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A meeting of **Cabinet** will be held in Committee Room 1 - East Pallant House on **Tuesday 3 November 2015** at **9.30 am**

MEMBERS: Mr A Dignum (Chairman), Mrs E Lintill (Vice-Chairman), Mr R Barrow, Mr B Finch, Mrs P Hardwick, Mrs G Keegan and Mrs S Taylor

SUPPLEMENT TO AGENDA

Plugged-in Fleets Initiative 100 Electric Vehicle Report

Chichester District Council

By Karl R Anders

January 2014

PIFI/1314/056

Contents

Executive Summary

This project has analysed the financial and operational viability of plug in vehicles, and combines this with an overview of the infrastructure implications of making such a move. The project was carried out by the Energy Saving Trust (EST) in partnership with EDF Energy and Route Monkey and funded by the Office for Low Emission Vehicles (OLEV).

CDC operates a fleet of 33 vans and 1 car. The Council also has a grey fleet of 74 Casual users, 111 Essential users and 48 cash allowance drivers who use their own private vehicles for business journeys and reclaim the mileage cost.

For this project, we received vehicle, mileage and fuel data. We received mileage and cost data on the grey fleet data but not any individual vehicle data so we provided examples from other recently reviewed Council grey fleets so as to provide an idea of the likely emission and age profiles.

The conclusion from the calculations completed on the light vans is that there is a strong financial and environmental business case for the adoption of electric vans within this part of the fleet.

Over the procurement pattern of 13,500 miles per annum (the CDC small van average mileage) over 7 years (the average age of the CDC vans), the EVs are less expensive to run than the Transit Connect models that currently dominate the light van fleet.

The extent via which EV's are less expensive may vary depending on the discount support that CDC may be able to negotiate with the relevant vehicle manufacturers. We did obtain a public sector supported quote from a Renault dealership for this review and have used the same discount percentage for the new Ford Transit.

The standard Kangoo Z.E. costs approximately £982 less to run per year over 7 years than a Transit Connect. The larger Kangoo Maxi Z.E. costs £865 less per year to run.

We would however recommend that CDC tests the market for pricing at each replacement opportunity so as to take advantage of any price reductions available at the time, (for both diesel and EV vehicles).

We accept that the Transit Connect is slightly larger than the EV alternatives and CDC would need to investigate every operational need to ensure that the smaller payload vans were still capable of meeting Council requirements.

Whilst it is unlikely that CDC could replace the entire grey fleet with a pool fleet of electric vehicles (EVs), there is a clear business case to consider adding some to the fleet and in doing so secure the commercial benefits from a lower carbon fleet.

The Council could run a mixed fleet with some EVs and some conventional pool cars meaning that CDC will still have vehicles available to cover the occasional longer journeys completed by staff.

Assuming a proportional reduction, migration from grey fleet (including all costs) into the lowest cost EV pool vehicle could lead to a £590 saving to the Council and a 1.8 – 1.9 tonne reduction in the total carbon footprint for each pool car (including tailpipe and carbon generation) covering 10,000 miles per annum.

There are other factors to consider in the decision to operate EV pool cars. The first being the volatility of diesel pricing which changes the financial business case as diesel (and petrol) vehicles are more at risk of cost increases as fuel cost is a greater proportion of whole life costs.

The cost of diesel has risen by 19% over the past three years and there is a considerable risk of significant rises continuing over the next 7 years. A conservative rise of just 5% represents an additional cost of £107 (at £1.18 ex-VAT) per diesel Transit Connect van per year at 13,500 miles per annum (MPA). A rise of 5% on a similar Kangoo EV represents a much lower additional cost of only £18 per van.

A worst case scenario of another 19% rise would add £407 to the cost of diesel per van per year on each Transit Connect but only £70 for one of the electric vans thus making the electric vehicle more cost effective than the diesel van. The fuel price risk is much greater over longer periods and the diesel is far more exposed to it.

Although it is probable that electricity costs may also increase, any percentage increase will have less impact on the total running cost due to the far lower starting price.

Another factor to consider is the emissions and air quality benefits from operating EVs can deliver which could be used to further enhance the environmental credentials of CDC. The tailpipe emissions of EVs are zero compared to the annual 4.7 tonnes of carbon that each Transit Connect is likely to produce at 13,500 miles per annum.

