Electric Vehicles workshop

Steve Halsey

Distributed Energy Resources Development Manager

UK POWER NETWORKS THE SUNDAY TIMES 25 BEST BIG COMPANIES TO WORK FOR 2016

Utility Week Awards 2015 WINNER Utility of the Year

INVESTORS IN PEOPLE | Gold

FutureSmart

UK Power Networks Delivering your electricity

Agenda

1 Introduction – who's here today

Background/scene setting/market intelligence

2 How we plan our network today

Application/connection process

Break

3 Innovation – Preparing for the future

Creating a market- Flexibility Launch

Q&A at end of each session

Who's here today

Thazi Edwards	LCT & EV Projects
Ismini Dimitriadou	Innovation Engineer
Thanos Zarogiannis	LCT Project Lead
Antony White	Stakeholder Engagement & Account Manager
Nigel Turner	DER Business Analyst
Judith Edgerton	Customer Relationship Manager
Michael Howe	Customer Relationship Manager
Holly Woolliscroft	Comms. Engagement and Events Lead
Neil Madgwick	Head of Service Delivery

About UK Power Networks

Measure	Data	% of industry
End customers	8.2m	28%
Population served	20m	28%
New metered connections	46,000	32%
Distributed generation connected	9GW	32%
ED1 totex allowance	£6,029m	25%
Energy distributed	85TWh	29%
Peak demand	16GW	28%

UK Power Networks
Delivering your electricity

Delivering our vision

The safest
The best employer

The most reliable
The best service
The most innovative
The most Sociably responsible

The lowest cost

…and consistently best performing DNO 2015 – 2018/9

Why the interest?

- Kyoto 1997
- Climate Change Act 2008
- Government commitments – Road to Zero Strategy
- Deaths associated with poor air quality
- London Mayors Transport Plan
- Sales of new Internal Combustion Engine powered cars to cease by 2040

up to 3.5 million
electric vehicles in our three licensee areas by **2030**

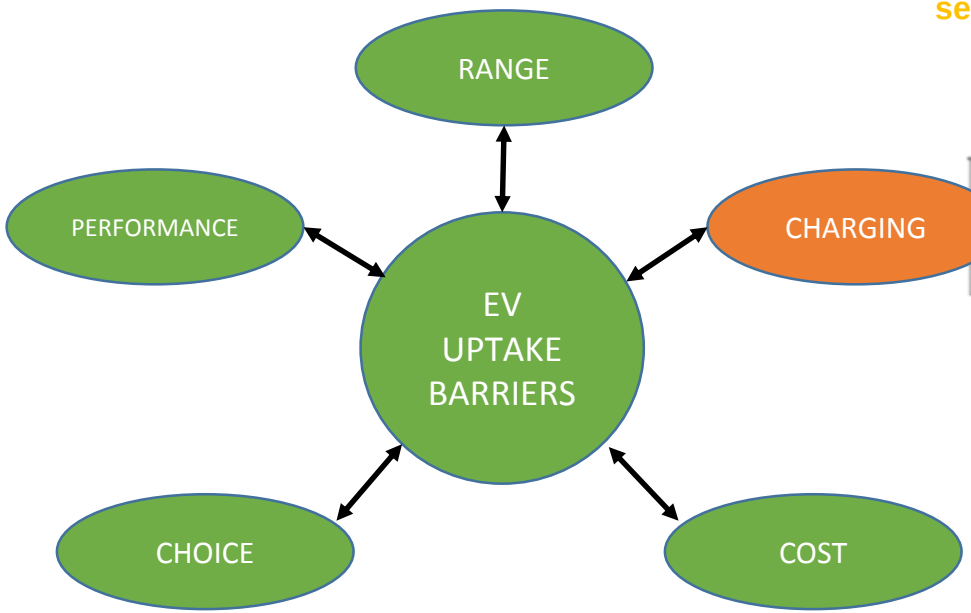
51% more
electric vehicles to date than our previous forecast

UK Power Networks
Delivering your electricity

EV Barriers & Charging Segments

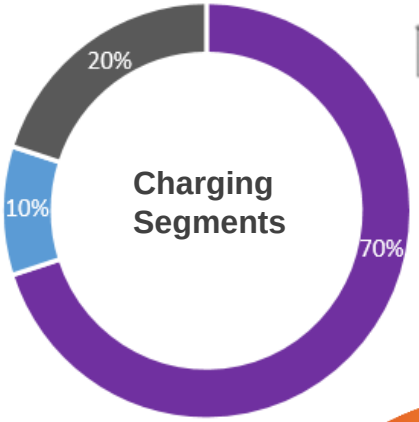
Charging segments

Commercial Fleets ‘at work’	Public ‘en-route’	Residential ‘at home’



'At Work' Charging

'En-Route' Charging



'At Home ' Charging

Focus on the LV Network first

UK Power Networks
Delivering your electricity

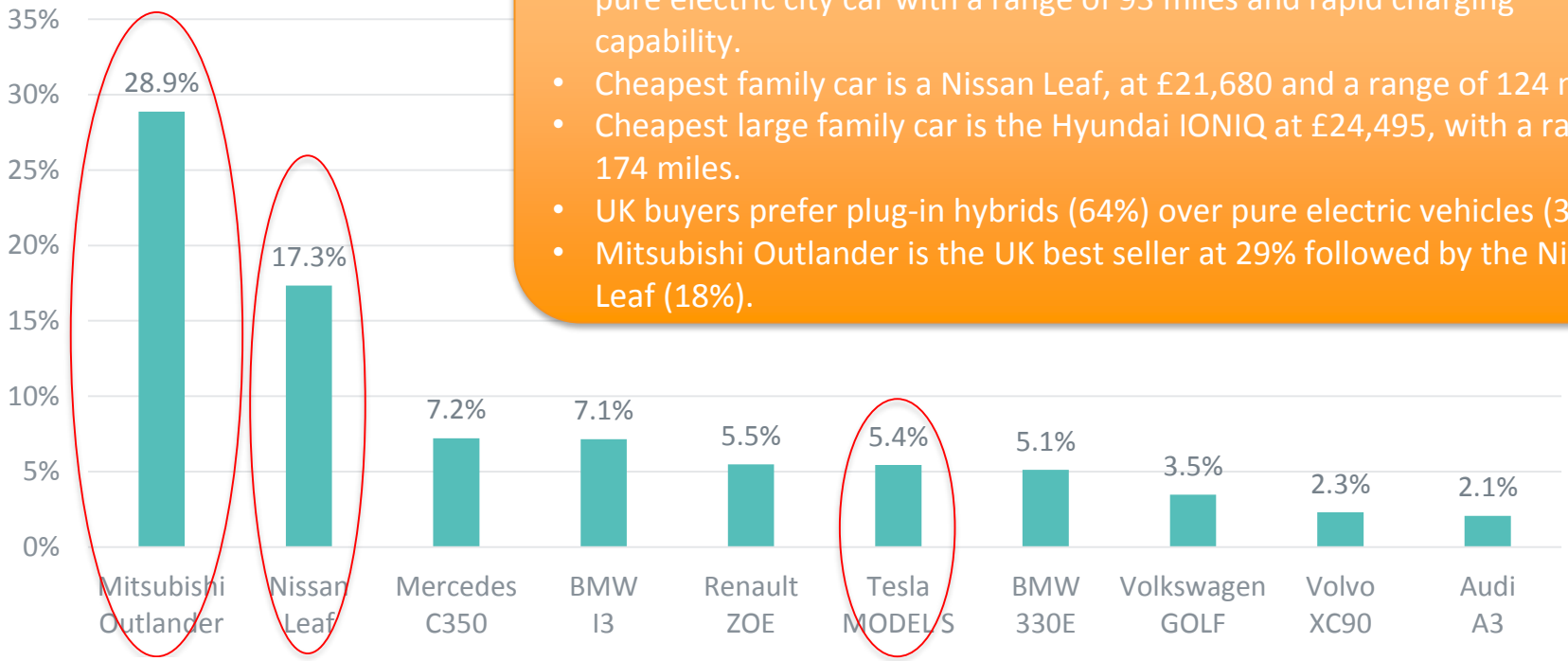
Typical charging times for PHEVs and EVs

	PHEV and EV models (battery capacity)		Residential charger from empty			Residential charger from ½ empty		
			3kW Domestic plug (13A)	3.7kW (16A)	7.4kW (32A)	3kW Domestic plug (13A)	3.7kW (16A)	7.4kW (32A)
	Mitsubishi Outlander (12kWh)	3kW On board charger	4hrs	3.5hrs	2hrs	2hrs	1.75hrs	1hr
	Tesla S 100D (100kWh)	10/20 kW On board charger	33.3hrs	27hrs	14hrs	17hrs	13.5hrs	7hrs
	2018 Nissan Leaf (40kWh)	7kW On board charger	13hrs	10hrs	6hrs	7hrs	5hrs	3hrs

