

Greening your fleet

Ultra Low Emission Vehicles: The business case, the technology and best practice

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Cenex Overview

- Not-for-profit independent research and consultancy organisation established in 2005.
- Specialists in low emission vehicles, associated infrastructure, energy systems and community/supply chain development.
- **Help clients to assess, validate and apply low emissions automotive strategies and technologies.**



Cenex Clients



APSE Transport Advisory Group Low Carbon Vehicle Event

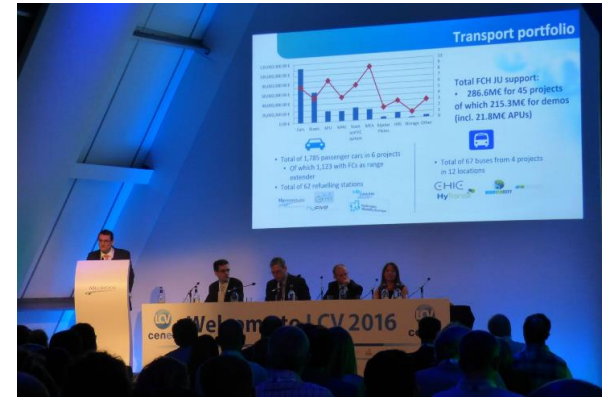
www.cenex-lcv.co.uk



Technology Showcase



Ride & Drive



Extensive Seminar Programme



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



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Where to begin?