Even factoring in an equivalent CO_2e amount to take into account the emissions from generating the electricity at the current mix of power production, each Transit Connect replaced with an EV would lead to a total reduction of approximately 3 tonnes of CO_2 per year.

1. Introduction

The Plugged-in Fleets Initiative 100 (PIFI), carried out by the Energy Saving Trust, is funded by the Office of Low Emission Vehicles (OLEV), and consists of bespoke projects for 100 organisations across a wide spectrum of market sectors.

Each project seeks to both analyse the financial and operational viability of EVs, whilst also providing guidance on infrastructure.

PiFi 100 follows the ‘Plugged-in Fleets Initiative’, which was delivered by Energy Saving Trust from April 2012- March 2013 funded by Transport for London and Department for Transport. We worked with 16 fleets in London and 9 across wider England.

The findings from each of the individual reports were incorporated into a report published and communicated to the wider fleet industry. This larger report offers valuable insights to all business and public sector fleets from a range of fleets from local authorities, NHS Trusts, small delivery companies, to private company car fleets.

Energy Saving Trust is an independent, not for profit organisation, organised as a social enterprise with charitable status, and has engaged with hundreds of organisations in the last eight years, highlighting how to reduce fleet-related emissions and costs.

EDF Energy has provided insight into the infrastructure requirements for fleets when adopting EVs in Appendix D in this report. Route Monkey has provided information on scheduling and maximising the mileage of electric vehicles to ensure best value for money.

With regard to lease costs, Alphabet (see Appendix H) are another partner in the PIFI100 programme via which we can source leasing quotes if required.

2. Project Scope

1.1 Organisation background

Chichester is a rural local government district in West Sussex that covers approximately 786 km². According to Census 2011, the total population for Chichester District was estimated to be 113,794 and the population density was just 1.4 people per hectare compared to 4.0 across West Sussex and 4.5 across the south east.

Chichester District Council (CDC) are a major employer in Chichester, along with Rolls Royce Motors who have a plant nearby.

1.2 Current CDC fleet vehicle profile

According to the data supplied, CDC has a fleet of 33 vans and 1 car. The Council vehicles are outright purchased and average around 7 years of age.

The Council also has a grey fleet of 74 Casual users, 111 Essential users and 48 cash allowance drivers who use their own private vehicles for Council use and reclaim the business mileage.

The Council supplied vehicle, mileage and fuel use data for the 6 month period April – September 2013 for the operated vehicles which we annualised by doubling. These vehicles are profiled in the table below where we can see that during the 20102/13 period the van fleet covered an estimated annual business mileage of over 365,000 miles using an estimated 51,000 litres of diesel.

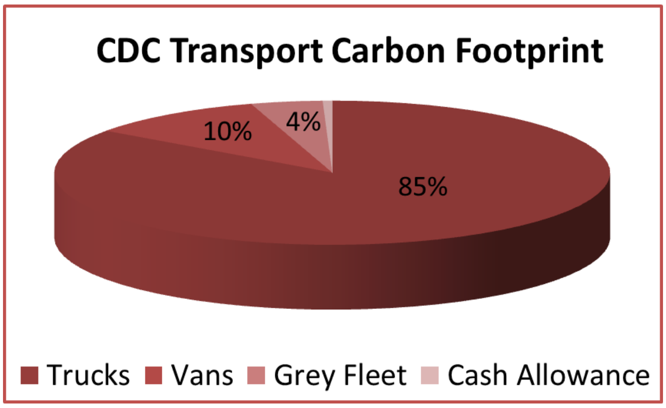
Subtracting the reported fuel used by the vans from the total reported fuel use in litres reveals that the heavy truck vehicles dominate the carbon footprint although they are not within the scope of this review.

