital cost of charge point) and is generally incorporated into any funding applications or commercial business plans.

- Land rent or ownership costs: The cost of real estate is rarely accommodated as part of achieving a viable payback period for networks. Land owners are usually sufficiently engaged to provide the land at favourable rates in the early years of deployment. As utilisation increases, higher rents/profit sharing are often accommodated into business plans.

Electricity supply arrangements

Most rapid CP networks use land that is owned by a variety of public/private sector players, in order to identify the optimal locations for their CP sites. In many cases, each land owner has their own supplier and agreed electricity tariff. However, differing electricity supply arrangements are not seen as a major barrier to achieving a consistent pricing structure across a network, as the range of tariffs can relatively easily be incorporated into the network business plan.

Opportunities for obtaining greener or cheaper electricity are often explored, through using dedicated green tariffs wherever possible, or through purchasing electricity of large electricity users or local/community energy supply companies.

In London, the GLA has a 'license lite' which allows it to sell excess locally generated electricity to the market without the significant licencing requirements of large utilities, whilst London Underground also has access to large amounts of cheap electricity. Arrangements for accessing this lower cost electricity may be complex however.

3.4.3 End-user experience

Impact of charge rate on charging curve

Whilst charging a car battery on a home slow charge point delivers a near-constant charging rate over a long period to the battery, the power delivered by faster charging mechanisms can drop off significantly as the battery becomes full, with the effect more pronounced as the charge rate becomes faster. This effect is illustrated in Figure 14.
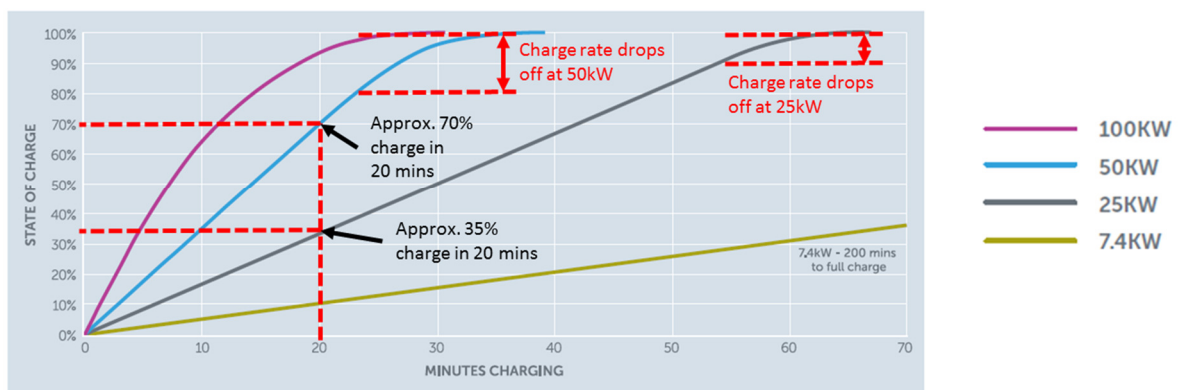
Figure 14 – Example charging curves for a 25kWh battery for different charge rates[11]

Clearly this charge rate behaviour can have a number of implications for rapid charging networks, including:

- It can make it difficult to accurately/fairly charge users starting/ending at different states-of-charge, when charging users on a time-charge basis, due to uncertainties about the rate of charge during that period. For example, the graph above indicates a user charging during 20 min at 50kW would obtain c. 17kWh (70% of 25kWh) if their battery state of charge is 0% at the start, whereas they would obtain c.12kWh if starting from 50%.

- It can incentivise users to keep charging for longer, if being charged on a kWh basis, given the rapid drop off in charge rates as the battery reaches its maximum state of charge.