CAZ – Clean Air Zone

Euro IV, V, VI, EEV

ULEV – Ultra Low Emission Vehicle

PiVG – Plug-in Van Grant

PiVC – Plug-in Car Grant

OLEV – Office for Low Emission Vehicles

GUL – Go Ultra Low

EV – Electric Vehicle

PHEV – Plug-In Hybrid Electric Vehicle

CVTF – Clean Vehicle Technology Fund

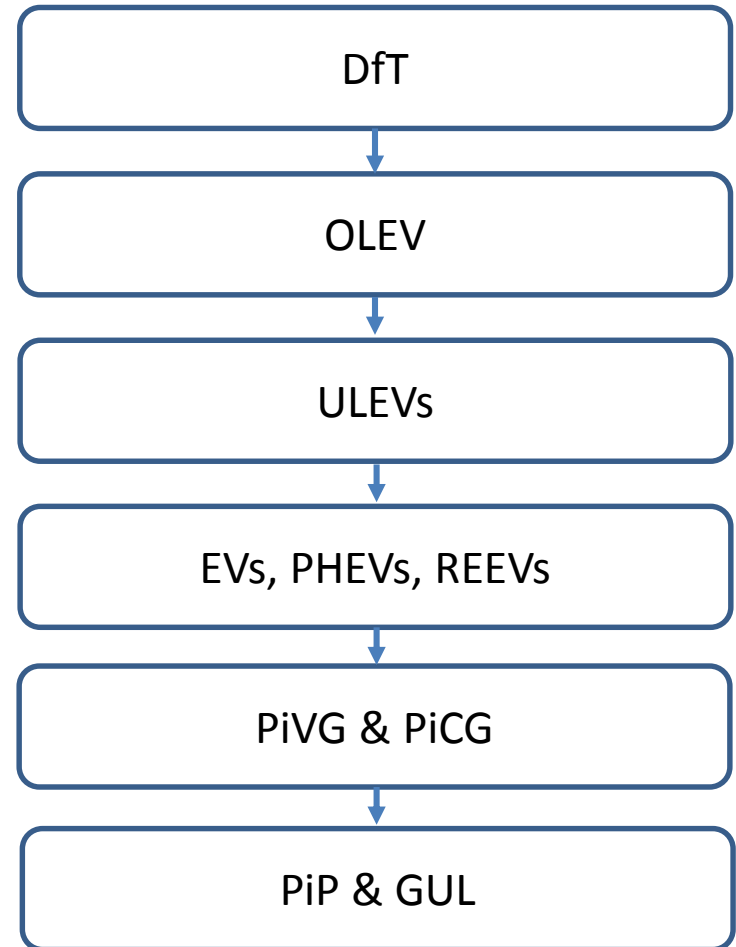
LEZ – Low Emission Zone

RPC – Reduced Pollution Certificate

REEV – Range Extended Electric Vehicle

PiP – Plugged-In Places

Euro 4, 5, 6



Air Quality



Cost Benefits

Plug-in
Van/Car
Grant
and work
place
charge
point grant

Low
Emission
Zone and
Congestion
charge
exempt

BIK tax
savings

VED

Fuel Costs

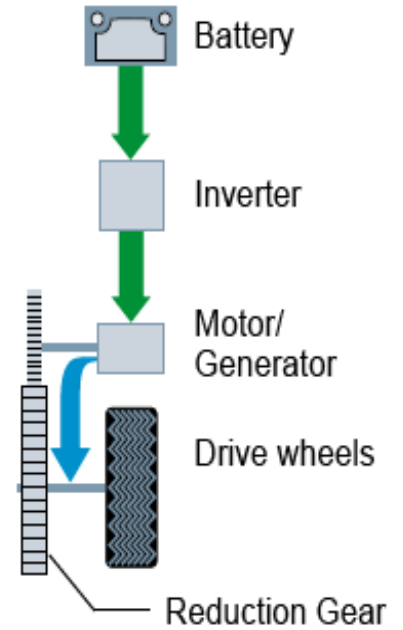
Reduced
SMR Costs

Whole life cost saving / total cost of ownership



APSE Transport Advisory Group Battery Electric Vehicles (EVs)

➡ Mechanical Power ➡ Electrical Power



Costs can be anywhere from £13,945 to £100,000+



APSE Transport Advisory Group Plug-In Hybrid (PHEVs)



Costs can be anywhere from £33,945 to £51,000+



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Range Extended Electric Vehicle (REx, REEV)



