APSE Big Energy Summit 2017
Electric vehicles and the Energy System

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www.Cenex.co.uk

Independent, not for profit, low carbon technology experts

Cenex, Centre of Excellence for Low Carbon and Fuel Cell Technologies

- Independent, not for profit, low carbon vehicle experts
- Established with support from UK Government and Automotive Industry
- 10 years experience in UK and EU collaborate research projects
- Experience in Electric, Gas, Biomethane and Hydrogen vehicles
- Expertise in vehicle trials and demonstrators using real world data for carbon and cost analysis
- Three years V2G experience
- Low carbon vehicle fuelling and charging infrastructure expertise
- Manage Europe's premier Low Carbon Vehicle Technology event – LCV www.cenex-LCV.co.uk

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Cenex Clients

amey

D2N2 Derby Derbyshire Nottingham Nottinghamshire

Scottish Enterprise

LENNAR URBAN

ZERO WASTE SCOTLAND

drive west midlands THE HEART OF UK AUTOMOTIVE

UK TRADE & INVESTMENT

Innovate UK Technology Strategy Board

شركة وادي الرياض riyadh valley co

LONDON HYDROGEN NETWORK EXPANSION

Nottingham City Council

Plugged-In Midlands

Royal Mail

energy technologies institute

HyTEC

Coca-Cola Great Britain

Environment Agency

BOSCH

JAGUAR LAND ROVER

eit Knowledge & Innovation Community Climate-KIC

automotive council UK

BMW

ADVANCED PROPULSION CENTRE UK

CATAPULT Transport Systems

UKEVSE

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Low Carbon Vehicle Event

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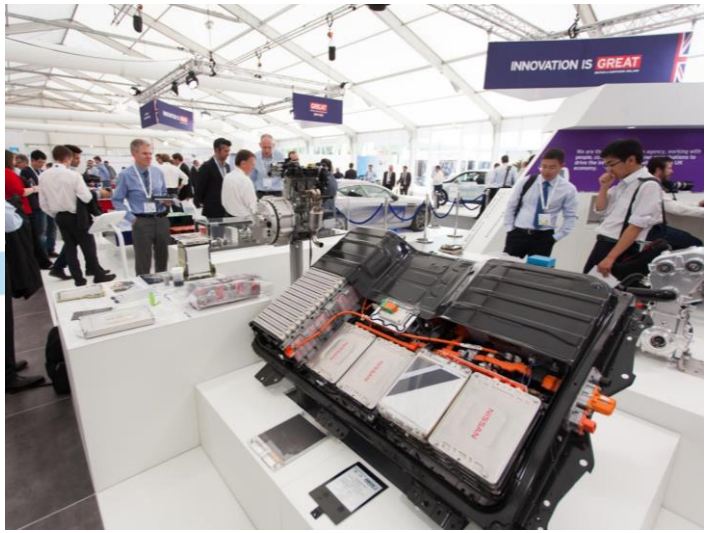
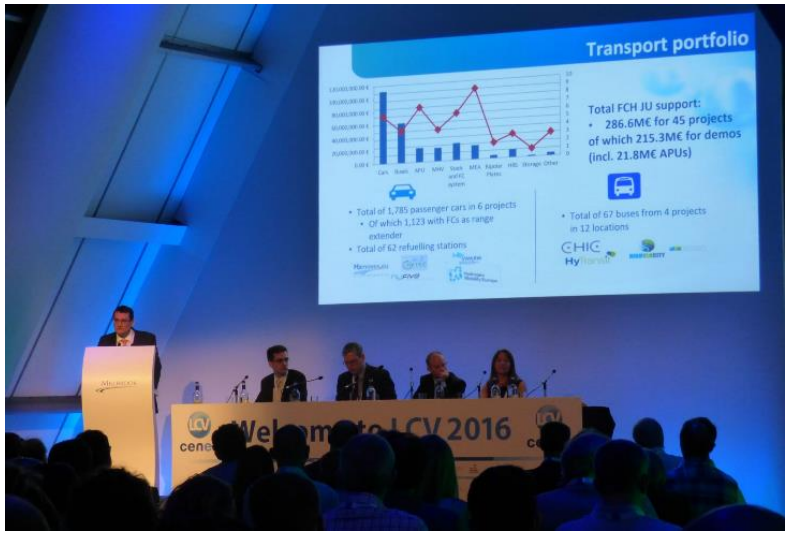


Technology Showcase

Ride & Drive



Extensive Seminar Programme

- **3,137 visitors**
- **226 exhibiting organisations**
- **1, 180 organisations attending**
- **122 vehicles**