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[11] Source: A guide to electric vehicle infrastructure, BEAMA, 2015

Pricing

Whilst different CPs may be subject to varying electricity and network capacity or connection costs, the vast majority of networks offer a single consistent pricing structure across all rapid CP sites, as this is seen as significantly more attractive to the end-user. A variety of pricing structures are in-use, ranging from unlimited usage monthly membership fees, to kWh-based invoicing, or time-based invoicing, with many networks offering free electricity for an introductory phase – this is discussed in more detail in Section 3.4.2 above.

> ***Focus on London***
>
> *Across Boroughs that have installed rapid charge points, the approach to tariff varies. Observed practises include £/kWh fee and fee linked to parking time*

As discussed above, price variations between sites can easily be accommodated into the overall business plan. However, where different sites within a network are owned by different organisations, achieving consistent cross-network pricing can be more challenging.

Rapid vs. fast charging

Many network operators prefer deploying 22kW AC fast CPs rather than rapid CPs where possible, for a number of reasons including:

- They are significantly cheaper than rapid CPs, e.g. c. £12-15k versus above £30k;
- They are easier to install than rapid CPs (smaller, lower electricity requirements);
- They can accommodate double the number of charge points for the same power supply;
- They require c. 1 hour charge time, which is a more useful amount of time for private users taking a break or running an errand whilst their car is charging;
- They offer greater compatibility with PHEVs, as discussed in Section 2.2 above.

However, despite this preference, demand for rapid CPs is growing, driven by two distinct markets:

- The city-centre rapid charging network aimed at:
  - Providing fleets (e.g. taxis, logistics fleets, etc.) with the ability to rapidly recharge when operating on challenging duty cycles that exceed the range of their vehicles;
  - Providing private users who do not have access to off-street slow charging, with access to rapid charging;
- The inter-city recharging network for private users, to remove their range anxiety for long-distance travel and ensure that an EV can be their primary car.

From a consumer point of view, consultees reported there is a growing preference for a quick ICE-like recharging experience, whereby users prefer to wait for 10-20 minutes for a rapid charge, whilst having a refreshment or using the free Wi-Fi that is often provided at CP sites, rather than having to deal with complicated parking arrangements with slower charge points and not having certainty that the recharging will be successful whilst they leave their car unattended.

Equipment configuration and compatibility

The vast majority of networks are today deploying integrated triple-headed rapid CPs (i.e. CHAdeMO, CCS and AC outlets), with a typical design shown in Figure 15[12]. Offering all three charging standards maximises compatibility with vehicles from different OEMs, with only a marginal cost increase over single- or double-headed CPs. Many of these triple-headed CPs are also able to charge both AC and DC vehicles at the same time, thereby increasing their potential vehicle throughput.

Figure 15 – Multi-outlets rapid charge point

Whilst the design of individual rapid CPs is relatively similar between suppliers, there is an increasing tendency amongst networks to deploy more than one CP at each location. Deploying recharging 'stations' in this way (see Figure 16 for an example layout[13]) provides a more familiar experience to users relative to traditional ICE vehicle refuelling, and has a number of additional perceived advantages, including:

- Reduced 'queuing anxiety' by instilling confidence in the availability of a charging spot – evidence in countries were charging networks are widely deployed shows that users are more likely to visit a multi-CP 'station' than a single CP, due to the increased likelihood that a CP will be available

- High-visibility marketing for the advent of EVs – there is a strong desire to ensure high visibility and accessibility to all vehicle types amongst network operators, in order to support their business model and to encourage wider take-up of EVs

- Significant cost savings through only having to run through the planning and deployment process once for multiple CPs, as well as reduced network upgrade costs

- A more 'social' experience for users, whereby they can interact with other drivers, exchange knowledge and tips on EV driving.

Whilst there has been limited evolution in the look and design of rapid CPs in recent years, certain technical barriers are forcing a re-think of the design in specific areas. This includes Paris, whereby strict conservation rules prevent the installation of long hanging connectors (between the charge point and the vehicle), whilst layout requirements led to the adoption of a 'transformer and satellite' system (the satellite unit, being placed close to the vehicle, reduces the charging cable length).