Costs can be anywhere from £35,000+



Gas – HGV, RCV and buses

- CNG
- LNG
- Biomethane

www.gasvehiclehub.org/

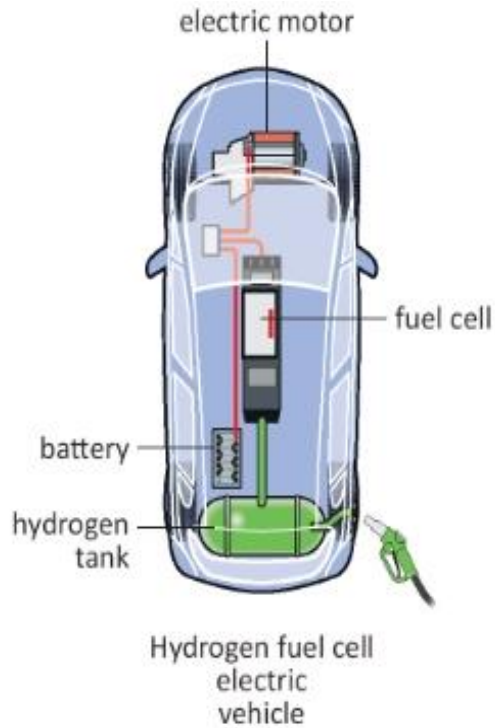


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Hydrogen



Costs can be anywhere from £53,050 to £65,954+



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Charging Electric Vehicles

Conductive



Case A



Case B



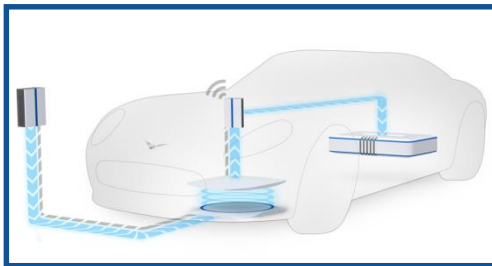
Case C



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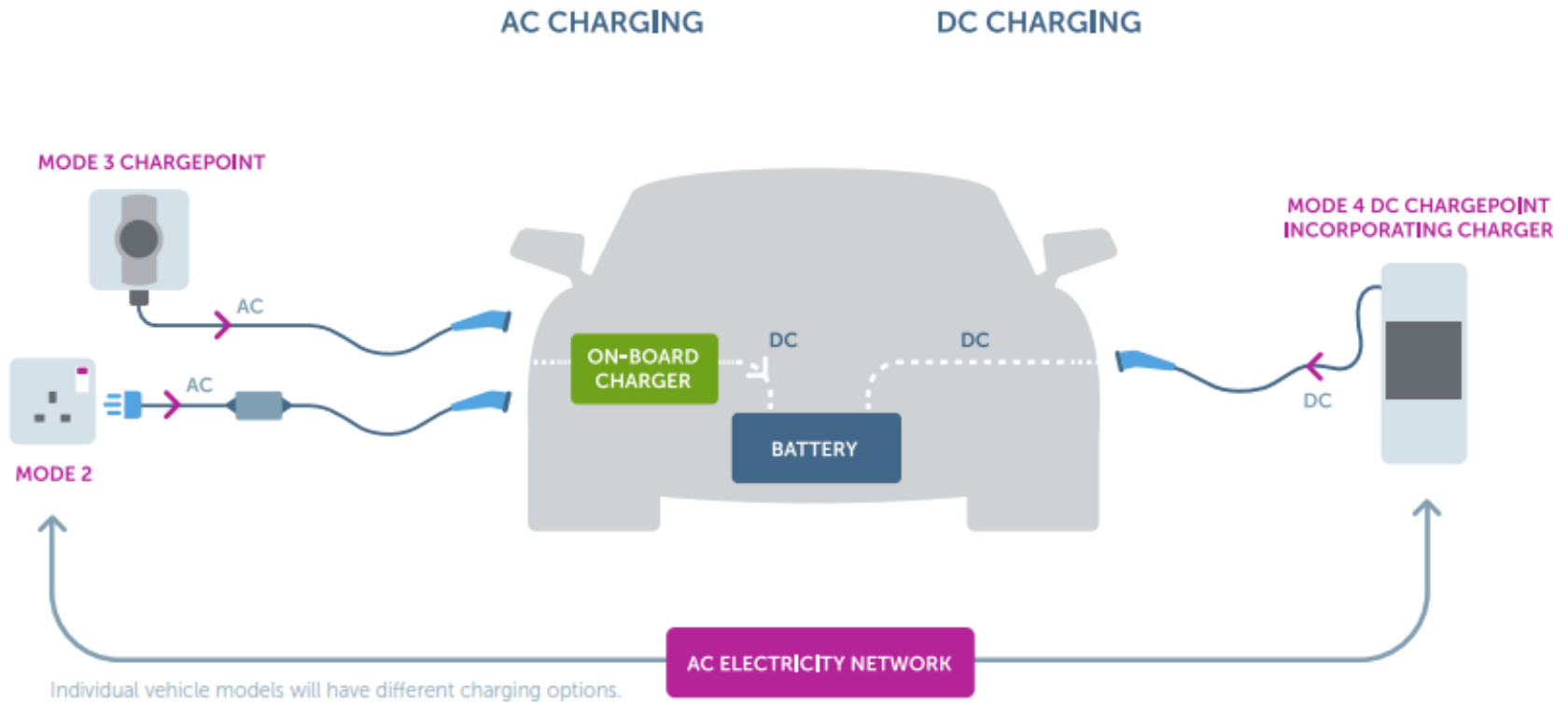
Charging Electric Vehicles

Inductive



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Charging Electric Vehicles



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Charging Speeds



Slow or standard charging is typically:

- **0-100% in 10-12 hours**
- 13-16 Amps AC single phase
- UK household or “caravan hook-up” style plug and socket (BS1363) or “Blue Commando” (EN60309)

Fast charging is typically:

- **0-100% in 4-6 hours**
- 16-32 Amps AC single phase
- Type 2 plug and socket

Semi-rapid charging is typically:

- **0-100% in 1-2 hours**
- 32 Amps AC three phase
- Type 2 plug and socket



Rapid charging is typically:

- **0-80% in 20-30 minutes**
- 63 Amps AC three phase or 100 Amps DC
- Type 2 (AC), JEVS/G105 (DC) or CCS Combo 2 (DC)