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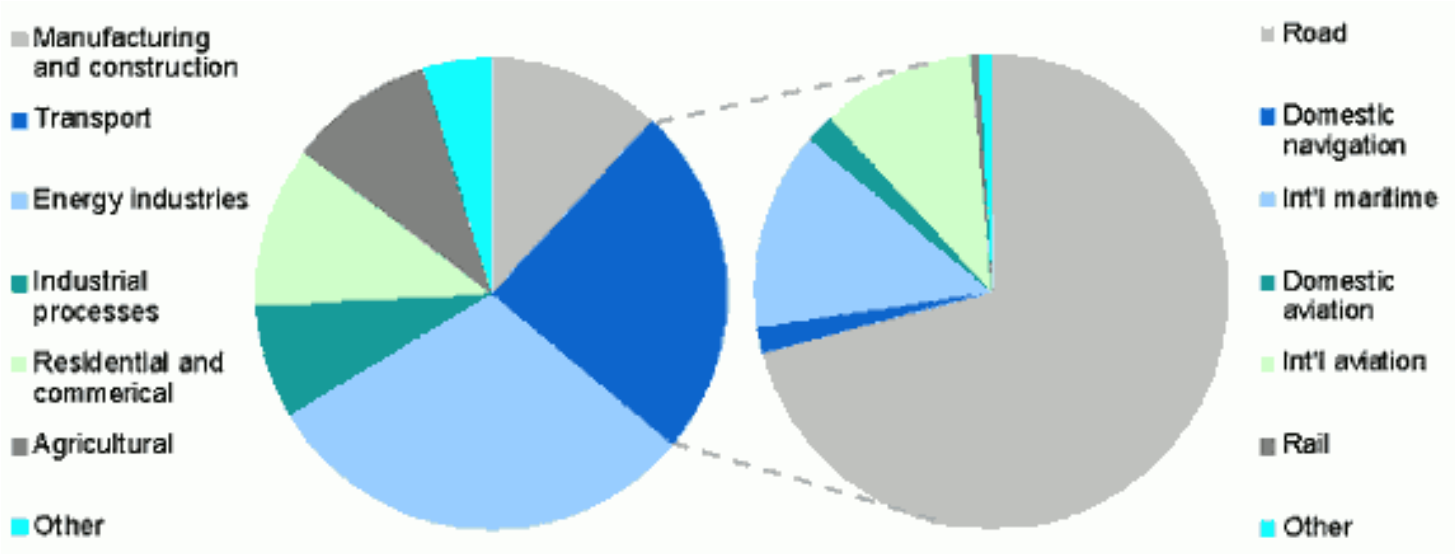
Transport emissions up 36% since 1990



Greenhouse gas emissions in other sectors decreased 15% between 1990 and 2007 but emissions from transport increased 36% during the same period. This increase has happened despite improved vehicle efficiency because the amount of personal and freight transport has increased.

Demand for goods will increase by approx. 30% between 2010 and 2030

Air quality - health cost to the EU 88 billion Euro

29,000 deaths in UK 2014 (NHS England)

EU fines?

Electric cars and consumer demand

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Tesla Model 3

373,000 pre-orders with $1,000/£1,000 deposit paid

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Grants for home and work place charging

Support for public charging

LCV Event

LCV Event

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So what are the alternatives to Petrol and Diesel?

- Electric
- Plug in Hybrid
- LPG
- CNG
- LNG
- Biomethane
- Hydrogen
- Liquid Air?

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Low cost data for better decision making

Purpose: “CLEAR Capture” stands for Cost-effective Low Emissions Analysis from Real-world Data Capture. This analysis is more accurate as it directly uses your real-world operational data, not estimates of performance, to calculate your whole life costs, operational performance and carbon savings comparisons of switching from a conventional vehicle to an ultra-low emission vehicle (ULEV).

This analysis includes:

- Plug-in device deployment
- Data collection
- Data analysis
- Analysis reporting
- 30 minute explanation call

What will I know? You will fully understand if there is an economic (total cost of ownership) or environmental business case (savings of NOx and CO2) to swap your conventional vehicles to a low emission vehicle, and know the technology types that offer the best savings in your bespoke fleet operational profile.

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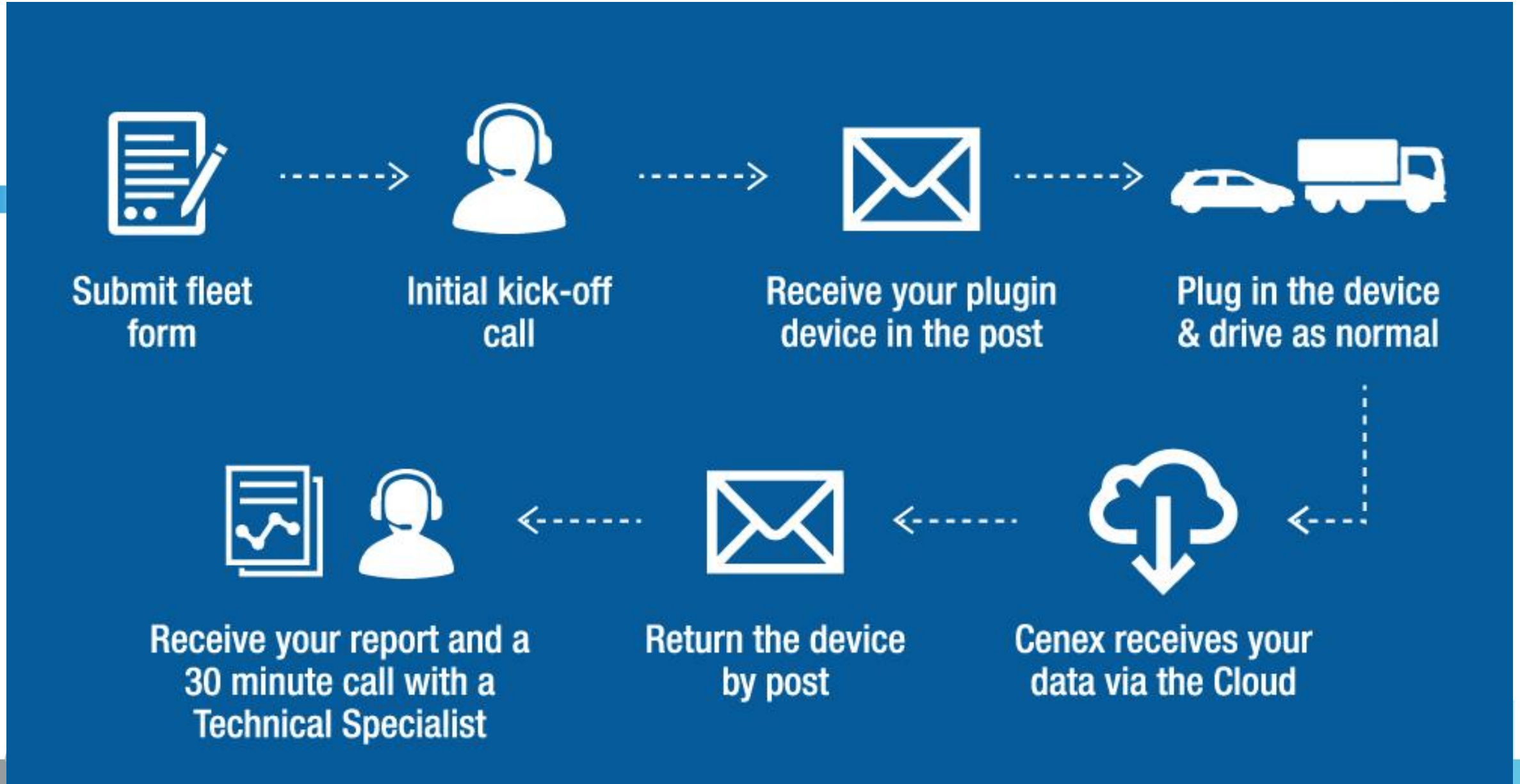
Data Collection Process