UK Power Networks
Delivering your electricity

Model Choice

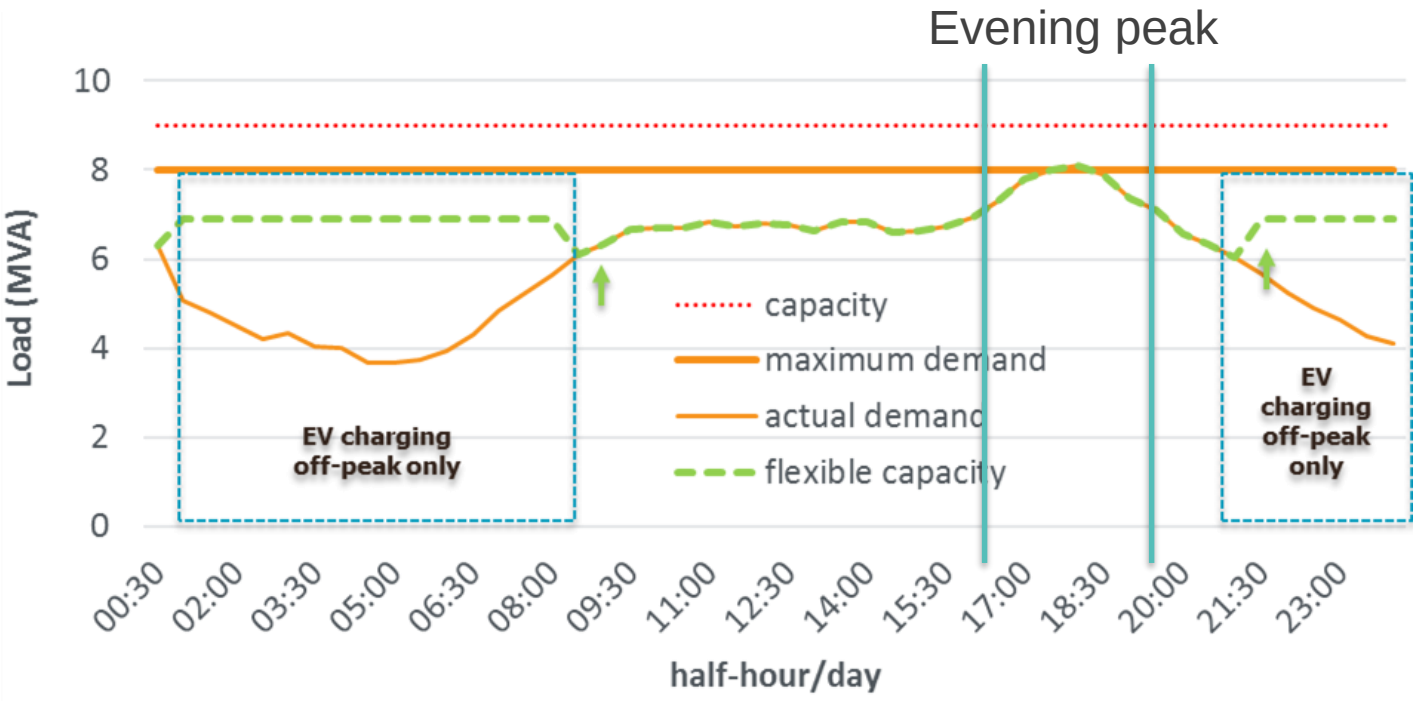
- 140+ EV models available, with on-the-road costs starting at £12,495 for a pure electric city car with a range of 93 miles and rapid charging capability.
- Cheapest family car is a Nissan Leaf, at £21,680 and a range of 124 miles.
- Cheapest large family car is the Hyundai IONIQ at £24,495, with a range of 174 miles.
- UK buyers prefer plug-in hybrids (64%) over pure electric vehicles (36%).
- Mitsubishi Outlander is the UK best seller at 29% followed by the Nissan Leaf (18%).



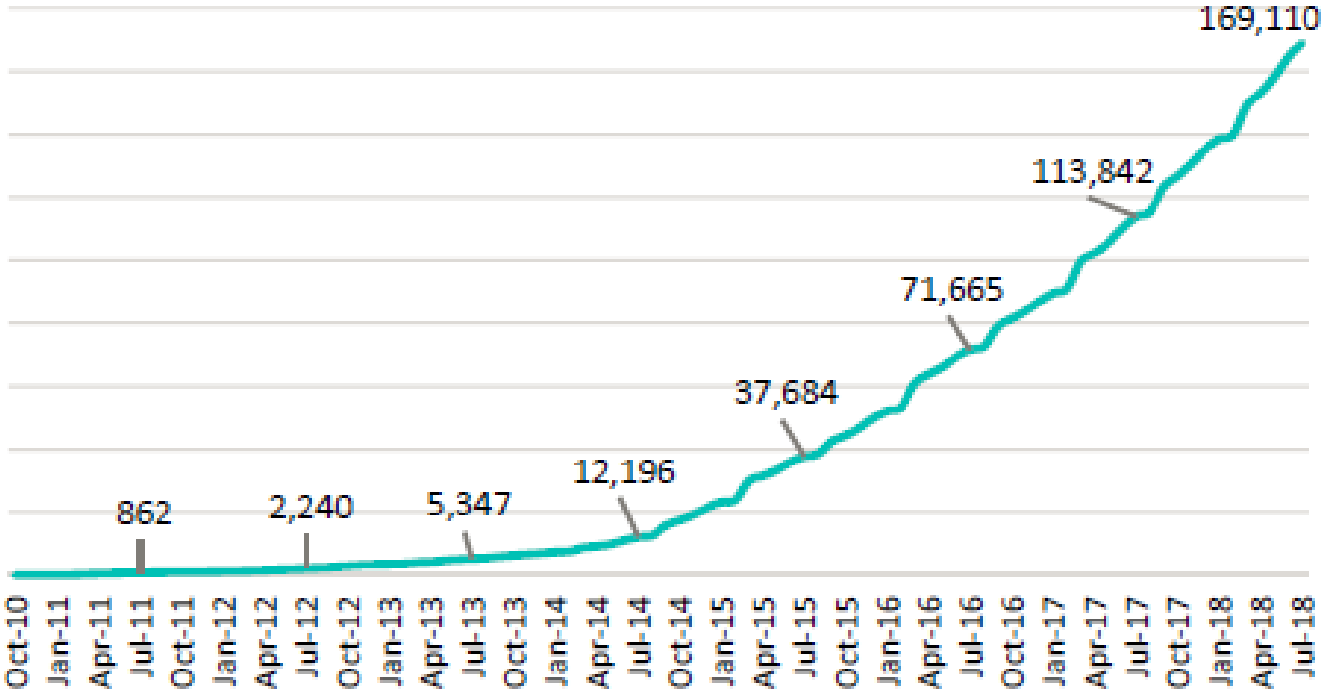
Leading electric vehicle models in the UK

UK Power Networks
Delivering your electricity

Typical demand profile



Market intelligence - EV uptake in UK

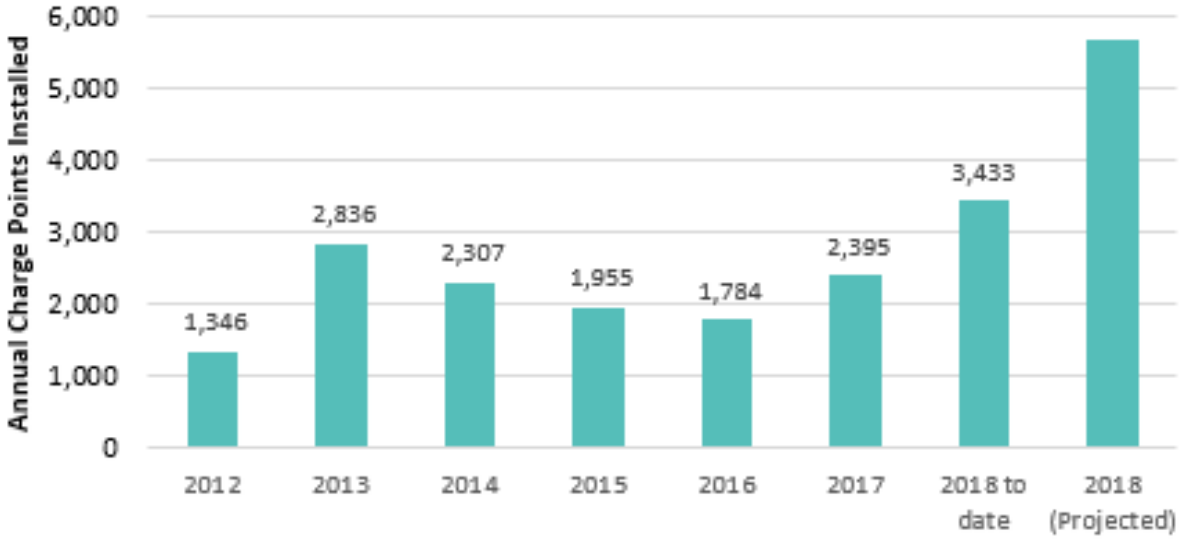


Represents 2.5% market share

Source: Society of Motor Manufacturers and Traders, Driver and Vehicle Licensing Agency

UK Power Networks
Delivering your electricity

Market intelligence UK charge point installations – excl. domestic



The first five months of 2018 saw more charge points installed than in any previous full year period, with the exception of the peak year of 2013.