Figure 16 – Fastned station (NL)

End-user experience

Providing an attractive and simple user experience is seen as key to attracting users to adopt EVs and to use a particular charging network. To this end, the top two priorities for network operators/owners are to provide accurate and up-to-date CP availability information via a mobile phone- and internet-based App, as well as network interoperability to ensure drivers can make longer-distance journeys when needed. Some operators such as Fastned also stress the need for a consistent 'look and feel' to charging sites, and have implemented a single design across all of their sites to reduce construction costs and increase brand visibility to users.

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[12] Source of picture: Hackney Council
[13] Source of picture: Fastned

Network interoperability is generally seen as a relatively easy addition to a network, achieved through reciprocal arrangements taken through the back-office system provider(s). However, CP inaccurate fault code reporting and communications issues have been known to frequently lead to inaccurate availability reporting on consumer Apps. This is seen as a technology teething issue but should be taken into account in any equipment procurement.

Safety risks

Whilst no major safety risks have been identified by rapid CP network owners/operators, there remains uncertainty around their effects on users of pacemaker devices. Whilst some equipment providers maintain there is no risk of using their equipment, others recommend that pacemaker users should not stand within 1m of the device whilst it is charging.

This is an issue to consider when deploying charge points on the street-side in dense urban areas and further clarity is required from manufacturers as to how best to comply with these restrictions.

> ***Focus on London***
>
> *A number of Councils in London are investigating approaches for dealing with this safety risk, including warning signs, painted exclusion zones on street, etc.*

Booking facilities

The vast majority of network operators/owners agree that booking facilities are not needed in the early stages of network rollout. As utilisation increases with the increasing penetration of EVs, most networks have a preference for installing additional CPs as part of a viable business strategy, rather than implementing complicated booking facilities, which may not be well received by users. In the case of commercial fleets however (e.g. taxis), it is recognised that some element of prioritisation or booking may be required to ensure minimal disruption to their activities.

4   Key insights for deployment of rapid charge points in an urban environment

This report provides a summary of best practice for the deployment of (fast and/or) rapid charge points, based on direct consultation with networks identified as relevant, across the UK as well as outside the UK.

Below is a brief summary of the key insights relevant to the case of a deployment in an urban environment.

Siting and practical considerations

- Siting is reported to be the most important barrier for urban rapid charge point deployment, i.e. finding available land that meets criteria such as size requirements, attractive location for CP users, access to adequate power and, in some cases, non-competition with parking revenues.
- Related to this, **early engagement with the many stakeholders concerned** is key to minimising the overall network deployment time: this includes investors, land owners, DNOs, planning authorities, parking authorities, transportation /highways authorities.
- New developments can be the best opportunities to obtain new charge point sites, i.e. by making provision of sites, or the provision of adequate space and power, a condition for planning approval.
- Feedback from existing networks also suggests that a **well-funded and dedicated project management resource** is essential to a successful rollout, given the significant work required with external actors and the risk of delays and cost increases.

Business Case and governance

Based on the expected payback period of over 5 years, **long-term contractual commitments** between network operators and landowners are typically needed to attract private sector investment, and investors usually seek commitment periods over 10 years. Ways to accommodate this include:

- Break clauses at regular intervals (e.g. every 5 or 8 years), with compensation agreements to pay for any losses incurred by the network operator up to that point;
- Sweeteners, such as profit-sharing agreements in the event that the rapid CP network breaks even earlier than initially planned (e.g. due to higher than predicted loading).