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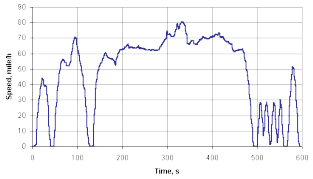
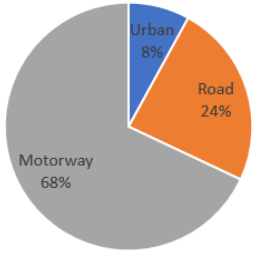
Fuel Consumption and Emissions Calculation





15,000 mi/year

+

- Vehicle type (small, medium, SUV, etc.)
- Fuel type: Diesel/Petrol
- Ownership period

ICE vehicles CO2 and NOx tests on different vehicle types

EMISSIONS ANALYTICS

Fuel & energy consumption tests on EV, REEV and PHEV

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Populate fuel consumption, CO2, PM and NOx lookup tables

Whole Life Fuel, CO2 and NOx Emission Savings

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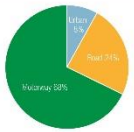
CLEAR - Reporting

Operational Analysis



This is your **Driving Habit Distribution** based on speed and acceleration statistical patterns captured through your plug-in device. Your plug-in device was deployed for a total of **28 days**.

Comparator Vehicle Make & Model	Mercedes C300 (Diesel)	
Vehicle reg. number	BJ16 XEN	
Data date range	24/11/2016 to 23/12/2016	
Average daily mileage	**53 miles**	
Days per week usage	4.6 days (out of 7 days)	
Extrapolated annual mileage	**12,623 miles**	
Average journeys per day	3.5 journeys	
Average journey mileage	15.2 miles	
Average daily driving time	1 hour and 11 mins	
Average journey driving time	20 mins	
	In an EV:	**In a REEV:**
Average daily % charge used	77%	95%
Average daily battery capacity used	17.2 kWh	18.5 kWh

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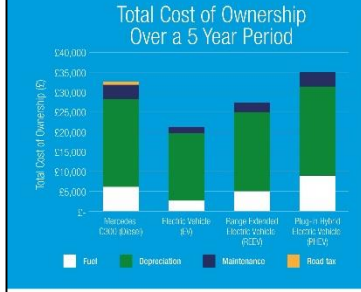
Total Cost of Ownership Study Over a 5 Year Period [7]

	Mercedes C300 (Diesel)	Electric Vehicle (EV) [8]	Range Extended Electric Vehicle (REEV) [9]	Plug-in Hybrid Electric Vehicle (PHEV) [8]
Purchase cost (£) [1]	£30,221	£24,479	£30,771	£34,166
Plug in grant discount (£) [2]		£4,500	£4,500	£2,500
Fuel cost (£) [3]	£5,535	£2,731	£4,789	£8,797
Road tax (£) [4]	£650			
Maintenance cost (£) [5]	£3,603	£1,355	£2,132	£3,322
Resale value (£) [6]	£7,650	£2,854	£6,141	£8,652
Non-EV additional charge (£) [8]				
Total cost of ownership (£)	£32,359	£21,211	£27,050	£35,132
Total cost per mile (ppm)	51.3	33.6	42.9	55.7
Whole life cost savings (£)		**£11,147**	**£5,308**	**-£2,773**



This cost model, based on **5 years of ownership**, proves the **strong economic advantage of an EV and REEV** against the diesel vehicle. The lack of taxes, the plug-in car grant, and the lower fuel and maintenance costs combine to allow strong whole life cost savings. In the case of a PHEV, the additional purchase cost is not paid back by the rest of the costs, assuming there is only one overnight charge. If the PHEV was to be charged once during the day as well (e.g. workplace charging), then the economics would still not work with whole life cost savings of -£917.