UK ELECTRIC VEHICLE SUPPLY EQUIPMENT ASSOCIATION

Times are based on a 24 kWh battery being charged to 80%

	MAXIMUM POWER OUTPUT FROM EVSE (KILOWATTS)	EXAMPLE CHARGING TIME (HRS:MIN)	INPUT VOLTAGE (VOLTS)	MAXIMUM CURRENT (AMPS)	MODE
AC	2.3kW	8hrs 20mins	230 1-phase AC	10	2 / 3
	3kW	6hrs 30mins	230 1-phase AC	13	2 / 3
	3.7kW	5hrs 15mins	230 1-phase AC	16	(2) 3
	7.4kW	2hrs 35mins	230 1-phase AC	32	(2) 3
	14.5kW	1hr 20mins	400 3-phase AC	21	3
	22kW	55mins	400 3-phase AC	32	3
	43kW	30mins	400 3-phase AC	63	3
DC	20kW	1hr	400 3-phase AC	40	4
	50kW	25mins	400 3-phase AC	100	4
	100kW	15mins	400 3-phase AC	200	4

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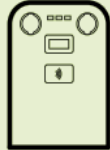
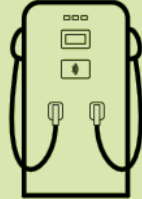

Charge Point Costs

Charge Point type and power output per outlet	Typical specification	Cost range (£ Ex VAT, delivery and installation)*
Fast - Type 2 wall mount 7kW 	<ul style="list-style-type: none"> ▶ Display + LED status indicators ▶ GPRS modem ▶ Mode 3 	£750 - £1,500
Fast - dual Type 2 wall mount 7kW 	<ul style="list-style-type: none"> ▶ RFID card, Contactless Payment Card reader and/or chip and pin enabled ▶ Display + LED status indicators ▶ GPRS modem ▶ Mode 3 	£1,700 - £2,700
Fast - dual Type 2 ground mount 7kW 	<ul style="list-style-type: none"> ▶ RFID card, Contactless Payment Card reader and/or chip and pin enabled ▶ Display + LED status indicators ▶ GPRS modem ▶ Mode 3 	£1,700 - £5,000
Fast - dual Type 2 wall mount 11kW or 22kW 	<ul style="list-style-type: none"> ▶ RFID card, Contactless Payment Card reader and/or chip and pin enabled ▶ Display + LED status indicators ▶ GPRS modem ▶ Mode 3 	£1,800 - £4,000



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Charge Point Costs

Charge Point type and power output per outlet	Typical specification	Cost range [£ Ex VAT, delivery and installation]*
Fast - dual Type 2 ground mount 11kW or 22kW 	<ul style="list-style-type: none"> ▶ RFID card, Contactless Payment Card reader and/or chip and pin enabled ▶ Display + LED status indicators ▶ GPRS modem ▶ Mode 3 	£3,000 - £5,000
Rapid - dual outlet 1 x Type 2 + 1 x JEVS G105 	<ul style="list-style-type: none"> ▶ RFID card, Contactless Payment Card reader and/or chip and pin enabled ▶ Display + LED status indicators ▶ GPRS modem ▶ 43kW AC or 50kW DC ▶ Mode 3 or 4 	£15,000 - £26,000
Rapid - triple outlet 1 x Type 2 + 1 x JEVS G105 + 1 x CCS Combo 2 	<ul style="list-style-type: none"> ▶ RFID card, Contactless Payment Card reader and/or chip and pin enabled ▶ Display + LED status indicators ▶ GPRS modem ▶ 43kW AC or 50kW DC ▶ Mode 3 or 4 	£16,000 - £30,000