The operation of a charge point network typically involves **5 distinct roles** although these are not always filled by 5 distinct entities (see right). Separating the procurement of CP equipment from that of operating contracts is seen as best practice: CP equipment and long-term maintenance is a one-off purchase designed to meet a technical specification, whereas CP management services are specifically tailored to the scheme and require greater flexibility (e.g. regular re-tendering).
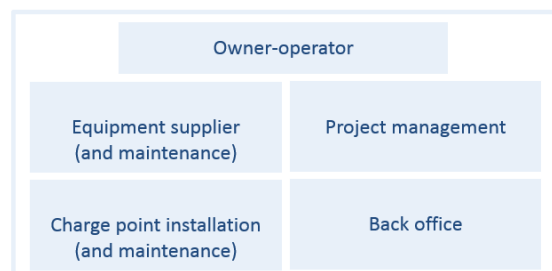
Owner-operator	
Equipment supplier (and maintenance)	Project management
Charge point installation (and maintenance)	Back office

Figure 17 – Typical stakeholders involved in operating a charging network

Tender documentation must be carefully prepared, with **expert advice on equipment specification**, and it must take into account Local Authority/public sector procurement rules and the needs of land owners.

End-user experience

Catering for all plug-in vehicles currently on the market requires deploying charge points with **3 outlets** (Type 2 AC, CHAdeMO, DC and CCS DC).

Deploying **several charge points per location** has proven popular in existing networks. It reduces 'queuing anxiety', can have cost advantages (fewer planning processes, fixed cost effects) and increases the visibility of the network.

Many users are seen to **prefer rapid charging** to other slower facilities and like using WIFI and/or buying food and drink during their charging slot. However it should be noted that the experience of rapid charging in cities is limited, as networks have mostly been deployed for intercity use to date.

A booking system is not seen as essential by network operators in the early rollout phase, with a preference to install additional CPs rather than implement a booking system. However, in the case of urban areas where siting is challenging and/or in the case of commercial fleets, this approach might prove impractical.

Different CPs are subject to varying electricity/capacity costs. However there is a strong preference amongst users for **consistent pricing**, so variations should be built into the business plan. Likewise, interoperable networks are more attractive, through allowing hassle-free charging across a wider geographic area. Interoperability can be relatively easily provided through the back-office system provider and Open Charge Point Protocol-compliant equipment.

Relevance to the case of London

Consulted London LAs agreed with the general findings, and their experience confirms that finding sites for fast/rapid charge points is often the greatest barrier to deployment. The London experience also highlights an opportunity to harmonise and streamline the planning permission process as well as improving the project management side by getting access to the relevant technical expertise – both among related stakeholders (e.g. local Distribution Network Operator) and among other Council teams.

Regarding the case of new developments providing an opportunity for siting, the London Plan already includes the provision of 'socket ready' car spaces, which was easily adopted by developers. It might therefore be possible to consider the inclusion of 'rapid charge point hubs' in new developments to address the challenge of finding space for such charge points, provided the evidence base is in place.

5 Appendix

5.1 Network maps and TEN-T projects

This section provides a few maps to illustrate the remit of some of the networks mentioned in the report and provides further information on the TEN-T charging network projects.
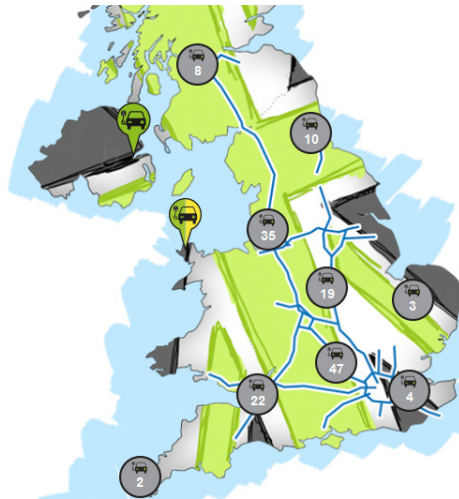
Figure 18 – Ecotricity network (not including the RCN).[14]

Figure 19 – Map of the nine core TEN-T network corridors.[15]

There are currently three TEN-T projects (and 5 pending approval) deploying rapid networks, interoperable across countries. Typically deploying multi-standard EV rapid charge points (CHAdeMO, Combo and AC Type 2), they aim at covering some of the core TEN-T corridors (see figure above) - they are summarised in Figure 20.