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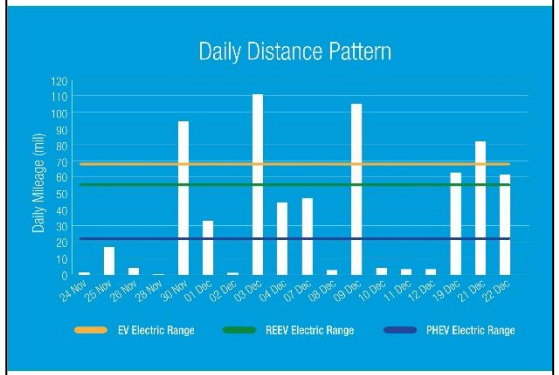
Ultra Low Emission Vehicle Range Study

6 days out of the 18 analysed showed a used battery State of Charge (SoC) of more than 80%, assuming the diesel vehicle was replaced by a pure electric one (EV). This means that **33% of the days the vehicle would need charging during the day**, approximately a 20% SoC top-up charge. Using a fast charger (6.6 kW) this would take 40 mins, while a slow charger (3.3 kW) would take 1 hour 30 mins.



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Lifetime Emissions Study Over a 5 Year Period [11]

The EV offers a 100% reduction in tailpipe CO_2, NOx and PM emissions, while offering a 38% reduction in well-to-wheel CO_2 emissions. The REEV offers a 48% and 13% reduction in tailpipe and well-to-wheel CO_2 emissions respectively, while offering very significant PM and NOx emission savings. The PHEV also presents significant PM and NOx savings, although it does not offer any CO_2 emission reduction. This is due to the worse fuel efficiency of the PHEV in hybrid mode compared to the diesel baseline vehicle (i.e. running on a depleted battery).

Emissions analysis supported by EMISSIONS ANALYTICS

Notes:

1. List price calculated using values from the manufacturer.
2. Plug-in car grant is 35% of the purchase cost of the vehicle (including VAT). This grant is capped at £4,500 for EVs and REEVs and at £2,500 for PHEVs.
3. Fuel consumption calculated using data from real world tests conducted by Cenex (ULEVs) and Emissions Analytics (conventional vehicles).
4. Vehicle tax according to the UK Government rates, which are based on fuel type and CO_2 emissions.
5. Maintenance cost and resale value calculated using the Fleet News Car Running Costs Calculator.
6. Non-EV additional charge comprises of all the costs not associated with an ULEV, e.g. London Congestion Charge, free EV parking, etc.
7. All costs exclude VAT.
8. EV, REEV and PHEV models based on Nissan Leaf (24 kWh battery), BMW i3 REx and Mitsubishi Outlander PHEV respectively.
9. Total cost of ownership model excludes any charging infrastructure cost.
10. Analysis assumes all ULEVs start the day with a full battery charge and they are not recharged during the day.
11. Emissions calculated using the UK Government fuel emission factors (CO_2) and test data from Emission Analytics (PM and NOx).

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Battery electric vans

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Whole Life Cost Example

	Nissan NV200 1.5dCi Acenta (Diesel)	Nissan e-NV200 Acenta (Electric)
Vehicle	*£15,030*	*£22,088*
Plug-in van grant discount		*£5,301*
Fuel costs	*£5,449*	*£2,103*
Road tax	*£700*	*£0*
Maintenance costs	*£2,114*	*£1,416*
Resale value	*£3,096*	*£4,622*
Life time cost	*£20,198*	*£15,684*
Cost per mile	*33.7p*	*26.1p*
Whole life cost savings		***£4,514***
If used in the London Congestion Zone (5 days/week)		
Life time cost	*£33,323*	*£15,684*
Whole life cost savings		***£17,639***

Vehicle:
2.2t Small panel van

Annual mileage:
12,000 miles (48 miles per day)

Ownership period:
5 years

Cost saving:
£4,514 rising to £17,639 if used daily in the London Congestion Charging Zone

The example shows the economic case for electric vehicles is strong. The plug-in van grant, lower fuel cost, zero road tax, lower maintenance costs and stronger residual value all work together to offer substantial whole life cost savings. When regional incentives, such as free entry into the London Congestion Charging Zone are included the whole life savings available become comparable to the purchase cost of the vehicle!