Charge Point Type	UK
Slow (0-3kW)	19%
Fast (7-22kW)	62%
Rapid (>43kW)	19%
Total	**100.0%**

UK Power Networks
Delivering your electricity

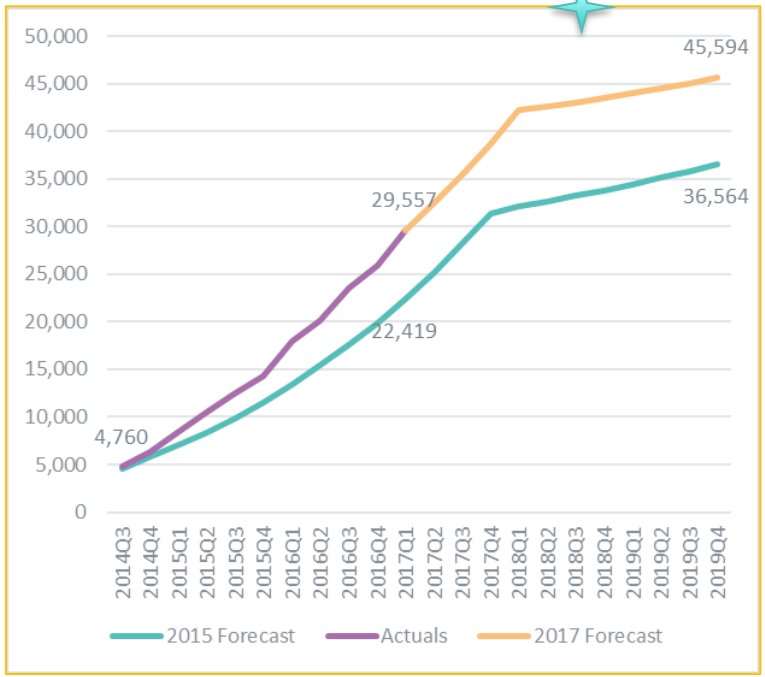
Market intelligence EV Uptake UK Power Networks level

Over 17,500
Public Charge points
and growing fast

53,000
Plug-in Cars, in our
patch- 31% of UK

By 2030 we forecast **4.1m**
Plug-in vehicles across
UKPN networks

UKPN EV actuals
53% ahead of
ED1 Forecast



Charging frequencies BEV & PHEVs

38% charge less than twice a week

33% charge 2-4 times a week

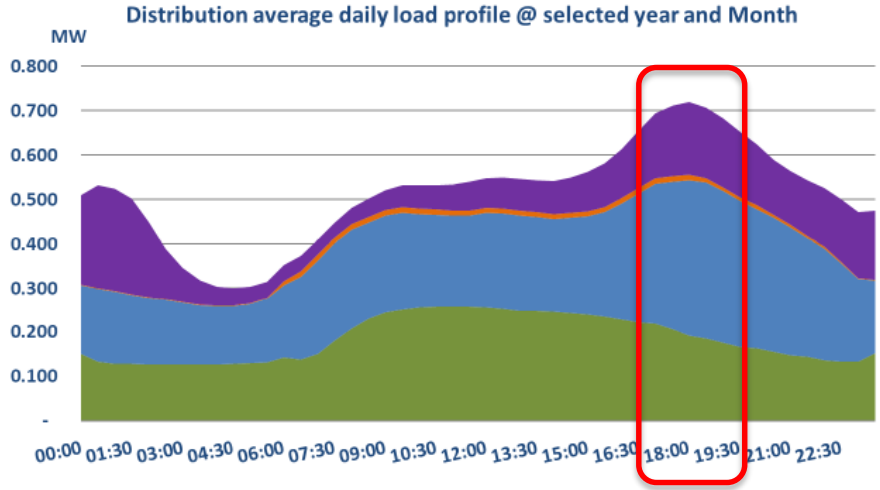
20% charge 4-6 times a week

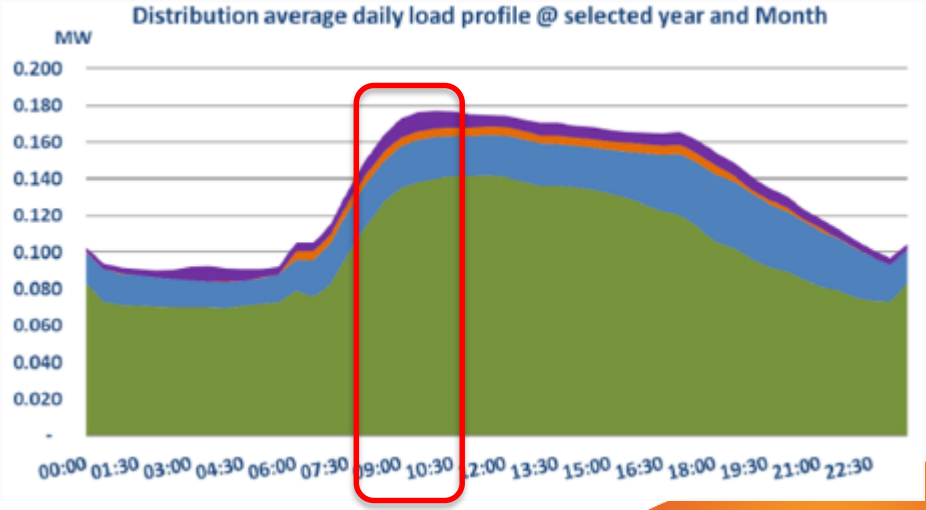
9% charge each day

By 2033- 500 London distribution subs could have 20 or more Taxi/ PHV connected

What does this mean for UK Power Networks?

The impact of EV load varies significantly across substations





UK Power Networks
Delivering your electricity

Challenges to EV Connection

Cost (the Capital Hurdle)

Partnering with fleet operators to trial new charging arrangements to unlock commercial business cases

Supporting deployment of 'Behind the meter' optimization for commercial customers

Setting up new local markets for flexibility to enable benefits to players across sectors

Time to facilitate infrastructure

Offering new customer products such as Profiled and Timed Connections

Bringing customers in for bespoke Connection Surgeries to advise on strategic EV infrastructure

Mapping visibility of network opportunity areas to enable informed planning and flexibility

Technical Challenges

Published new guidelines under UKPN EV Connection Standard

Consulting and creating evidence to inform industry Codes of Practice, standards and processes

Enabling smart charging benefits and demonstrating value of EVs as mobile energy assets (V2G)

UK Power Networks
Delivering your electricity

Early engagement with stakeholders

Supporting TfL, Local Authorities and the wider stakeholder community

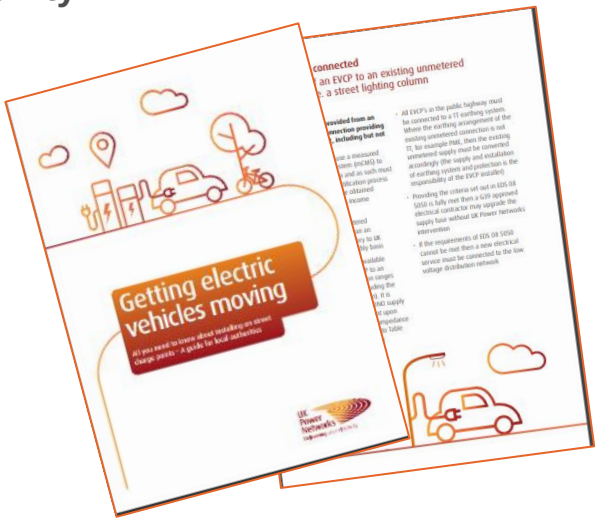
Running Local Government Forum to raise awareness of EVs with Councillors and Officers

In discussion with all London Local Authorities in receipt of Go Ultra Low funding to offer advice and support

Developed EV charging guides for Local Authorities and street furniture officers to help them understand the opportunities and challenges of connecting EV infrastructure

Developed EV charging guide for Taxi fleet

Running workshops with the London Lighting Engineers Group (LoLEG) and other Local authority Officers to support the rollout of EV charging infrastructure in the Highways



How are connections planned, how do we plan at network level?

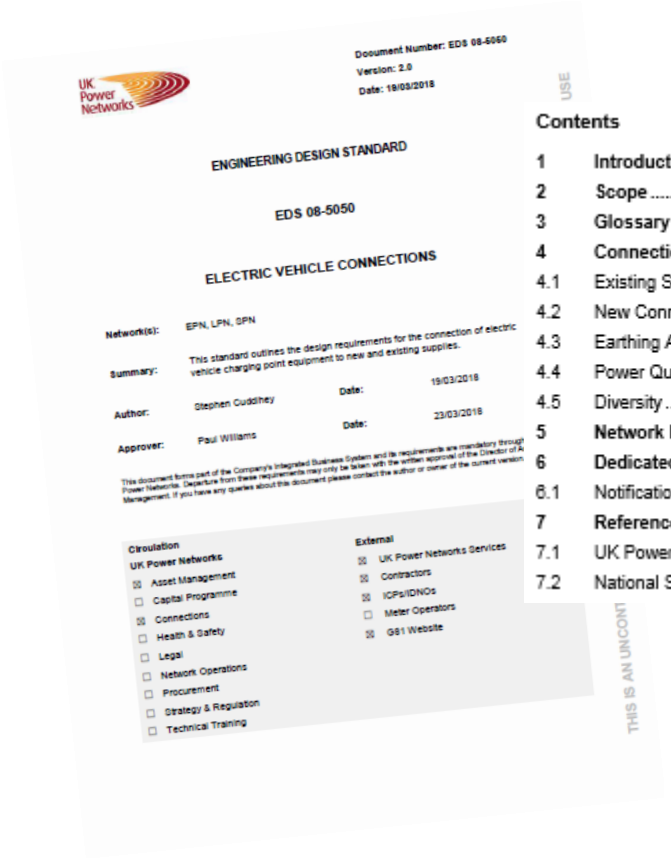
ADMD* calculation of house – IET COP

- IET COP advises that Diversity Factor (DF) used to calculate the ADMD* when installing an EVCP should be 1 (no diversity allowed)
  - This is the DF installers are using to ensure that new maximum demand of the house doesn't exceed the fuse cut-out rating
  - Installers seem happy with this value

*After Diversity Maximum Demand

UK Power Networks
Delivering your electricity

EV Connection Standard EDS-08 5050



Doument Number: EDS 08-5050
Version: 2.0
Date: 19/03/2018

ENGINEERING DESIGN STANDARD

EDS 08-5050

ELECTRIC VEHICLE CONNECTIONS

Network(s): EPN, LPN, SPN

Summary: This standard outlines the design requirements for the connection of electric vehicle charging point equipment to new and existing supplies.