Council Operated Vehicles

Type	Number	Annualised Miles	Annualised Fuel Used (litres)	Carbon Footprint (tonnes)
Van	33	365,456	51,273	132.3
Car	1	Unknown	Unknown	Unknown
Trucks	37	Unknown	Unknown	1,075.1
Total CDC	107	Unknown	468,000	1,207.4
In Scope	**77**	**365,456**	**51,273**	**132.3**

CDC Private Staff Owned Vehicles

Type	Number	2012/13 Business Miles	2012/13 Cost	Carbon Footprint (tonnes)
Cash Allowance	48	20,942	£3,664.85	6.6
Essential Users	111	145,220	£68,108.18	45.5
Casual Users	74	25,164	£11,801.92	7.9
Total	**233**	**191,326**	**£83,574.95**	**59.9**



Current van fleet profile

CDC has a fleet of 33 vans which are dominated by the larger size vehicles available in this sector. These large vans comprise many makes and models but the Iveco Daily and Ford Transit are the most popular; these are considered in a following section.

Type	Number	Miles 2012/13	Fuel Used 2012/13 (litres)	Carbon Footprint (tonnes)
Small	12	133,728	13,738	35.4
Large	19	220,636	35,704	92.1
Pickup	2	11,092	1,831	4.7
Total Vans	**33**	365,456	51,273	132.3

1.3 Light vans

The table below shows the data on the 12 light vans used for our analysis, the results of which are discussed in the following section:

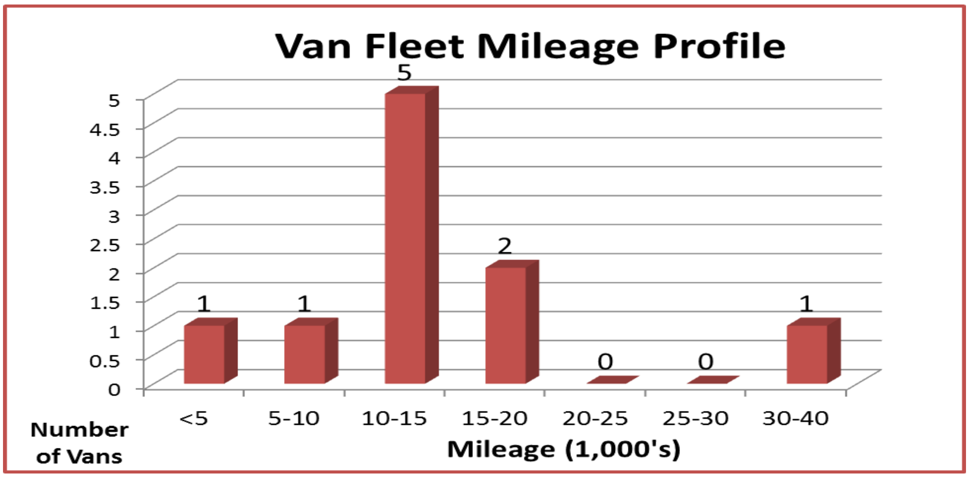
Registration	Model	Engine Size (cc)	Annual Mileage 2012/13	Fuel Used 2012/13 (litres)	MPG	Average Daily Miles
HY04 VFH	Citroen Berlingo	1,997	6,606	791.1	38.0	20
HY04 VFJ	Citroen Berlingo	1,997	15,056	1,659.1	41.3	46
FD60 OTP	Ford Transit Connect	1,753	11,284	1,356.1	37.8	35
FP57 ZPB	Ford Transit Connect	1,753	12,218	1,838.1	30.2	38
HK55 OHX	Ford Transit Connect	1,753	**N/A**	**N/A**	**N/A**	**N/A**
HN08 YOM	Ford Transit Connect	1,753	19,322	2,448.8	35.9	59
HN08 YOP	Ford Transit Connect	1,753	10,040	1,268.5	36.0	31
HN08 YOR	Ford Transit Connect	1,753	14,576	1,729.0	38.3	45
HN55 WZZ	Ford Transit Connect	1,753	**N/A**	**N/A**	**N/A**	**N/A**
HV07 RXB	Ford Transit Connect	1,753	402	54.5	33.5	1
HK11 KWT	Peugeot Partner	1,560	32,578	1,463.9	**N/A**	100
HT02 LGD	Vauxhall Combo	1,686	11,646	1,129.2	46.9	36
AVERAGE		**1,772**	**13,372.8**	**1,373.8**	**N/A**	**41.1**

In terms of mileage, only 1 of the Peugeot Partners (HK11 KWT) covers a daily mileage that is likely to be outside the capability of an EV. It covers 100 miles per day on average so would require recharging more than once in this period. This was calculated by dividing the annual miles by 6.5 days per week (we were advised many cover 6-7 days per week and are on call) and 50 weeks (assuming two weeks downtime for servicing etc.).