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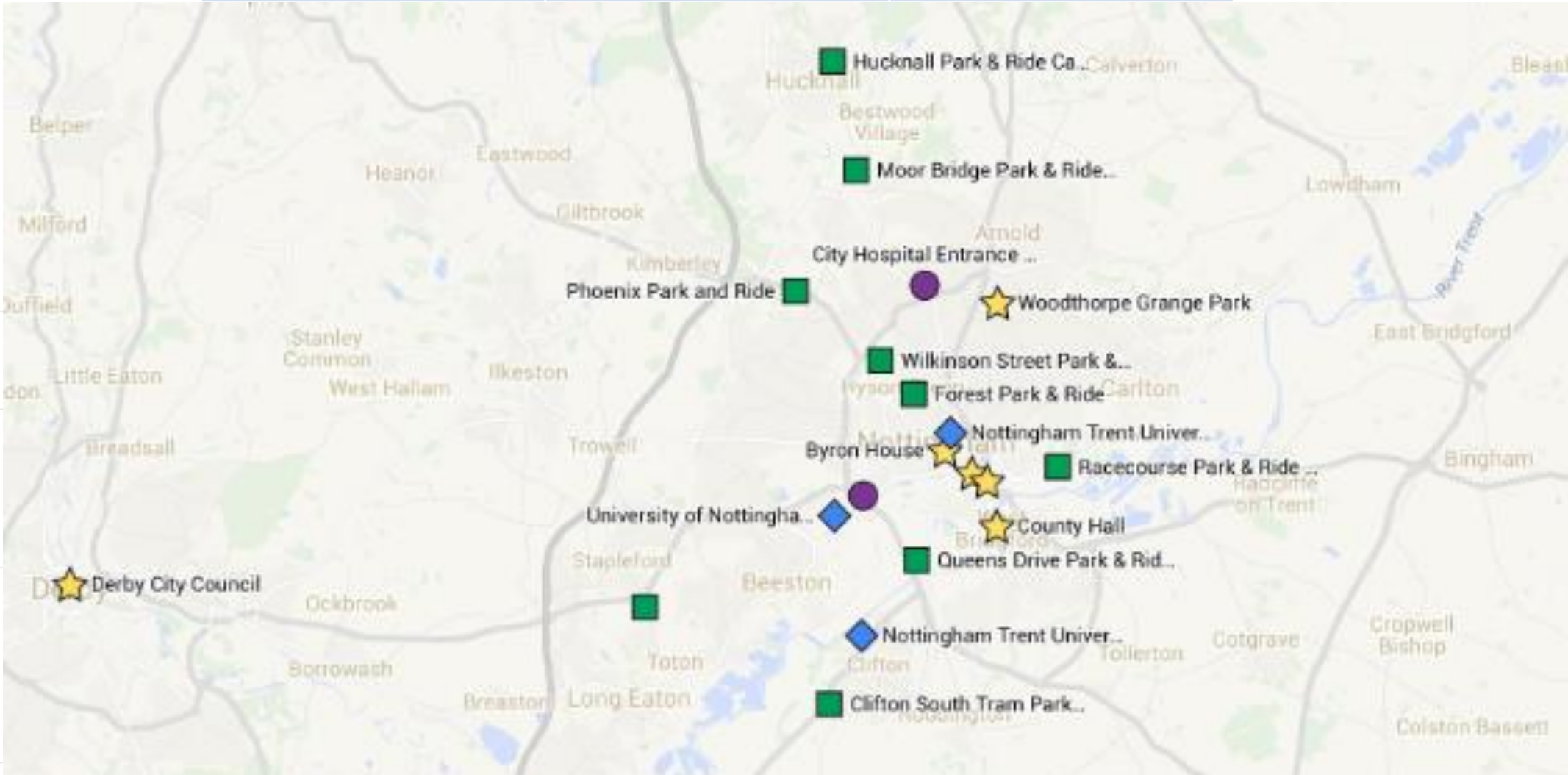
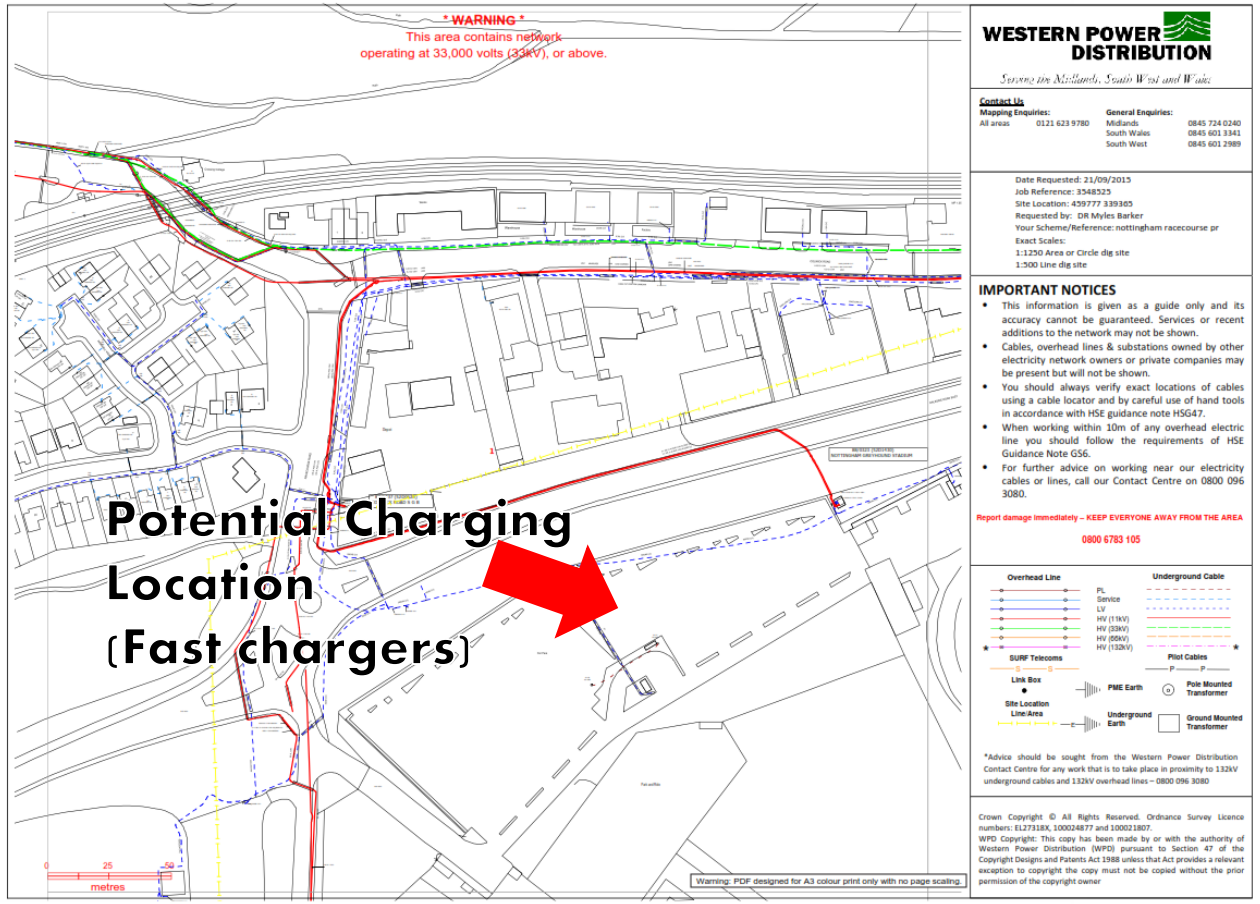
Charging infrastructure - Locations