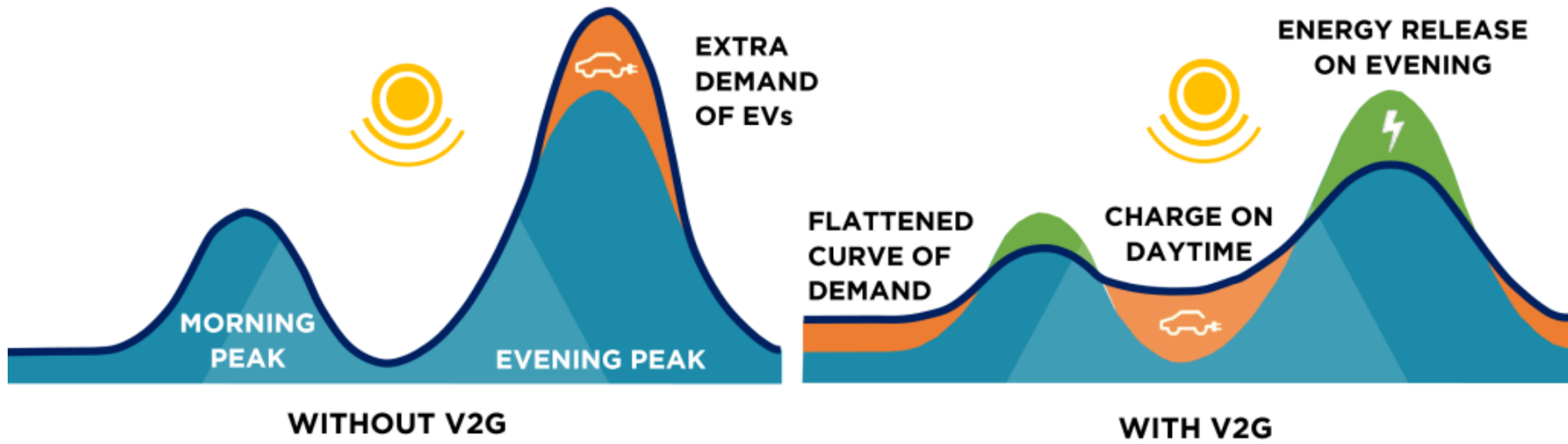


Grid impacts?