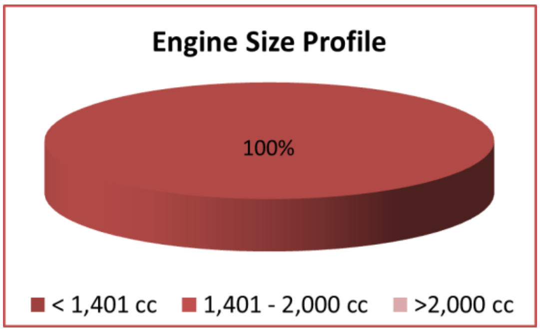
The average annual mileage in this part of the fleet is 13,372 miles (with the highest being 32,578). Although many EVs give a maximum range figure in excess of 100 miles, this is calculated on the New European Drive Cycle (NEDC).

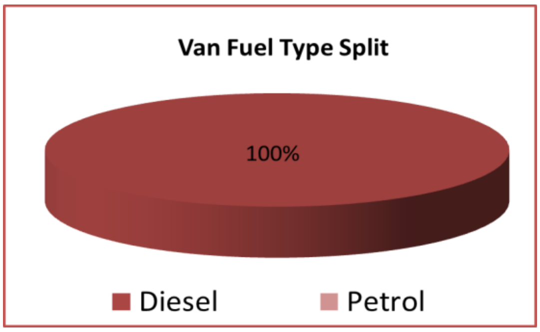
Experience has shown that in real life, EVs have a slightly lower range, particularly in winter months when temperatures are lower and vehicles regularly have lights, wipers and heaters operating at the same time.

Figures vary, but from our experience in working with several other organisations, we'd suggest that between 60-70 miles should be considered the range limit.

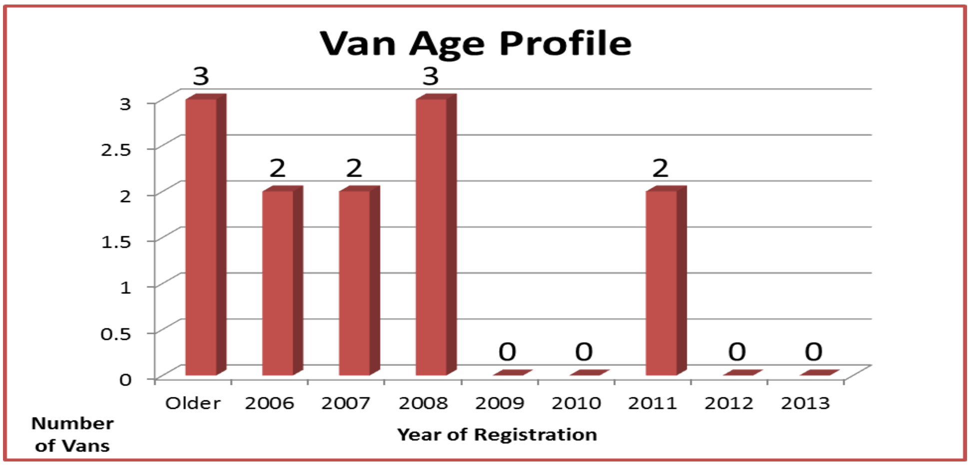


As can be seen above and as eluded to earlier, the CDC vans do not cover large mileages.





Perhaps unsurprisingly, the vans are all diesel and all have engine sizes in the typical 1,401 – 2,000cc range, the average being 1,772cc which is not excessive but smaller, more efficient engines than this are available.



In terms of fleet age, this is a relatively aged fleet. 10 (83%) of the vans were registered in or prior to 2008. Only 2 vans have been registered since 2009. Councils typically keep their vans longer than private organisations (who normally replace every 4 years on average).

This is a very old fleet that may have higher service, maintenance and repair costs than newer fleets and relies on older, less clean technology so produces higher emission compared to newer vans.

There are several makes and models used in the light van fleet but the dominant van is the Ford Transit Connect. There are 8 of these which comprises 67% of the light van fleet. These are all superseded older model Transit Connect and a new Transit Connect model was launched by Ford to replace this in 2013.