	Fast chargers	Rapid chargers
Number of chargers	135	95



Charging infrastructure – Power Supply



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Serving the Midlands, South West and Wales

Contact Us

Mapping Enquiries: All areas 0121 623 9780

General Enquiries: Midlands 0845 724 0240; South Wales 0845 601 3341; South West 0845 601 2989

Date Requested: 21/09/2015
Job Reference: 3548525
Site Location: 459777 339365
Requested by: DR Myles Barker
Your Scheme/Reference: nottingham racecourse pr
Exact Scales:
1:1250 Area or Circle dig site
1:500 Line dig site

IMPORTANT NOTICES

- This information is given as a guide only and its accuracy cannot be guaranteed. Services or recent additions to the network may not be shown.
- Cables, overhead lines & substations owned by other electricity network owners or private companies may be present but will not be shown.
- You should always verify exact locations of cables using a cable locator and by careful use of hand tools in accordance with HSE guidance note HSG47.
- When working within 10m of any overhead electric line you should follow the requirements of HSE Guidance Note GS6.
- For further advice on working near our electricity cables or lines, call our Contact Centre on 0800 096 3080.

Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA

0800 6783 105

Overhead Line: PL, Service, LV, HV (11kV), HV (33kV), HV (66kV), HV (132kV)

Underground Cable

SURF Telecoms

Pilot Cables

Link Box

PME Earth

Pole Mounted Transformer

Site Location Line/Area

Underground Earth

Ground Mounted Transformer

*Advice should be sought from the Western Power Distribution Contact Centre for any work that is to take place in proximity to 132kV underground cables and 132kV overhead lines – 0800 096 3080