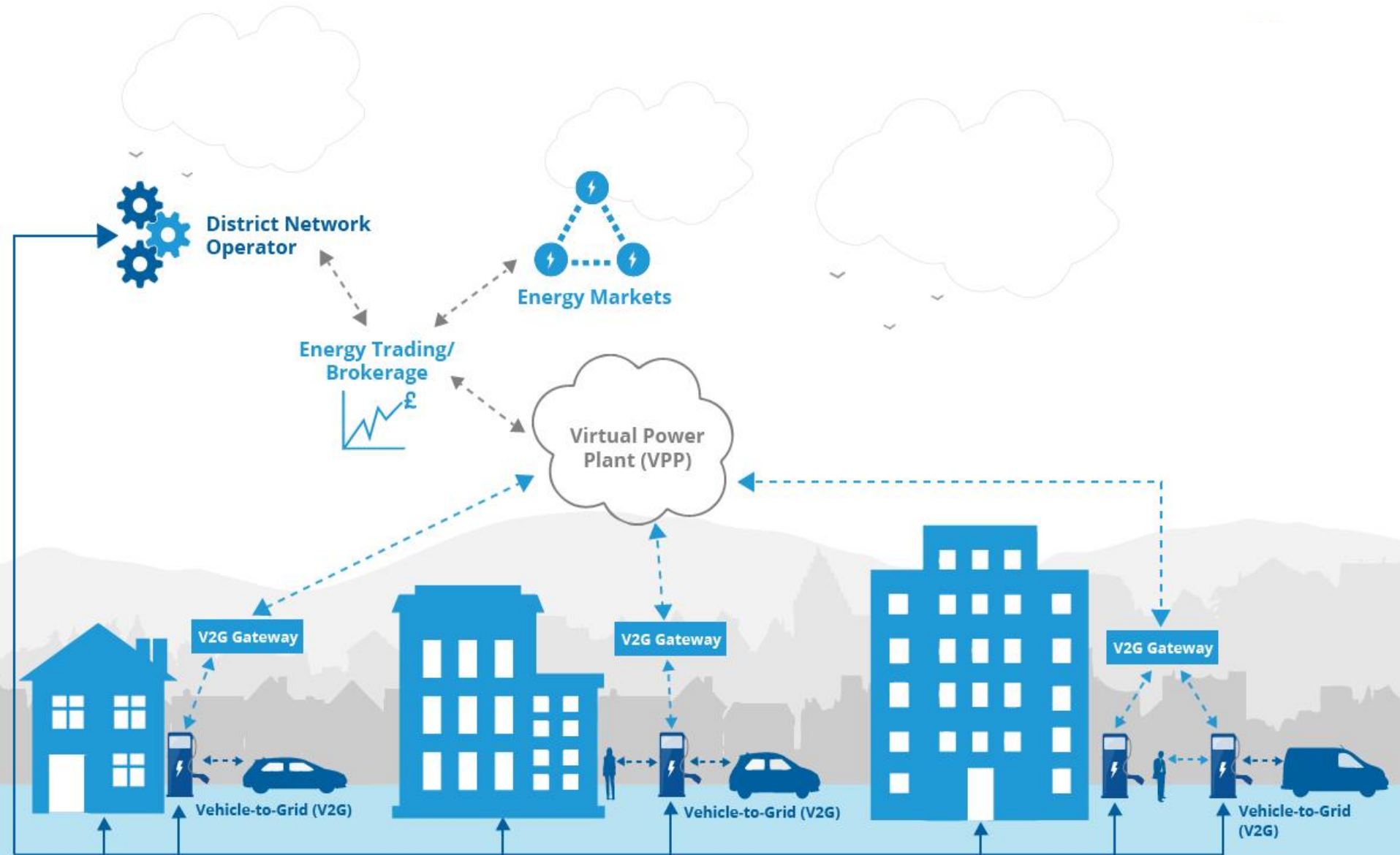


**Need for Smart
charging at depots
to avoid cost of grid
reinforcement**

Vehicle 2 Grid



Ebbs and Flows of Energy Systems (EFES)



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Battery electric vans

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!

Whole Life Cost Example

	Mercedes Sprinter 316 CDI (Diesel)	Mercedes Sprinter 316 NGT (CNG)	
Vehicle purchase cost	£28,740	£31,710	Vehicle: 3.5t CNG Large Panel Van
Fuel cost	£23,865	£16,219	Annual mileage: 25,000 miles
Road tax	£1,350	£1,350	Ownership period: 6 years
Maintenance costs	£8,760	£9,885	Cost saving: £1,823
Resale value	£3,135	£1,407	<p><i>The cost example opposite shows that the additional purchase cost of a CNG Mercedes Sprinter covering 25,000 miles per annum saves the operator over £1,800 on a whole life cost basis over 6 years. With the increased purchase and maintenance costs and lower residual value offset by the savings in fuel costs.</i></p> <p><i>The price of CNG varies significantly between suppliers. Availability of low cost CNG coupled with high annual mileage will be the key factors in achieving an overall whole life cost saving.</i></p>
Life time cost	£59,070	£57,247	
Cost per mile	39.4p	38.2p	
Whole life cost savings		£1,823	

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Hydrogen

Whole Life Cost Example

	Kangoo Maxi 1.5dCi 90PS (Diesel)	HyKangoo ZE Maxi (Battery Electric with SymbioFCell Hydrogen Fuel Cell Range Extender)
Vehicle	£15,296	£45,899
Plug-in van grant discount		£5,436
H2ME Grant discount		£7,500
Fuel costs	£9,268	£3,328
Road tax	£700	£0
Maintenance costs	£4,260	£5,385
Resale value	£1,975	£4,225
Life time cost	£27,549	£39,999
Cost per mile	27.5p	39.3p
Whole life cost savings		Not Available
If used in the London Congestion Zone (5 days / week)		
Life time cost	£40,674	£39,261
Whole life cost savings		£1,413

Vehicle:

2.2t Hydrogen Fuel Cell Range Extended EV Van

Annual mileage:

20,000 miles (75 miles per day)

Ownership period:

5 years

Cost saving:

£1,413 if used daily in the London Congestion Charging Zone

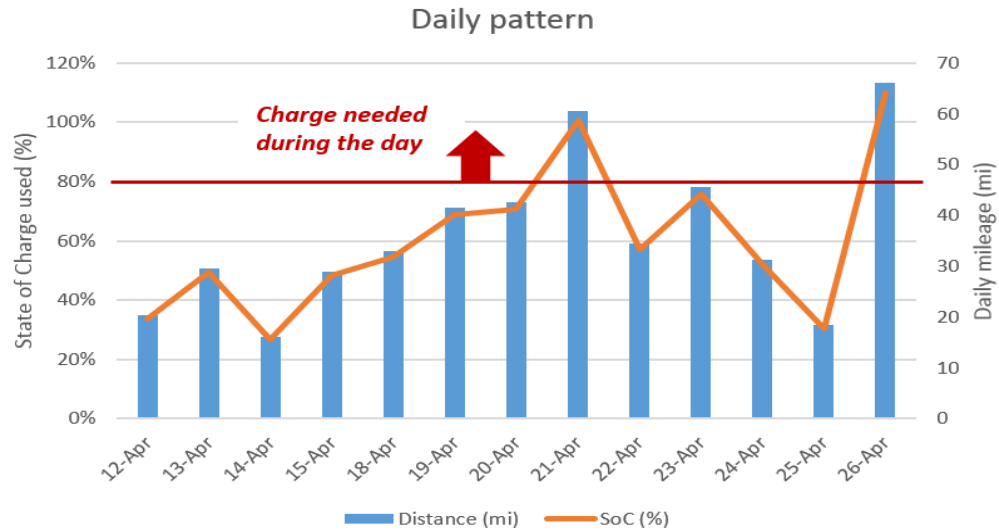
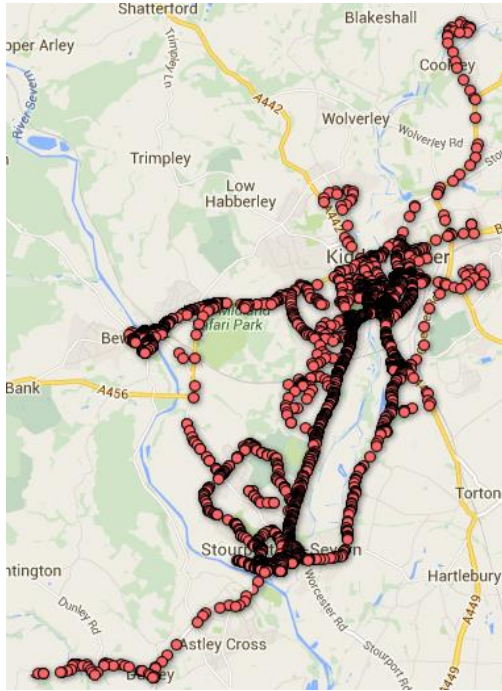
The example shows a saving is available from the fuel cell range extended battery electric van. The plug-in van grant, EU grant and daily free entry into the London Congestion Charging Zone combine to offer a positive total cost of ownership.

In this example the vehicle covers 65 miles per day using electricity stored in the battery through normal charging and 10 miles per day using electricity generated on-board from the hydrogen range extender.

The range extender allows the whole capacity of the EV battery to be used every day, taking full advantage of low cost grid electricity.

Because the cost of hydrogen from refuelling stations is currently high, cost savings will diminish if more miles are driven using the on-board hydrogen fuel cell.