Previous model Transit Connect

New model Transit Connect

Potential light van alternatives

The table overleaf compares the recently superseded Ford Transit Connect T200 model that the Council currently operates as the main light van with EV alternatives.

We have compared to the Kangoo ZE and Kangoo Maxi ZE, using data from the respective manufacturer websites to allow CDC to be able to forecast the operational viability and business case. There are other alternatives from competitors due to be released which should also be considered.

Model	Ford Transit Connect T200 75PS	Renault Kangoo ZE ML20	Renault Kangoo Maxi ZE LL21
Engine	1,753cc turbo diesel	Electric, direct drive	Electric, direct drive
Overall Length (mm)	4525	4,282	4,666
Overall Height (mm)	1,980	1,805	1,810
Overall Width (mm)	2,044	1,829	1,829
Wheelbase (mm)	2,912	2,697	3,081
Max Range (NEDC less 15%)	N/A	92	92
Gross Vehicle Weight (kg)	2,340	2,126	2,175
Maximum Payload (kg)	908	650	650
On Road (discounted & ex-VAT) *	£13,000.86	£16,541.32	£17,653.27
Plugged-In Van Grant (PiVG)	N/A	£4,093.00	£4,388.00
List price after PiVG (ex-VAT) *	£13,000.86	£12,448.32	£13,265.27
Tailpipe NEDC CO_2 (g/km)	162	N/A	N/A

*** = New model pricing.**

The table below shows the battery rental costs (ex-VAT) from Renault for the Kangoo ZE and Kangoo Maxi ZE, inclusive of battery capacity warranty and recovery services to minimise risk of the battery degrading and failing to perform over time. For this analysis, 13,500 miles per annum equates to £89 net of VAT per month. This will more than cover the 13,500 miles P.A.

Annual mileage			
6,000	9,000	12,000	15,000
£61.00	£65.00	£75.00	£89.00

The Renault Kangoo Z.E. and Kangoo Maxi Z.E.

The electric Kangoo Z.E. is currently available directly from the manufacturer and it meets the payload requirements, of the light vans. The Kangoo Z.E. model (or similar Citroen and Peugeot models when available) may have potential to replace the Transit Connect vans in the fleet. The lithium-ion battery pack of the Kangoo Z.E. provides a range of up to 106 miles based on the New European Drive Cycle, the same test used to derive ICE vehicles' MPG and CO_2 g/km results.

It can be recharged with Mode 3 ('fast') charging station (16 amps) or optional Mode 2 unit ('standard'). 'Standard' (10 amps) charge time is 6-8 hours. Based on a standard Kangoo platform, the ZE offers a payload of 650kg, from a Gross Train Weight of 2,452 kg and a Gross Vehicle Weight of 2,126 kg. The volume payload for the Kangoo Z.E. is up to 3.5 cubic metres and up to 4.6 cubic metres for the Kangoo Maxi Z.E. More details are available at http://www.renault.co.uk/vans/model/kangoo-van-ze/product.aspx

Other potential electric vans soon to be launched

There are several other vans on the horizon although launch dates haven't yet been announced. In presenting these models, we would urge CDC to contact the manufacturers of these EVs to get a direct quote for supply in case there is finance support available to which we have not been party when preparing these price comparisons.

Peugeot Partner Electrique (and Citroen Berlingo Electrique)

The Partner Electrique uses dual lithium-ion battery packs with a total capacity of 22.5kw/h, providing a 100-mile range. The L1 variant has a load volume of 3.3m^3 while the longer L2 has a load volume of 3.7m^3. The batteries can be fast-charged up to 80-percent capacity in 30 minutes and a standard recharge takes six to nine hours. A similar Citroen Berlingo Electrique EV version has been announced.

Nissan E-NV 200 (due 2014)

Nissan has announced an electric version of its NV200 van will go into production in 2014. Pricing has not been announced but this van will be larger than the Renault, Citroen and Peugeot models with a load volume of 4.2m^3 and may be an option in applications where CDC requires a larger payload. The range is described as 'similar to the LEAF' which is over 100 miles on the combined cycle.

Whole Life Cost (WLC) financial analysis

The table overleaf shows the Whole Life Cost (WLC) outlines of both Kangoo Z.E. van models in this project compared to the Ford Transit Connect.