Plans generated by DigSAFE Pro (tm) software provided by PelicanCorp


L1
EV CHARGING STATION
EV
L1
EV CHARGING STATION

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Electric Vehicle Overview

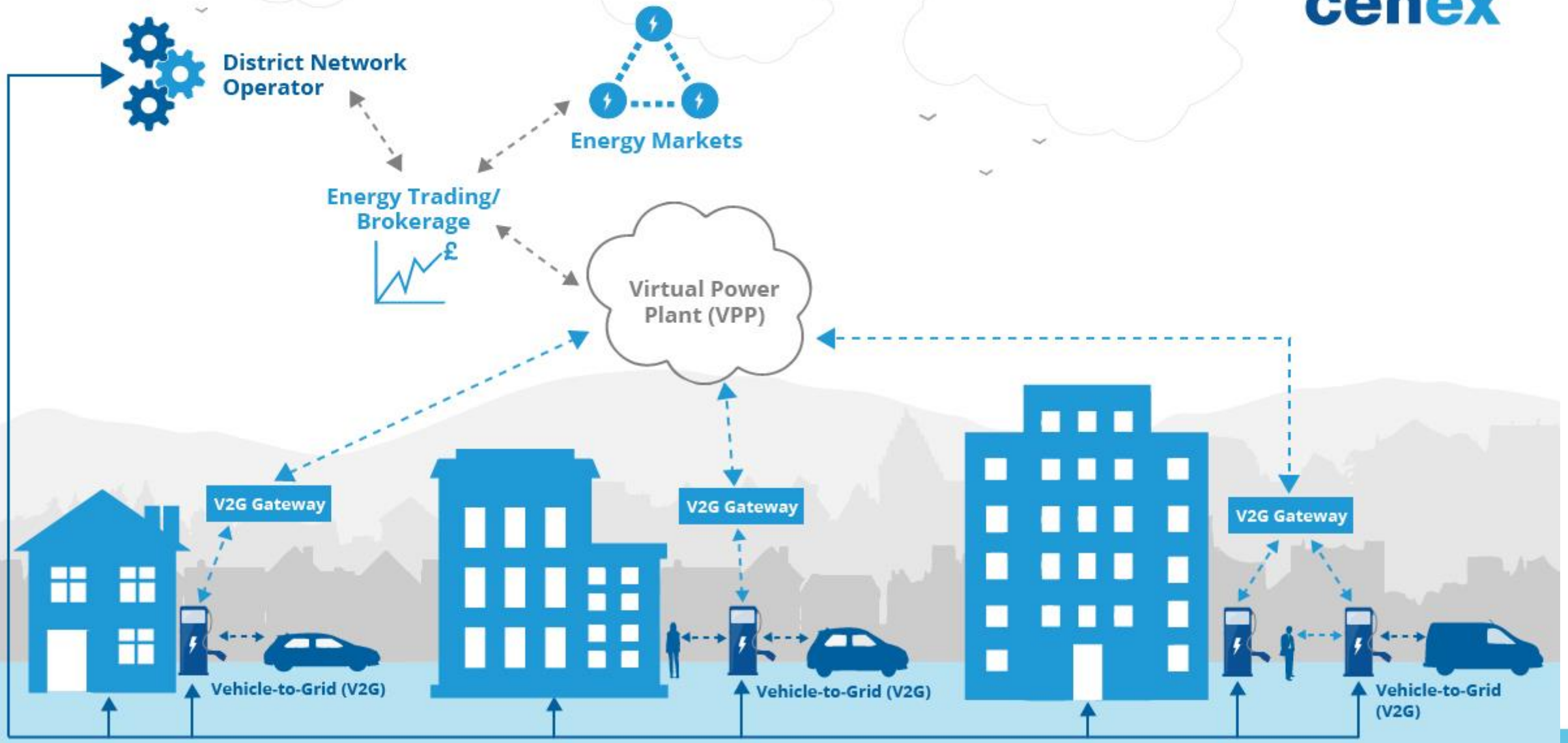
Constraints

- Electric vehicles (EV) projected to contribute up to 60% of total new car sales by 2030.
- By 2035 EV charging could represent up to a 20GW increase in peak demand.

Opportunities

- Assuming ~16.2kWh per vehicle is available for grid support, this represents ~11.3GWh energy storage capacity by 2020.
- **But what does this mean and how does it work?**

Ebbs and Flows of Energy Systems (EFES)



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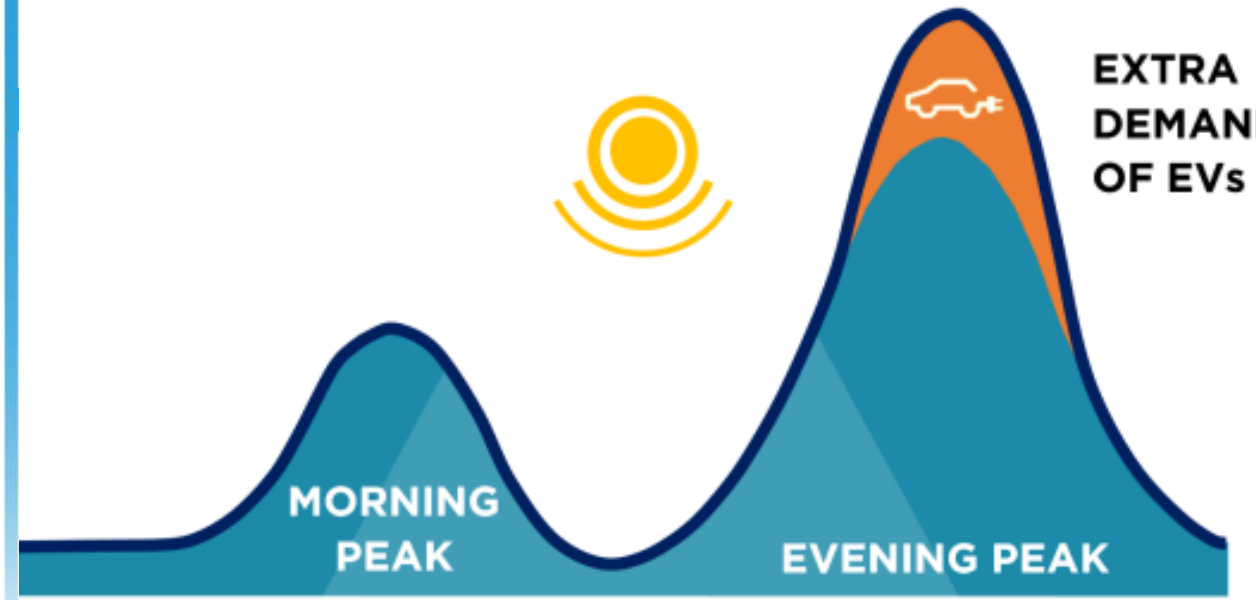
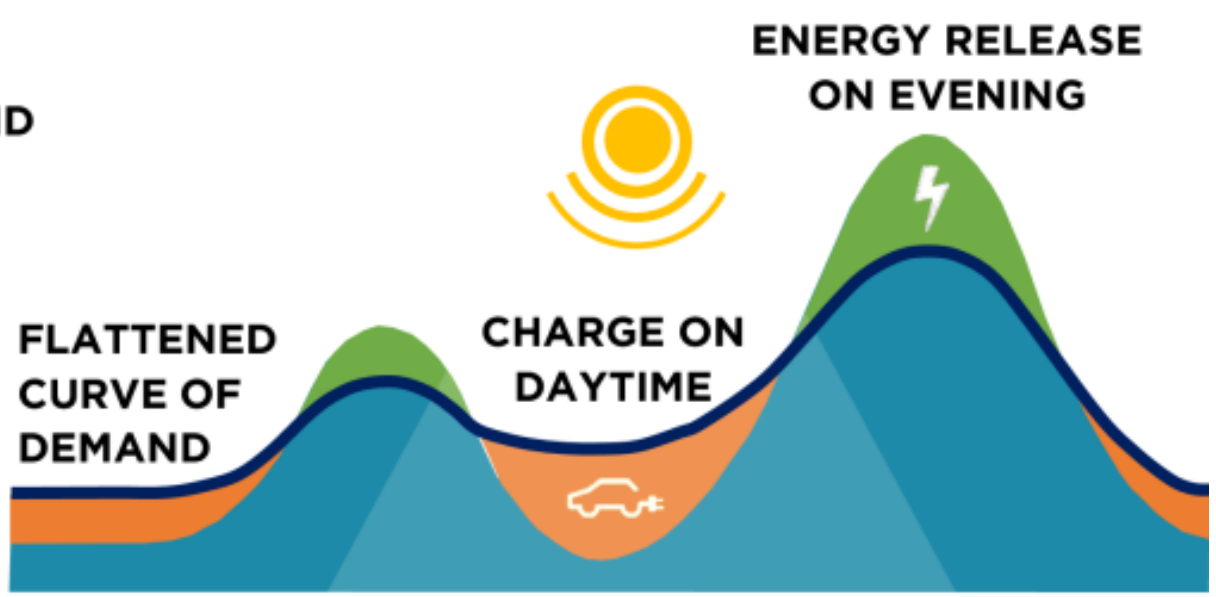
Innovation – demand side management and Vehicle 2 Grid