Author: Stephen Guidney Date: 19/03/2018

Approver: Paul Williams Date: 23/03/2018

This document forms part of the Company's Integrated Business System and its requirements are mandatory through Power Networks. Departure from these requirements may only be taken with the written approval of the Director of A Management. If you have any queries about this document please contact the author or owner of the current version.

Circulation
UK Power Networks
- ☒ Asset Management
- ☐ Capital Programme
- ☒ Connections
- ☐ Health & Safety
- ☐ Legal
- ☐ Network Operations
- ☐ Procurement
- ☐ Strategy & Regulation
- ☐ Technical Training

External
- ☒ UK Power Networks Services
- ☒ Contractors
- ☒ ICPs/IDNOs
- ☐ Meter Operators
- ☒ G81 Website

USE

THIS IS AN UNCONT

Contents

Table 4-1 – EVCP Diversity Factors

Context	Diversity factor†
1. Single charging point in a single dwelling	0.5
2. Multi Occupancy Buildings (No. of EVCPs >= no. of dwellings)	0.5
3. Multi Occupancy Buildings (No. of EVCPs < no. of dwellings)	0.8
4. Public Car Parks or On-Street Charging Points	0.8
5. Multiple charging points, in commercial customer applications	Case specific

† diversity factor applied to the total kW rating of the EV charging points

UK Power Networks
Delivering your electricity

Diversity factor from network point of view – EDS 08-5050

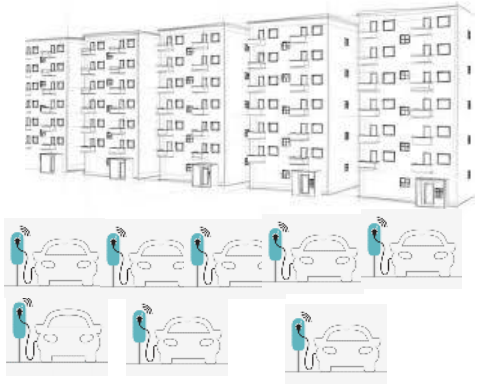
- UK Power Networks EDS 08-5050 advises on the diversity factors that should be used when considering an installation of an EVCP from the network point of view

UKPN

Each dwelling's EV load should be given **0.5** diversity from the network point of view

✓ DF=0.5 refers to a single dwelling as considered when designing the network

✓ DF=0.8 refers to a multi-occupancy dwelling where amount of CPs<amount of homes, when designing the network



UKPN

Each EVCP load should be given **0.8** diversity from the network point of view

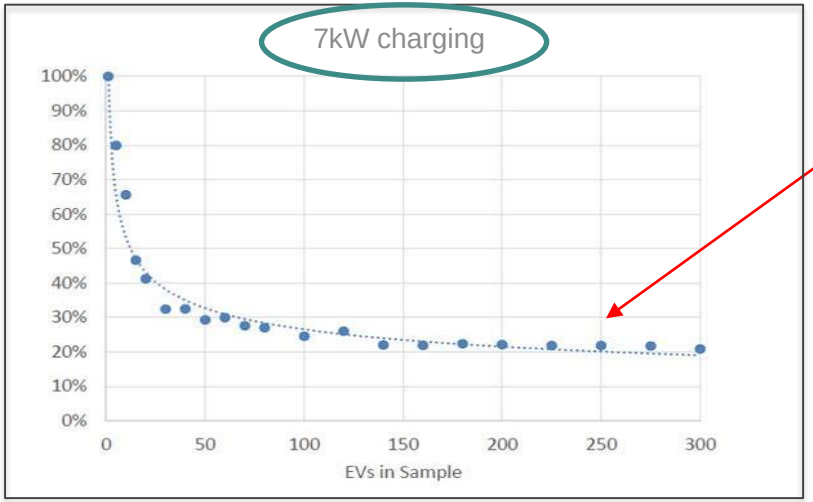
Diversity factor from network point of view

For how many dwellings does the DF=0.5 hold true?

Electric Nation findings indicate that a 250 EV sample would need a DF=0.3.

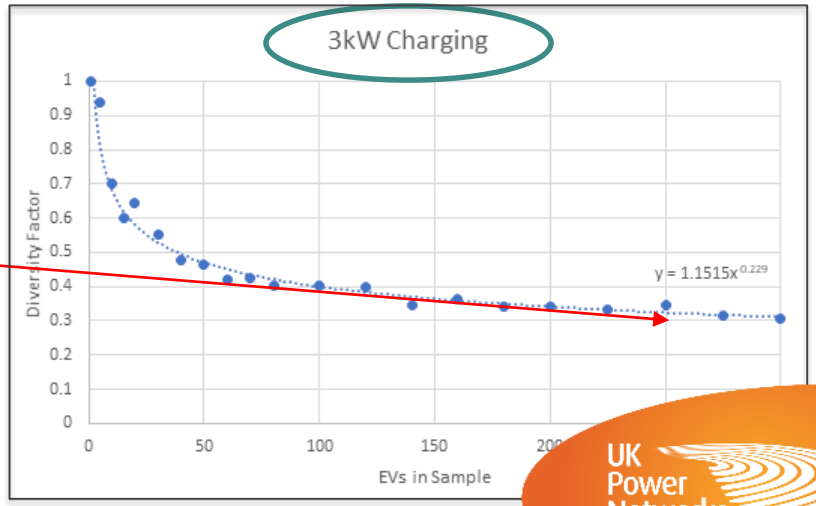
Diversity factors - data analysis

- Sample size n=377 – real sample size though was down to 150 customers
  - Graph flattens out after 150 sample size
- 12 months worth of data – this analysis only used the 3 winter months
- All are single houses with 1 EV each
- Assumed charge rate is 7kW across all charge points. Separate analysis done for 3kW charging



0.2

0.3



Diversity factor from network point of view – EDS 08-5050

What's the effect of PV and/or battery storage on site?
What's the effect of load management solutions installed with EVCPs?
How does smart charging alter the effect of EV charging on house's demand?

UK Power Networks
Delivering your electricity

Working together to deliver the optimal connection

Supporting TfL in attaining a zero emission bus fleet by 2037

Taking a strategic approach

- Look holistically at the local infrastructure and location of garages to deliver the most efficient upgrade programme
- Spend the time analysing the bus routes and dwell times to minimise charging at peak times
- Space is at a premium in most bus garages and you will need space for electrical infrastructure
- If you want to charge on route be clear you may not be able to connect from the passing main – make sure you have the space for the electrical infrastructure

Waterloo Garage – timed connection

Delivery on the ground

- Working closely with the Bus team in TfL and the Bus Operators
- Delivered upgrades at three garages with two more in the pipeline

We have taken an holistic approach to estimate the total cost of electrifying all the garages in TFL footprint significantly reducing TfL's previous estimates

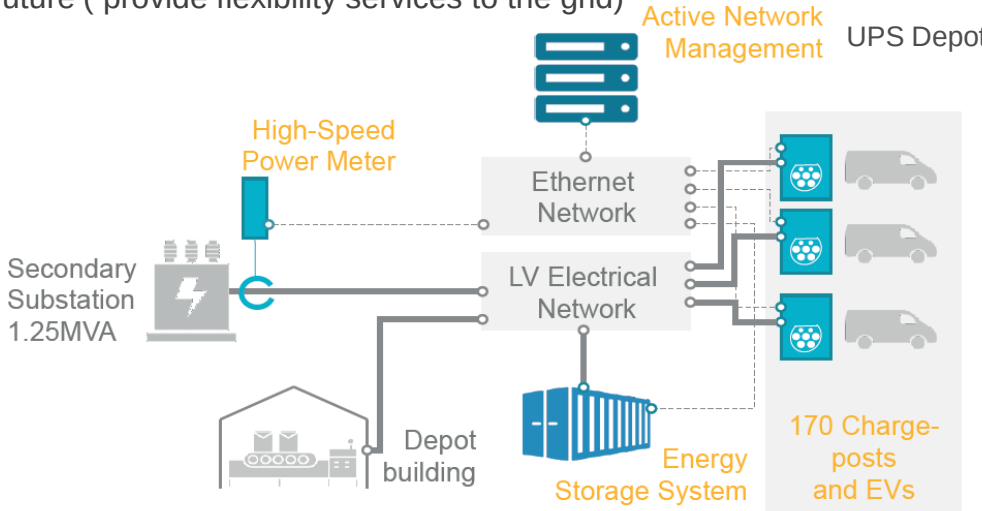
UK Power Networks
Delivering your electricity

How new technology can support your connection

Behind the meter smart:

- Smart charging reduces the capital expenditure required for fleet electrification
  - An uncontrolled peak demand of 2200 kVA is catered by a 1250 kVA grid connection using smart charging
- Smart charging can reduce operational costs
  - Reduce cost of energy (benefit from Time of Use tariffs)
  - Earn revenue in the future (provide flexibility services to the grid)

UPS Depot – intelligent network analysis



UPS Smart Charging System

UK Power Networks Delivering your electricity

Powering the taxi fleet

Supporting the Mayor's commitment to make 300 rapid chargers available by 2020.