The average annual mileage of the vans was 12,182 but the annual average mileage of the smaller light vans was 13,373. Therefore we have used 13,500 miles per annum in this project over the 7 year replacement cycle.

	Ford Transit Connect T200	Renault Kangoo Z.E. ML20	Renault Kangoo Maxi Z.E. LL21
Cost of Diesel £/litre	£1.18	N/A	N/A
Electricity (pence / kWh)	N/A	9.5	9.5
Monthly Battery Cost	N/A	£89.00	£89.00
Official MPG	38.7	N/A	N/A
Actual CDC 'in service' MPG	35.3	N/A	N/A
Consumption (Wh/km)	N/A	155	155
Real-world (Wh/km)	N/A	178.3	178.3
SMR (PPM)	3.88	3.87	3.87
On Road Price (after PIVG)	£12,725.86	£12,393.32	£13,210.27
Insurance (@ £500/year)	£3,500.00	£3,500.00	£3,500.00
Total Fuel Costs	£15,043.77	£2,574.79	£2,574.79
Battery Rental	£0.00	£7,476.00	£7,476.00
SMR	£3,666.60	£3,657.15	£3,657.15
FRF & VED over term	£1,595.00	£55.00	£55.00
Lifecycle Whole Life Costs	**£36,531.23**	**£29,656.26**	**£30,473.21**
Annualised WLC	**£5,218.75**	**£4,236.61**	**£4,353.32**

We have obtained a purchase quote using Public Sector support from a Renault Fleet Specialist Retailer to the derive the costs of the Kangoo Z.E. models. We do not have the same figures from Ford so we have assumed the same level public sector support for the Transit Connect and have used the pricing of the new model as the previous model that the Council uses is no longer available.

We are not party to any discounts that the Council may have access to directly with Ford, Renault, or similar manufacturer. Should CDC enjoy any such preferential terms, their financial value can easily be subtracted from the WLC calculated here.

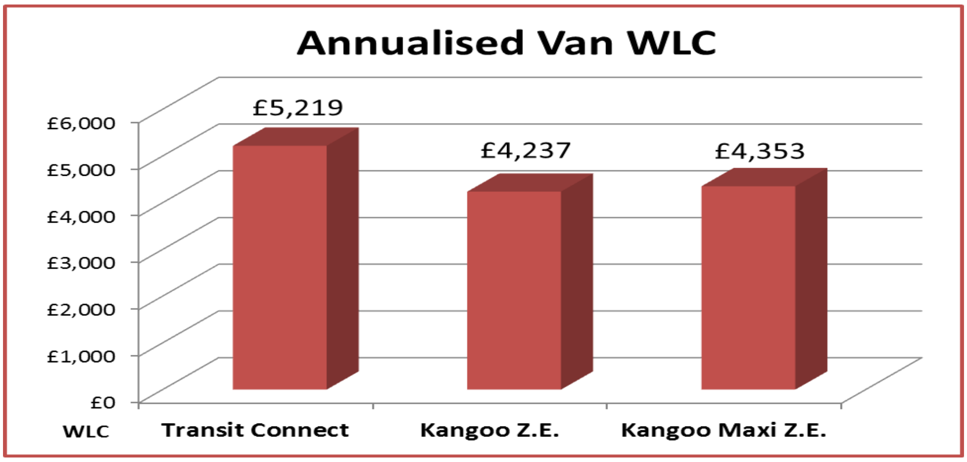
Alternatively, at the point that CDC decides to investigate further and obtain actual purchase quotes on the van alternatives, the Council can contact EST and we can enter the revised costs into our WLC matrix and recalculate this table.

The Service, Maintenance & Repair (SMR) figures are sourced from Fleet Van using data supplied by Kee Resources (although it should be noted that the lowest mileage option is 15,000 miles per annum so this has been used).

The longest period given is 5 years so the pence per mile has been used over 7 years. This makes less than £15 difference between the vans over the whole 7 years as it is very close on all 3 vans so is not a significant difference.

We cannot forecast a residual value for each van over 7 years as the maximum listed is 5 years so we have depreciated each van to zero. However, these vans will have a value at the end of the term even though we cannot forecast at this stage whether the diesel vans will have a value above or below that of the EVs.