WITHOUT V2G



WITH V2G

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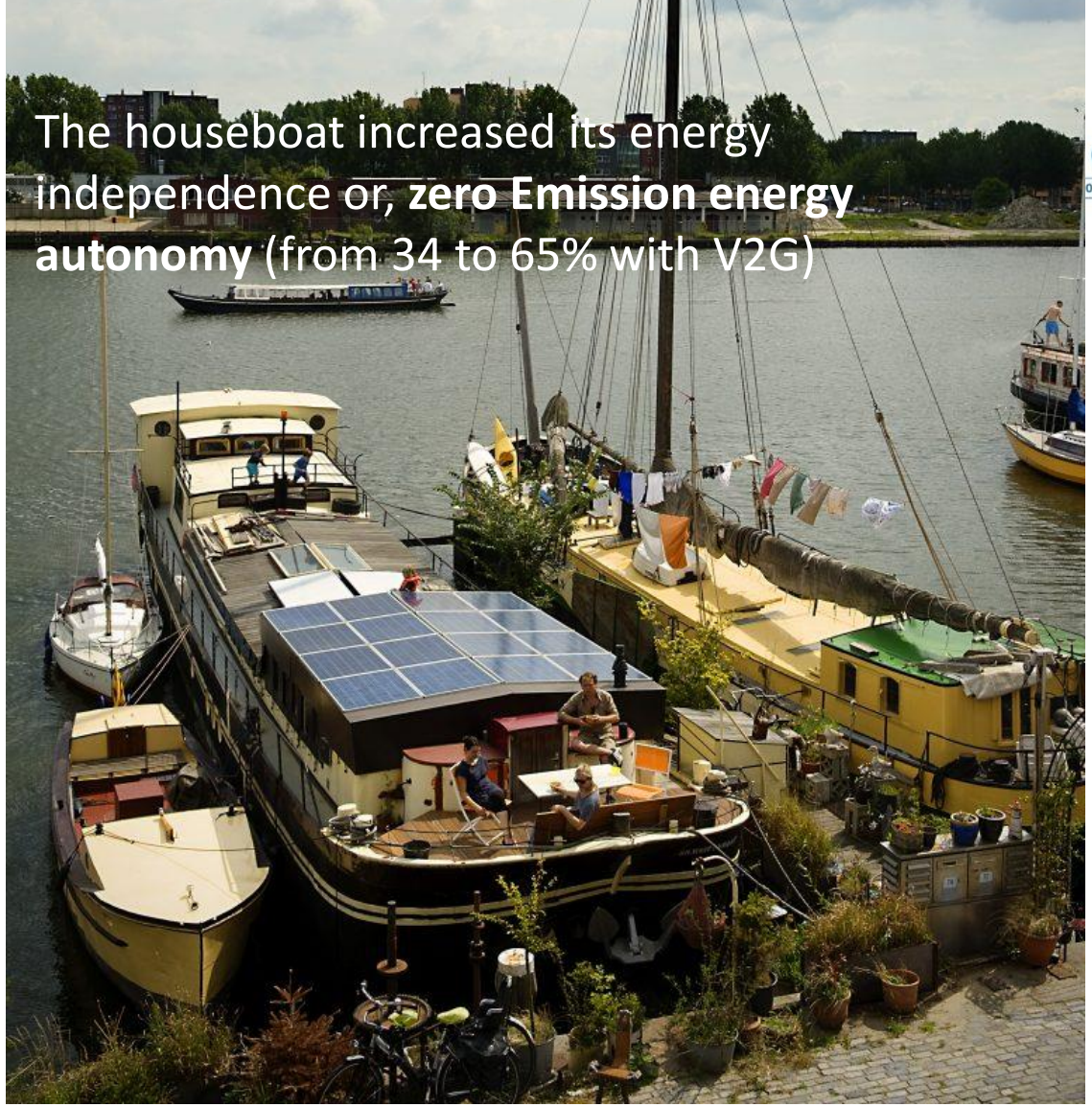
Cenex installed the UK's first installed V2G unit at Aston University. Storing cheap night time electricity from on site CHP scheme run by Engie.



The houseboat increased its energy independence or, **zero Emission energy autonomy** (from 34 to 65% with V2G)

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Robin Hood - Integrated multi model E-mobility and Green Energy

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PAY AS YOU GO TRAVEL

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A not for profit company

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Thank you