- Large point loads that may not be able to connect to the passing main
- Majority of the chargers are double-headers (i.e. circa 100kW) and therefore we need to undertake a network assessment
- Harmonics can have a significant impact and the chargers should be type-tested to the appropriate European standards

- It is helpful to:

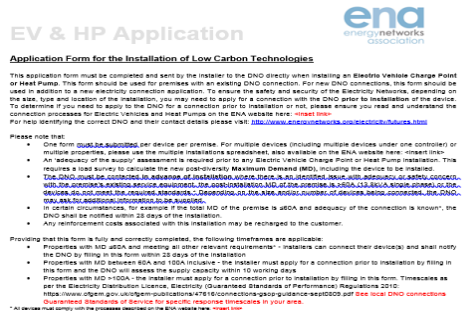
(a) Have early engagement with the customer and their charge point infrastructure provider
(b) Understand the wider on street-scheme rather than the location of individual charge points

We continue to project manage and deliver all of the complex installations and those where more than one charger is required in the same location.

UK Power Networks
Delivering your electricity

Making an application for connection

ENA application form for where an electricity connection already exists



EV & HP Application

ena energy networks association

Application Form for the Installation of Low Carbon Technologies

This application form must be completed and sent by the installer to the DNO directly when installing an Electric Vehicle Charge Point or Heat Pump. This form should be used for premises with an existing DNO connection. For new DNO connections, this form should be used in addition to a new electricity connection application. To ensure the safety and security of the Electricity Networks, depending on the size, type and location of the installation, you may need to apply for a connection with the DNO prior to installation of the device. To determine if you need to apply to the DNO for a connection prior to installation or not, please ensure you read and understand the connection processes for Electric Vehicles and Heat Pumps on the ENA website here: <insert link>
For help identifying the correct DNO and their contact details please visit: http://www.energynetworks.org/electricity/futures.html

Please note that:

- One form must be submitted per device per premise. For multiple devices (including multiple devices under one controller) or multiple properties, please use the multiple installations spreadsheet, also available on the ENA website here: <insert link>
- An 'adequacy of the supply' assessment is required prior to any Electric Vehicle Charge Point or Heat Pump installation. This requires a load survey to calculate the new post-diversity **Maximum Demand (MD)**, including the device to be installed.
- The DNO must be contacted in advance of installation where there is an identified issue with adequacy or safety concern with the premise's existing service equipment, the post-installation MD of the premise is ≥60A (13.8kVA single phase) or the devices do not meet the required standards *. Depending on the size and/or number of devices being connected, the DNO may ask for additional information to be supplied.
- In certain circumstances, for example if the total MD of the premise is ≤60A and adequacy of the connection is known*, the DNO shall be notified within 28 days of the installation.
- Any reinforcement costs associated with this installation may be recharged to the customer.

Providing that this form is fully and correctly completed, the following timeframes are applicable:

- Properties with MD ≤60A and meeting all other relevant requirements* - installers can connect their device(s) and shall notify the DNO by filling in this form within 28 days of the installation
- Properties with MD between 60A and 100A inclusive - the installer must apply for a connection prior to installation by filling in this form and the DNO will assess the supply capacity within 10 working days
- Properties with MD >100A - the installer must apply for a connection prior to installation by filling in this form. Timescales as per the Electricity Distribution Licence, Electricity (Guaranteed Standards of Performance) Regulations 2010: https://www.ofgem.gov.uk/ofgem-publications/47616/connections-gsop-guidance-sept2009.pdf See local DNO connections Guaranteed Standards of Service for specific response timescales in your area.

* All devices must comply with the processes described on the ENA website here: <insert link>

Installer Contact Details

Name	
Company	
Address line 1	
Address line 2	
Town	
Postcode	
Contact Number	
Email	

Customer Contact Details

Name	
Address line 1	
Address line 2	
Town	
Postcode	
Contact Number	

Installation Location Address (if different from Customer Address)

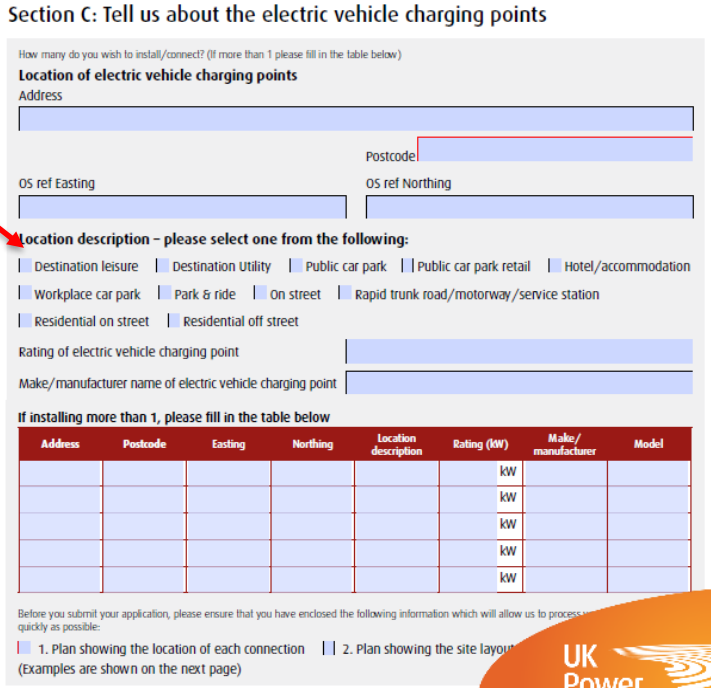
Name	
Address line 1	
Address line 2	
Town	

Destination location description

Charger Type	Power (kW)	Charge Time	Connection Type
Slow	2.3-3.7 kW	0-100% in 10-12 hours	Home, workplace, Long-stay car parks, Publicly accessible locations
Fast	7-22 kW	0-100% in 4-6 hours	
Semi-Rapid	22-43 kW	0-100% in 1-2 hours	Workplace, service stations, depots, shopping centres, depots, Tesla Supercharger station
Rapid	43kW AC -50 kW DC, 120 kW - Tesla Supercharger	0-80% in 20-30 mins	
Ultra-rapid	150kW, 350kW	0-80% in 20 mins	EU electric highway from Norway to Italy
Wireless charging	up to 7kW	0-100% 5-7 hours	Home, workplace

TYPICAL USAGE

DNO application form for where a new connection is required



Section C: Tell us about the electric vehicle charging points

How many do you wish to install/connect? (If more than 1 please fill in the table below)

Location of electric vehicle charging points

Address

Postcode

OS ref Easting

OS ref Northing

Location description – please select one from the following:

Destination leisure | Destination Utility | Public car park | Public car park retail | Hotel/accommodation

Workplace car park | Park & ride | On street | Rapid trunk road/motorway/service station

Residential on street | Residential off street

Rating of electric vehicle charging point

Make/manufacturer name of electric vehicle charging point

If installing more than 1, please fill in the table below

Address	Postcode	Easting	Northing	Location description	Rating (kW)	Make/ manufacturer	Model
					kW		
					kW		
					kW		
					kW		
					kW		

Before you submit your application, please ensure that you have enclosed the following information which will allow us to process ... quickly as possible:

1. Plan showing the location of each connection | 2. Plan showing the site layou...

(Examples are shown on the next page)

UK Power Networks
Delivering your electricity

Facilitating Electric Vehicles through Innovation

THE SUNDAY TIMES 25 BEST BIG COMPANIES TO WORK FOR 2018

Utility Week Awards 2016 WINNER Utility of the Year

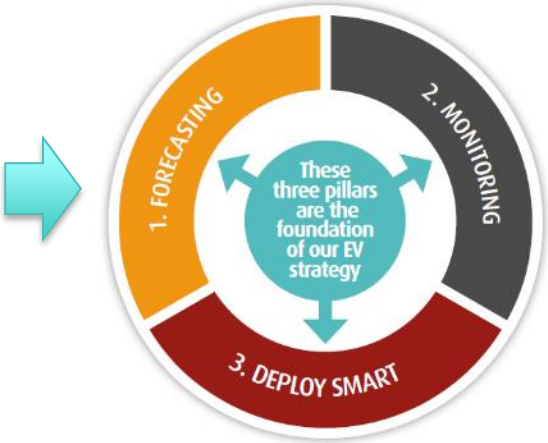
INVESTORS IN PEOPLE | Gold

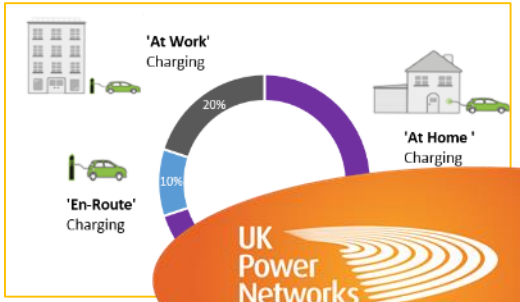
UK Power Networks
Delivering your electricity

Our EV Strategy

Facilitate the EV uptake through top engagement, great customer experience and a future ready network

UK Power Network's objectives	Appropriate investments, policies and standards	Deliver good customer experience	Network readiness
Activity areas	1 Improve planning and scenario analysis	3 Expand choice and convenience	5 Ensure targeted investment
	2 Develop policies and standards	4 Engage and educate/learn	6 Develop smart toolbox of offering in response to uptake scenarios