The annual insurance costs were estimated at £500 per annum for each van. The annualised whole life costs are illustrated in the graph overleaf.



The analysis shows that running an EV van covering 13,500 miles per annum over 7 years is financially beneficial compared to the Transit Connect. At the supported pricing used, the Kangoo Z.E. costs approximately £982 less to run each year compared to a Transit Connect. Even the larger Kangoo Maxi LWB costs £865 less per year.

Given that each van is periodically subject to price promotion, or discounting, that can significantly change the comparable analysis figures, we would recommend that CDC tests the market for pricing of both diesel and electric vehicles at each replacement opportunity).

We also accept that the Transit Connect is slightly larger than the Kangoo ZE and as such would recommend CDC satisfy itself that the ZE has sufficient space and payload capability for the work required of it.

1.4 Potential EV alternatives to the larger vans

For the roles filled by the larger vans, there are currently only the Smiths Edison and Mercedes Vito large vans available. It will be far more difficult to build a financial business case for larger vans due to the current expense of similar sized alternatives. There is a larger Kangoo Maxi (LWB) ZE model available as discussed above should CDC be able to downsize some of the large vans where operational requirements use a smaller payload.

Kangoo ZE Maxi as a possible downsize alternative EV

Although CDC currently operates vans in the heavier roles, we would suggest a first challenge would be whether they still require the larger payload of the large vans. If the operational requirements do not need the full size payload for some (not necessarily all), then the larger version of the Kangoo (or forthcoming e-NV200 may be a viable alternative.

Smiths Edison as an alternative EV

The second alternative is the Smiths Edison built on the Transit chassis but only in MWB and LWB versions (not SWB). The Edison has a range of up to 80 miles between charging and recharging takes 6-8 hours with standard charging and 3-4 hours with fast charging. These vans are already in service with fleets like Essex County Council and Gateshead Council.

Mercedes Benz Vito E Cell

Another potential alternative of a similar size is the Vito but this is only available direct from Mercedes-Benz and the van must be returned to Mercedes-Benz at the end of the term. The monthly rental is normally around £1,300 per month although there is currently a deal through their Charterway Leasing subsidiary on specific stock vehicles down to £563+VAT on a 2 year contract up to 10,000 miles per annum. It is unlikely to be viable in running cost financial terms for the CDC vans based on the low van mileage data supplied by the Council.

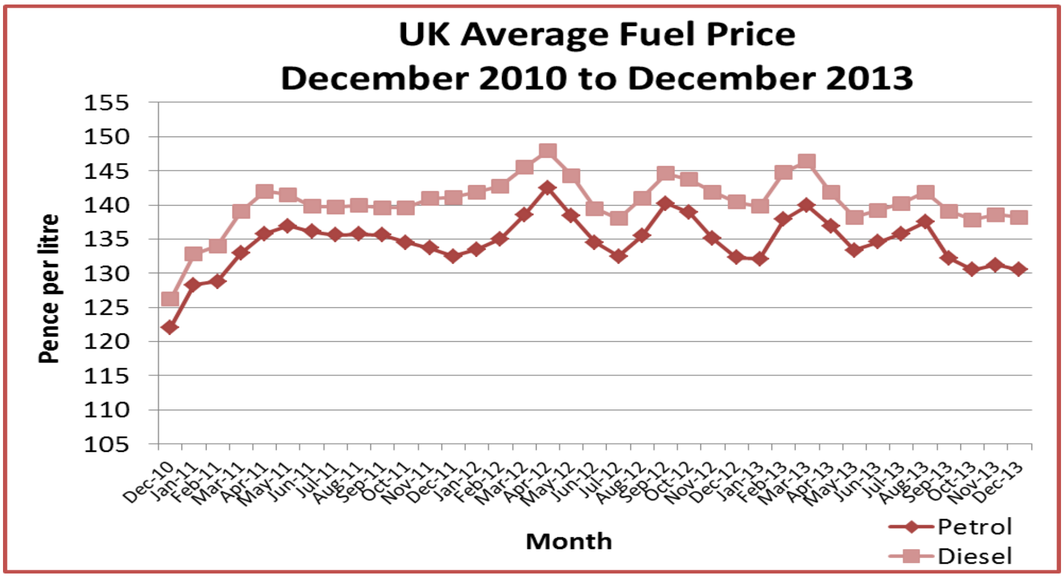
Van size and purchase cost comparison

The table overleaf presents the possible EV options to the larger Iveco Daily and Ford Transit vans operated by the Council, the slightly larger Smiths Edison, the Mercedes Vito plus also the downsizing option with the Renault Kangoo Maxi ZE. This data is from the respective manufacturer websites for information. However, we do understand that this would require a decision based on strong environmental grounds due to significantly higher costs than a diesel Relay, Daily, Cabstar, Master, Trafic or similar van.