CLEAR Capture

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

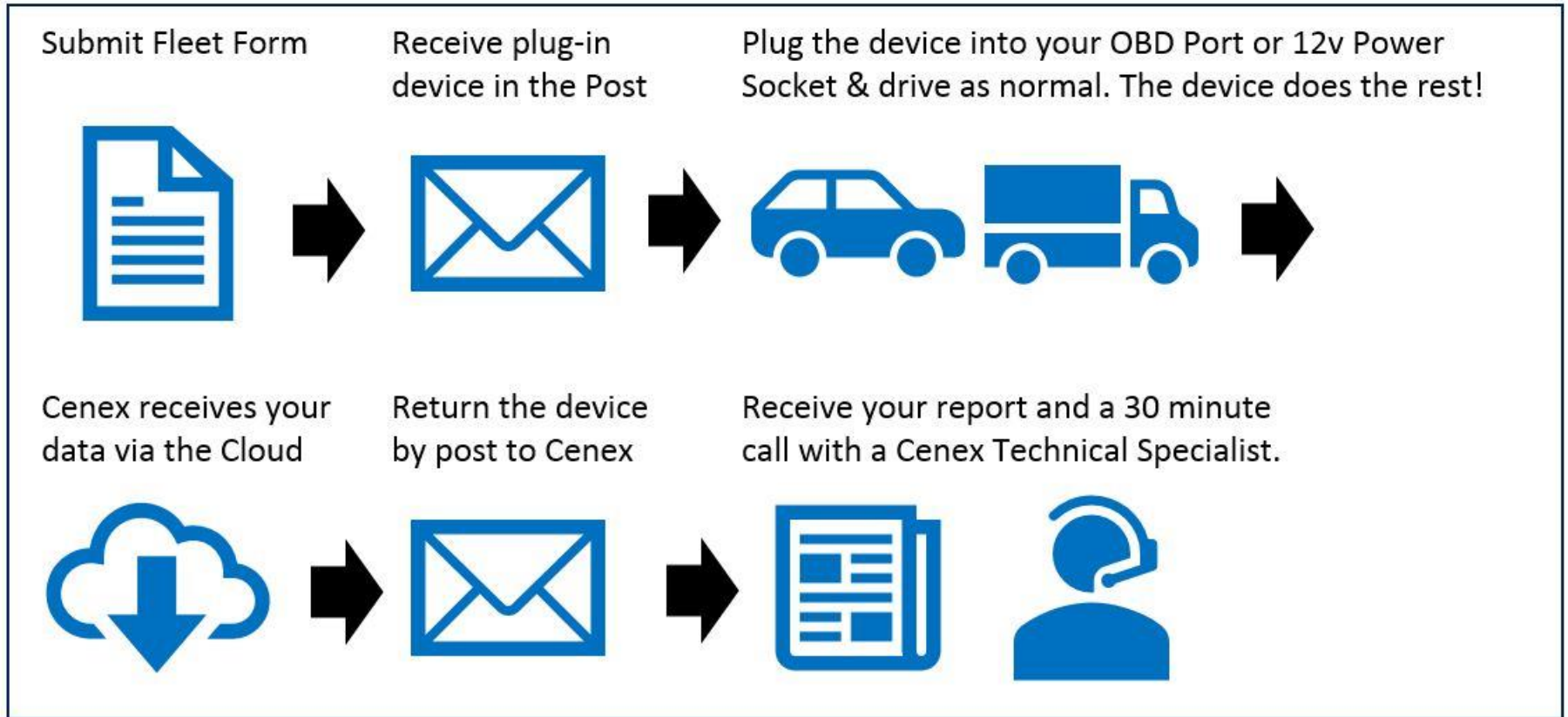


What will I know? You will fully understand if there is an economic (total cost of ownership) or environmental business case (savings of PM, NOx and CO2) to swap your conventional vehicles to a low emission vehicle, and know the technology types that offer the best savings in your bespoke fleet operational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



CLEAR Capture

Data Collection Process



CLEAR Capture

Fuel Consumption and Emissions Calculation

Vehicle Data Capture



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

ICE vehicles CO₂, PM and NO_x tests on different vehicle types

Fuel & energy consumption tests on EV, REEV and PHEV

Populate fuel consumption, CO₂, PM and NO_x lookup tables



Whole Life Fuel, CO₂, PM and NO_x Emission Savings



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West Midlands Police Service

- Cenex ran a consultancy project with West Midlands Police (WMP) to test the possibility of using the Nissan LEAF as “diary cars” in their fleet operations
- After a successful trial with Cenex, in June 2013 the force ordered 30 LEAFs to be split evenly across all 10 local policing units (LPUs) as diary cars to attend pre-arranged meetings with victims of crimes who have contacted the police
- The cars typically travel 40 to 45 miles a day, but this varies depending on the LPU. They are currently exploring other opportunities for further LCVs in their fleet operations.



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West Midlands Police Service

- After eight months, the real-world data showed...

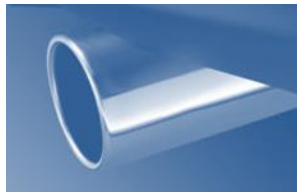


Total EV miles:
256,200



Total fuel cost saving:
£24,472

Equivalent to the cost of a year's
pay for one new police recruit!



Reduced tailpipe emissions:
68 tonnes CO₂



Thank you for listening

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