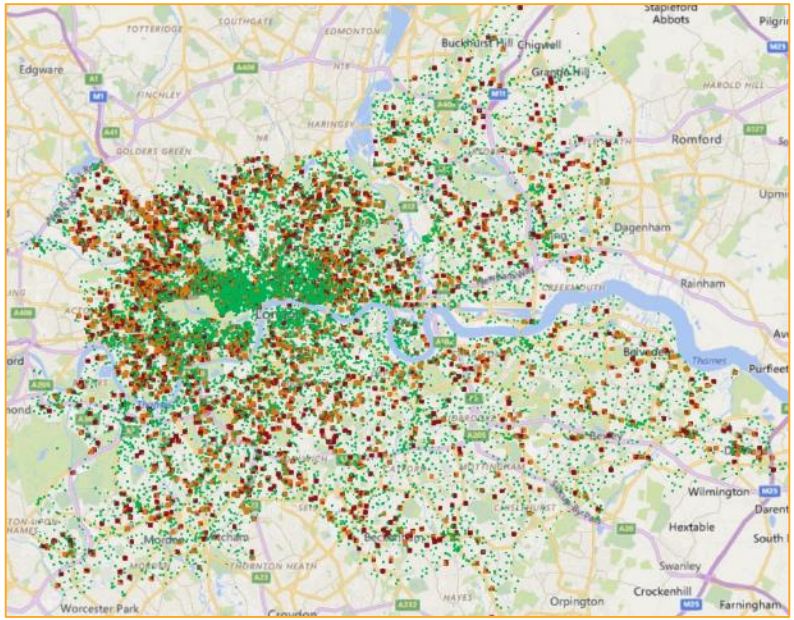




A Facilitator of, not a blocker to the Low Carbon Transition

UK Power Networks
Delivering your electricity

EV Market Forecasting

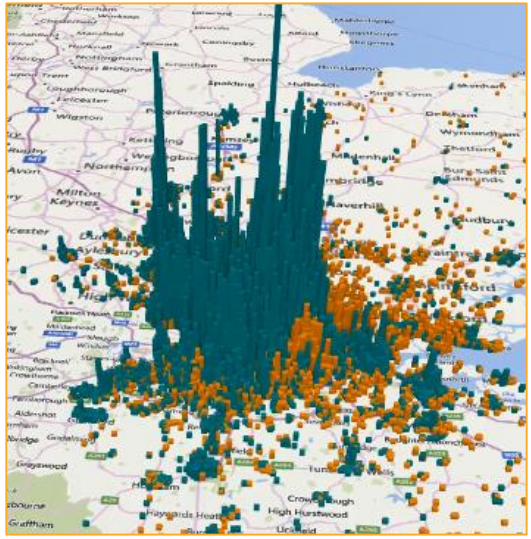


London Hotspots 2025

By 2030 we forecast **1.9-4.1m** vehicle across UKPN networks

55,000 Plug-in Cars, in our network (31% of UK share)

18,000 Charge Points in UKPN's network area (c.4700 Public)



London Taxi and PHV uptake 2034

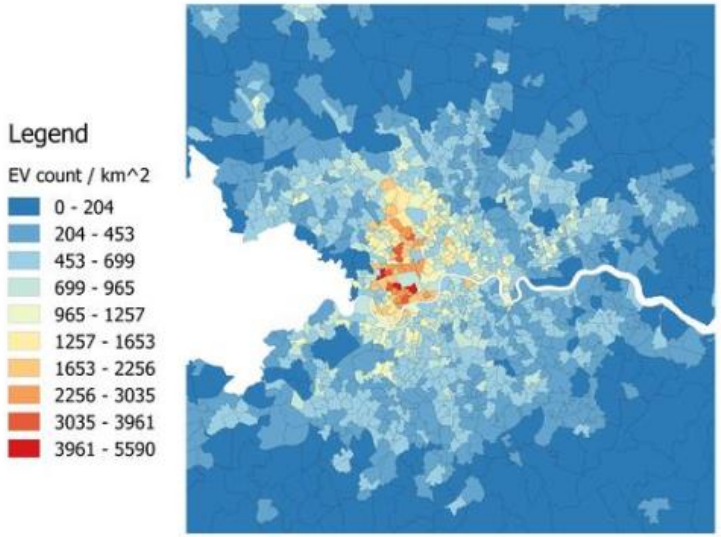
Constrained areas will be released publicly to trigger market response

UK Power Networks
Delivering your electricity

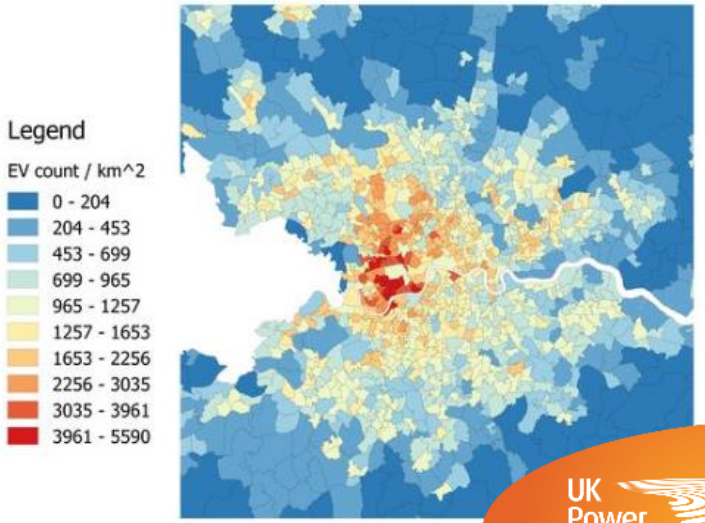
Preview of Final Report: EV Uptake in London

Recharge the Future gives us a high resolution understanding of where EV uptake will occur.

Baseline EV uptake
Number of EVs charging per area in "EV / km^2"
2030



High EV uptake
Number of EVs charging per area in "EV / km^2"
2030

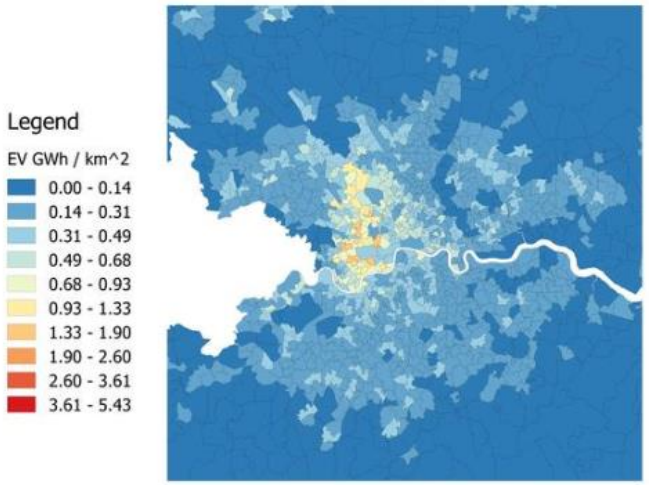


UK Power Networks
Delivering your electricity

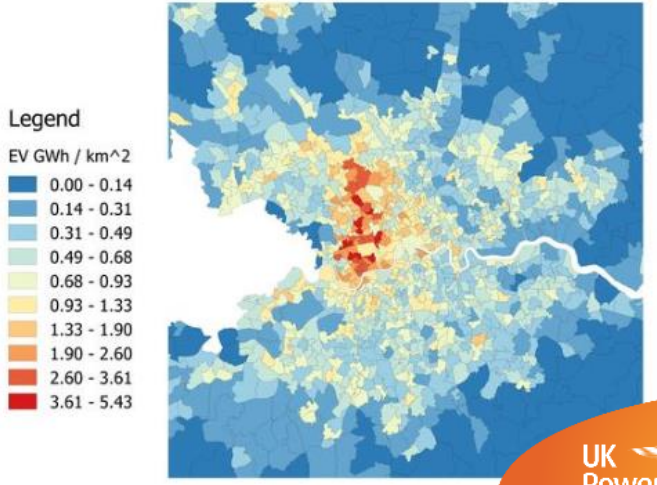
Preview: EV demand density in London

- Recharge the Future's state of the art charger use study enables us to understand where consumers will require electricity in the future

Current Policies
EV consumption in GWh / km^2
2023



Unmanaged Growth
EV consumption in GWh / km^2
2023



UK Power Networks
Delivering your electricity

Full LV Control & Visibility

Findings from our forecasting project will advice on where to install monitoring at LV substations

Geoview

- Limited functionality
- No connectivity
- Just a Picture
- Unable to trace
- Simple dressing
- End of life

LV PowerOn project will deliver;

PowerOn functionality at LV
PowerOn Mobile LV Diagram
Reporting functionality

Enabler for;

LV Smart Solutions, Monitoring
Network data by feeder and phase
Customer to Network Link / phase
LV Automation
Customer Service Improvement

PowerOn;

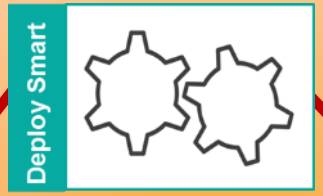
- Fully functional Tracing
- Safety Logic
- Connectivity
- Work Package Manager
- Equipment Explorer
- Widen existing interfaces- APRS

Deploy Strategically targeted LV network monitoring

- **5,834 dist sub coverage in 5y**
- **Targeted on LCT-driven capacity constraints**
- **Scalable pending annual EV uptake**

UK Power Networks
Delivering your electricity

EV Deploy Smart approach



Commercial Solutions

- Timed Connections
- **Smart Charging flexibility**
- V2G Flexibility
- Beyond the meter Smart