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[14] Source: https://www.ecotricity.co.uk/for-the-road/our-electric-highway
[15] Copyright: Railway Gazette International

Target: 74 multi-standards rapid posts
(c. 30 installed to date)

Coordinator: Nissan

Countries: UK, Ireland

Target: 200 rapid posts by end 2015 (<5 installed to date)

Coordinator: EDF

Country: France

Target: 90 multi-standards posts and 115 fast and rapid posts in total

Coordinator: Verbund

Countries: Austria, Germany, Slovenia, Slovakia

Figure 20 – Maps and key facts of the three rapid network projects currently co-funded by the TEN-T program[16]

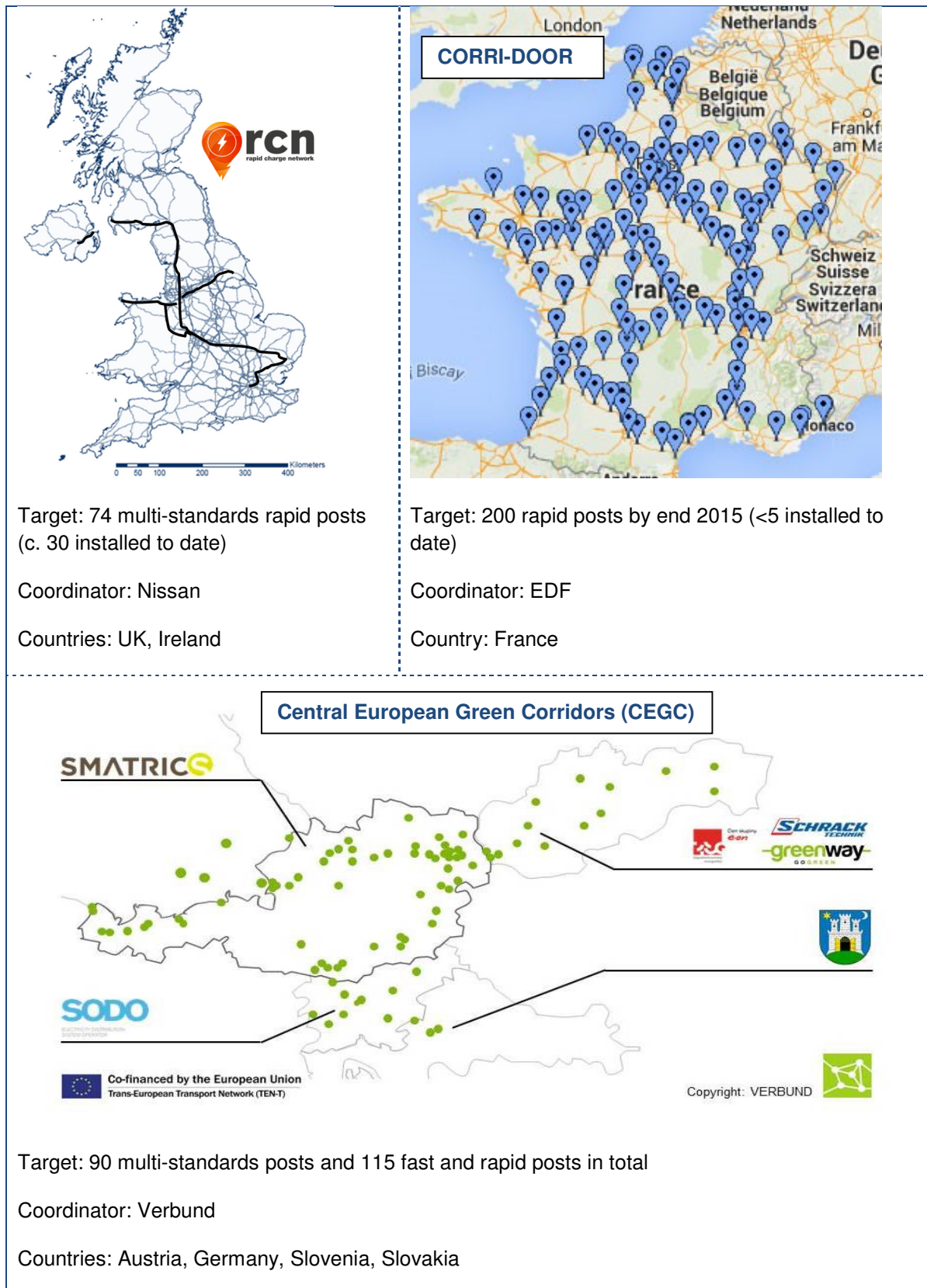[16] Sources: respective projects websites or press release, maps: Element Energy,
http://www.greencarcongress.com/2015/06/20150612-corridor.html and http://www.cegc-project.eu/