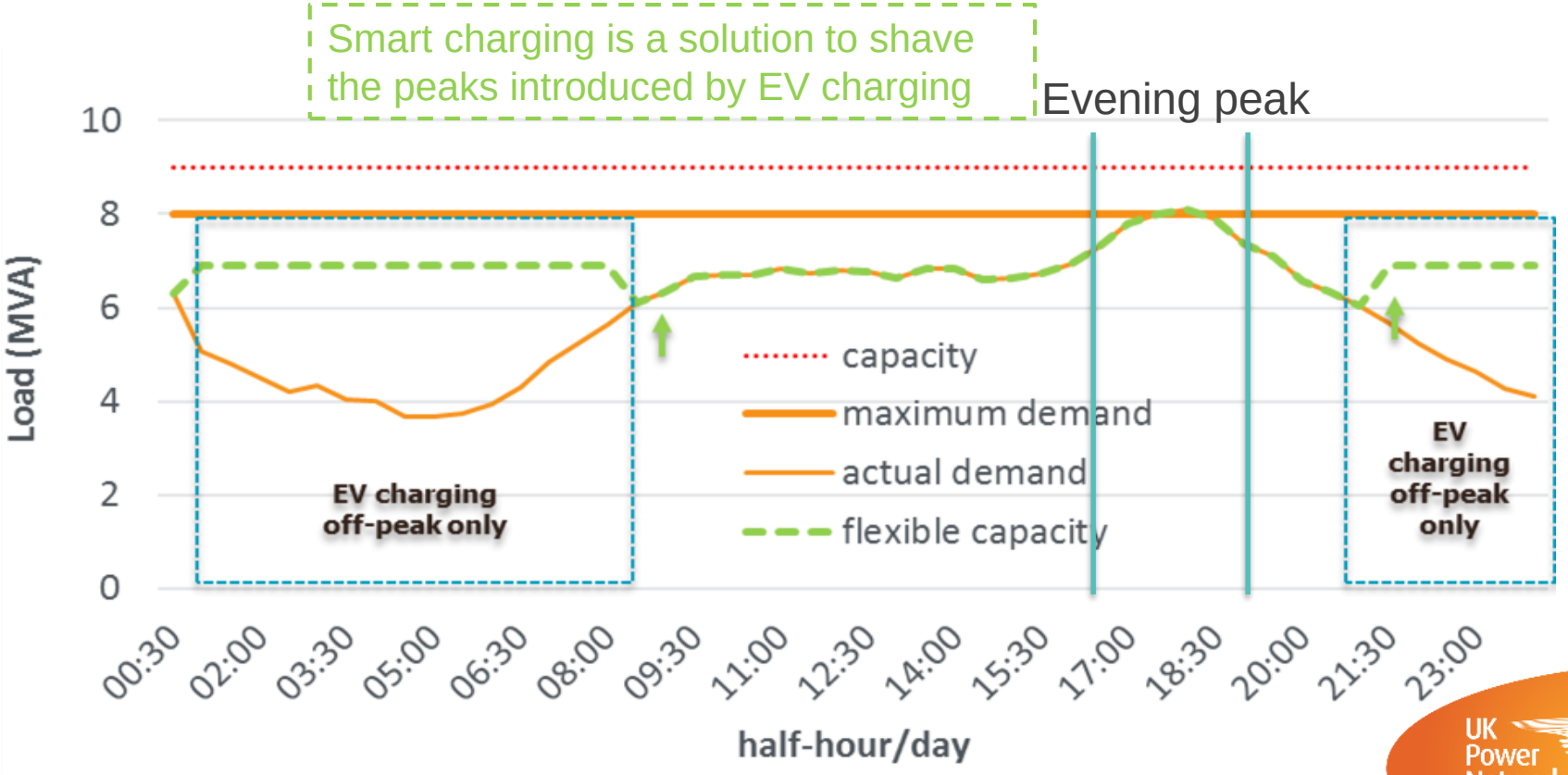
Non Exhaustive list

Technical Solutions

- LV Full Control
- LV Monitoring
- LV Engine
- Network Meshing- proactive reconfiguration- Active Response

Non Exhaustive list

Typical residential load profile – smart charging introduced

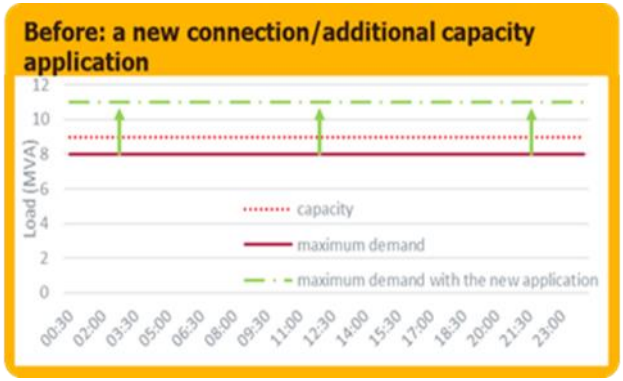


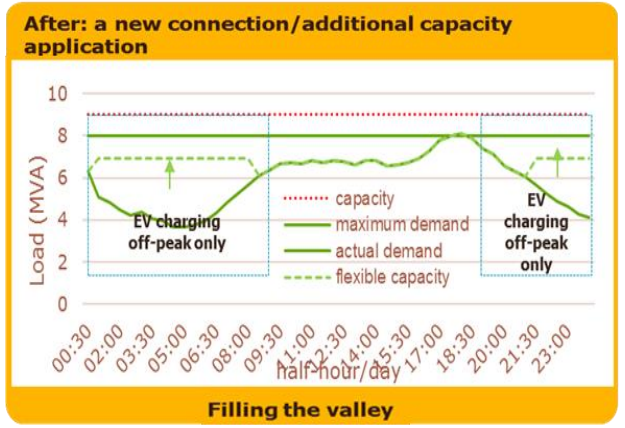
Timed Connection solution

Project Objective
Develop an advanced network capacity assessment tool, to assign customer charging to capacity valleys

Timed Approach :

- Customer sets EV charging requirements
- Timed software tool assesses capacity & network constraints using historic data without the assumption of 'any time, any day'
- Assessment reviews customer charging requirements against valley opportunities
  'off peak' charging periods are identified
- Customer is offered a timed connection layer based on the software's prediction of headroom & peak clash





Case Study: Waterloo Bus Garage

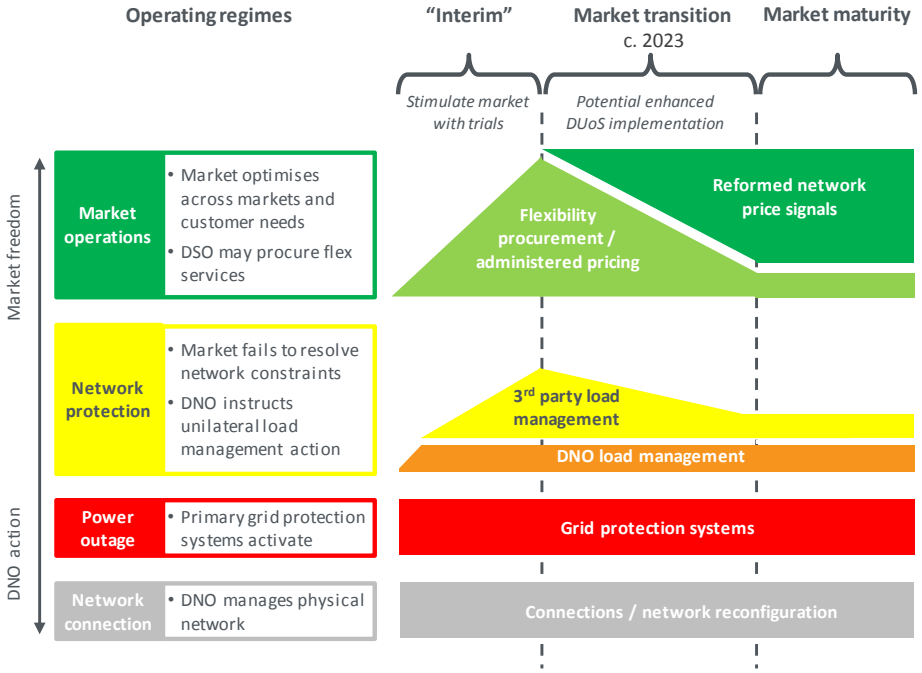
1st fully electric bus fleet in the UK/EU, all Waterloo single decker buses now electric and operating on a timed connection with no network reinforcement required

UK Power Networks
Delivering your electricity

Smart charging – UKPN position

We will support maximum market freedom, pursuing a market based "interim solution"

Potential evolution over time



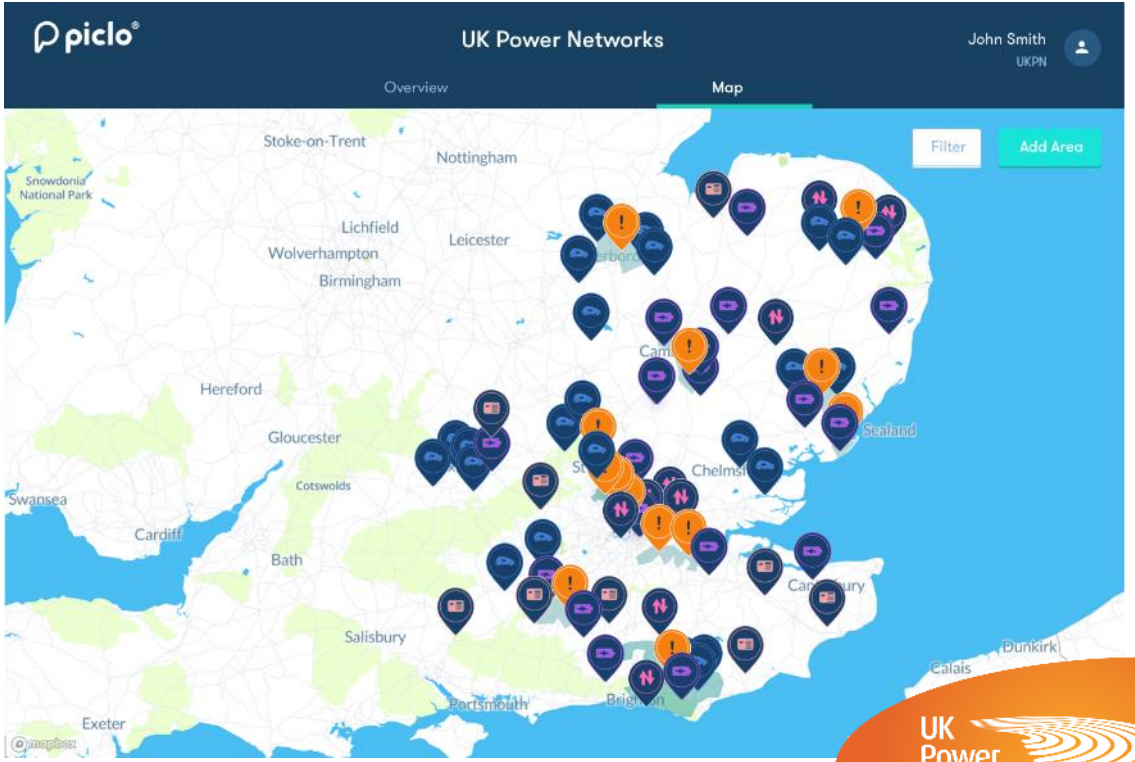
Our position for smart charging:

1. We will maximise the capacity available to the market through network reconfiguration where possible
2. We will facilitate a market for flexibility procurement as a means to mitigate EV constraints, and utilise the value of EV flexibility
3. We will support distribution charging reform as a long-term solution to influence charging patterns via prices; however, this will take time, and in the interim we will investigate procurement of smart charging response at LV through administered pricing
4. Where required, we will approach customers or 3rd parties to request a unilateral load-management option for the DNO on an opt-in basis, that is compensated and enacted via 3rd party infrastructure

UK Power Networks
Delivering your electricity

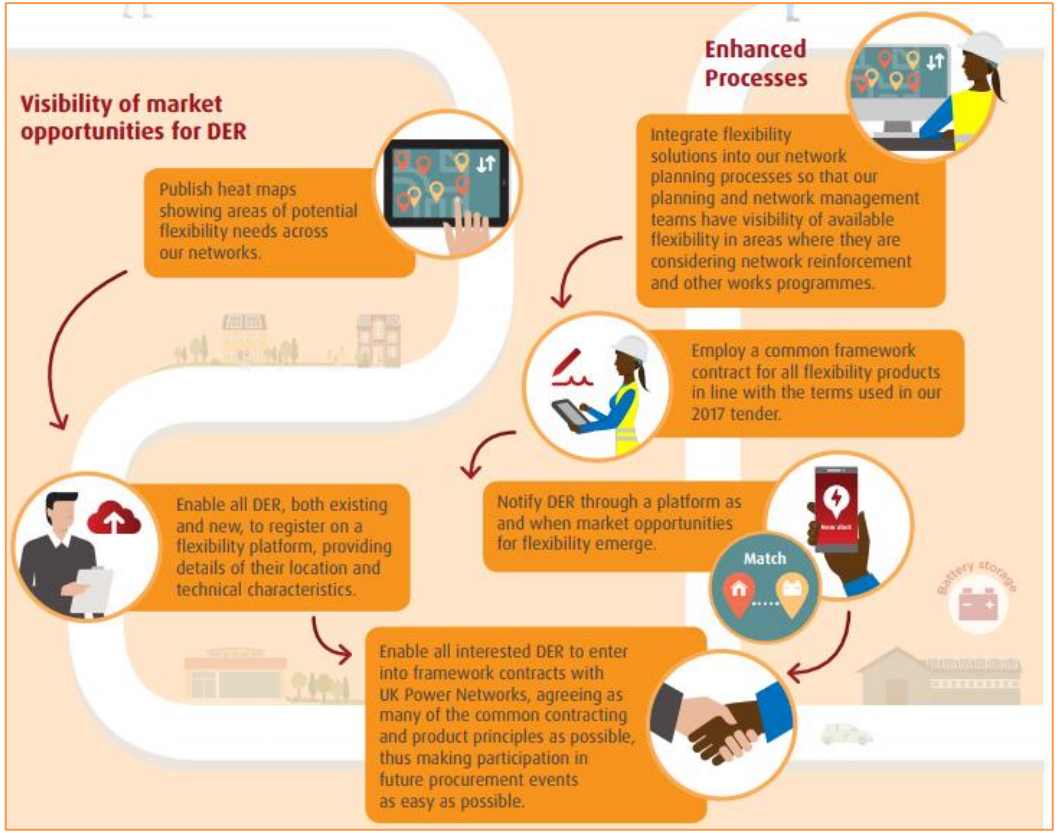
Enabling the market – Providing visibility

- Publish heat maps showing areas of potential flexibility needs across our networks
- Enable all DER, both existing and new, to register on a flexibility platform
- Enable all interested DER to enter into framework contracts with UK Power Networks



UK Power Networks
Delivering your electricity

Flexibility Roadmap



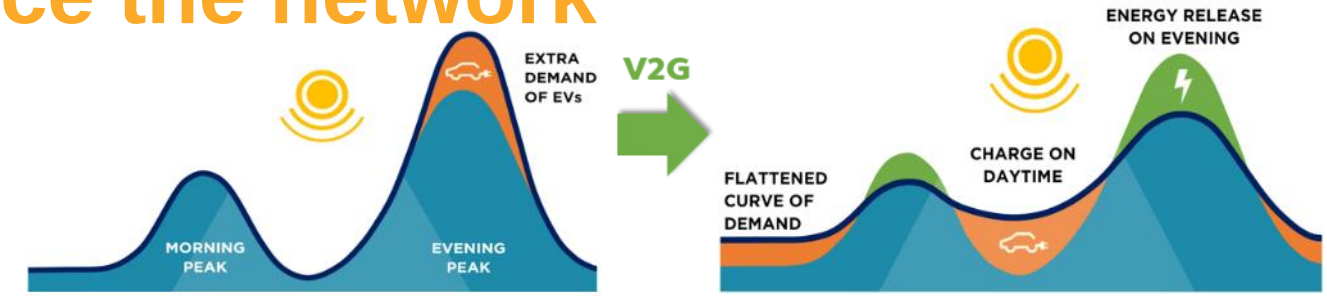
What's in it?

- What our current distribution network needs are.
- How these DSO system needs might evolve in the future.
- Why flexibility from DER can help us efficiently manage these system needs.
- How we will work with DER to facilitate efficient contracting and maximum participation of all DER types.
- What our proposed flexibility products and contracting principles are.
- How we will engage with DER over the coming years in a fair and transparent manner.

UK Power Networks
Delivering your electricity

Visit: FutureSmart.ukpowernetworks.co.uk

Enabling the future: using mobile batteries to balance the network



Source: 2014 Resourcefully NL V2G

Portfolio

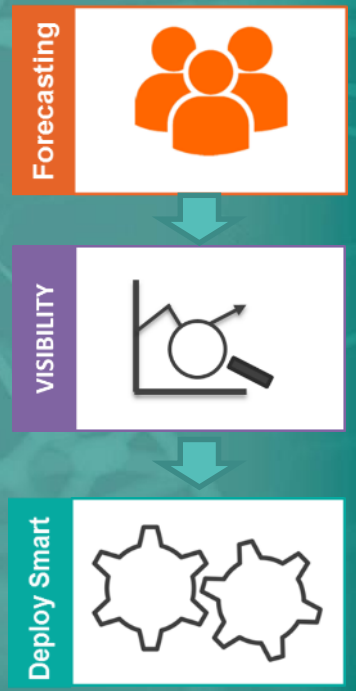
e4future	Bus2Grid	V2Street	PowerLoop	Sciurus
1,000 fleet chargers	30 e-bus garage	Research & Development	135 domestic chargers	Advisor
Commercial Fleets 'at work'		Public 'on route'	Residential 'at home'	

- **BEIS funding of £30m and led by Innovate UK and Office for Low Emission Vehicles**
- **We are working with partners across automotive, energy and tech sectors**
- **Largest energy and transport sector project on electric vehicles in the world**

UK Power Networks
Delivering your electricity

EV Conclusions

- We are creating the best possible forecast of EV uptake and charging behaviour (Data access is key)
- Developing LV Control & Monitoring capabilities fast
- Optimisation of existing network capacity first through using a ready toolbox of Smart solutions, then deploy strategic infrastructure



Summary

1. EV uptake is increasing – acceleration in requests from fleet and commercial customers
2. Implementation of ‘EV only’ streets in London could accelerate the pace of transition
3. It is a new industry and we are still learning about consumer and charging habits
4. We are undertaking a number of trials to make sure we are at the forefront of this industry - SMART will play a significant role in the future