elementenergy

5.2 Full list of plug-in electric vehicles and charging capabilities[17]

PLUG-IN HYBRID/ RANGE EXTENDER EVs

Vehicle	Fast 7kW	Fast 22kW	Rapid >40kw
Audi A3 e-tron			
BMW i8 (2014)			
Chevrolet Volt			
Chevrolet Spark			
Mercedes S500 PHEV (2014-2015)			
Mitsubishi Outlander PHEV (2014)			CHAdeMO
Porsche Panamera PHEV (2013)			
Toyota Prius PHEV (2012)			
Vauxhall Ampera (2012)			
Volvo V60 PHEV (2013)			
VW Passat PHEV (2015)			

BATTERY EVs

Vehicle	Fast 7kW	Fast 22kW	Rapid >40kw
BMW i3	✓		Combo
BYD e6	✓	✓	Type 2
Citroen C-Zero			CHAdeMO
Ford C-MAX Energi (2014)			
Ford Focus EV (2014)	✓		
Kia Soul EV	✓		CHAdeMO
Mercedes B-Class E-Cell Plus	✓		
Mercedes SLS EV (2014-2015)	✓	✓	
Mercedes Vito E-Cell Van (2012)	✓		
Mitsubishi i-Miev (2012)			CHAdeMO
Mitsubishi i-Miev (2010)			CHAdeMO
Nissan Leaf (2011)			CHAdeMO
Nissan Leaf (2013)	✓		CHAdeMO
Nissan e-NV200 (2014-2015)	✓		CHAdeMO
Peugeot iON (2012)			CHAdeMO
Renault Fluence EV(2012)			
Renault Kangoo Electric Van(2012)			
Renault Twizy Electric (2012)			
Renault Zoe	✓	✓	Type2
Daimler Smart ED (2013-)	✓		
Daimler Smart ED (2010)			
Tesla Roadster (2011)	✓	✓	
Tesla Model S (2014)	✓	✓	CHAdeMO
Tesla Model X (2015)	✓	✓	CHAdeMO
VW E-Up (2014)			Combo
VW E-Golf (2014-2015)	✓		Combo

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[17] Sources: Element Energy, UK Electric Vehicle Equipment Supply Association, OEM specifications.

5.3 Planning guidance

Extract from UKEVSE guidance document (*Making the right connections, General procurement guidance for electric vehicle charge points*, UKEVSE, 2015):

Planning consent (or permission) for Charge Points is only needed under certain circumstances. The permitted development can be found in Statutory Instrument 2056. It indicates that you will need planning permission if the Charge Point;

1. *Exceeds 0.2 cubic metres in volume at off-street locations where a wall mounted Charge Point is used (most wall units are well within this volume);*

2. *Exceeds 1.6 metres in height at on-street locations where a ground mounted Charge Point is used (most fast charge Points are within this height. However, Rapid Charge Points are usually around 2 metres in height);*

3. *Faces onto and within 2 metres of the highway;*

4. *Is within a site designated as a scheduled monument;*

5. *Is within the curtilage (open space surrounding) of a listed building.*

For further details please see [Statutory Instrument 2056](#).