Model	Mercedes Vito E-CELL	Smith's Edison Transit MWB Mid Roof	Renault Kangoo Maxi ZE
Engine	Electric, direct drive	Electric, direct drive	Electric, direct drive
Overall Length (mm)	5,008	5,230	4,597
Overall Height (mm)	1,895	2,390	1,802
Overall Width (mm)	1,901	2,374	1,829
Wheelbase (mm)	3,200	3,300	3,081
Range – Miles (NEDC)	80	55-110*	92
Load Volume (m3)	5.7	6.45	4.0
Gross Vehicle Weight (kg)	3,050	3,500	2,078
Maximum Payload (kg)	775	1,160	650
List Price (ex-VAT) on road (incl del)	N/A	£55,500	£22,590
Plugged-In Van Grant (PiVG)	N/A	£8,000	£4,388
List price after PiVG (from)	N/A	£47,500	£18,202
Annual VED	£0	£0	£0

1.5 Diesel cost volatility as an additional risk factor

Any analysis assumes fuel costs remain at current levels for the next 7 years. The graph below from AA fuel reports (November is latest as at 30/01/2014) shows that the cost of diesel has risen by 10% over the past 3 years.



To understand the potential cost implications of this volatility, a rise of just 5% represents an additional cost of diesel of £107 per year (using £1.18 per litre ex-VAT) per diesel Connect van at 13,500 miles per annum.

A similar rise of 5% on the fuel cost of a Kangoo EV represents a much lower additional cost of only £18 per van each year. A worse scenario of another 10% rise represents an additional £215 to diesel cost every year on each Connect but only £37 for one of the electric vans. The fuel price risk is much greater over longer periods and the diesel is far more exposed to it.

Although it is probable that electricity costs may also increase, the operation of an electric van holds less risk of cost increases than diesel so has the positive benefit of insulating the Council from at least some of the price increase risk.

1.6 Carbon footprint reductions

To estimate comparable CO_2e emissions for EVs including the emissions generated in producing the electricity, we use an emissions figure comparable to the published tailpipe emissions of conventional vehicles with internal combustion engines. The methodology is on **Appendix H** at the end of this report.

Model	Ford Transit Connect	Renault Kangoo ZE	Renault Kangoo Maxi ZE
Engine	Diesel	Electric	Electric
Tailpipe NEDC CO_2 (g/km)	162	N/A	N/A
Tailpipe NEDC CO_2e (kg/kWh)	N/A	0.445	0.445
Annual Carbon Footprint	4.7	1.7	1.7
Lifecycle Carbon Footprint	32.9	12.1	12.1

This shows that each diesel Transit Connect replaced with an electric van would lead to a total reduction of approximately **3.0 tonnes** of CO_2 every year.

1.7 Air quality and environmental leadership

In addition to the carbon benefits, the use of EVs can also deliver health benefits derived from improved air quality. This in turn helps to enhance the environmental credentials of CDC and so has a positive effect on image, particularly if the van(s) are prominently liveried to promote the electric powertrain like the example Kangoo pictured below operated by social housing maintenance firm Rydon Group who have also participated in the Plugged-In Fleets Initiative.

In applying for PIFI 100, CDC automatically becomes a member of Motorvate. Benefits include access to the online Motorvate network where members can share ideas & best practice, use of the Motorvate logo for promotional use, information on funding opportunities and invitations to free transport conferences.

Motorvate also has a Plugged-in Fleets Group so the Council can share and benefit from the EV experience of others.

1.8 EV pool cars as an alternative to grey fleet

The table below shows the number, mileage, cost and carbon footprint of the privately owned vehicles used by staff for Council business mileage in 2012/13.

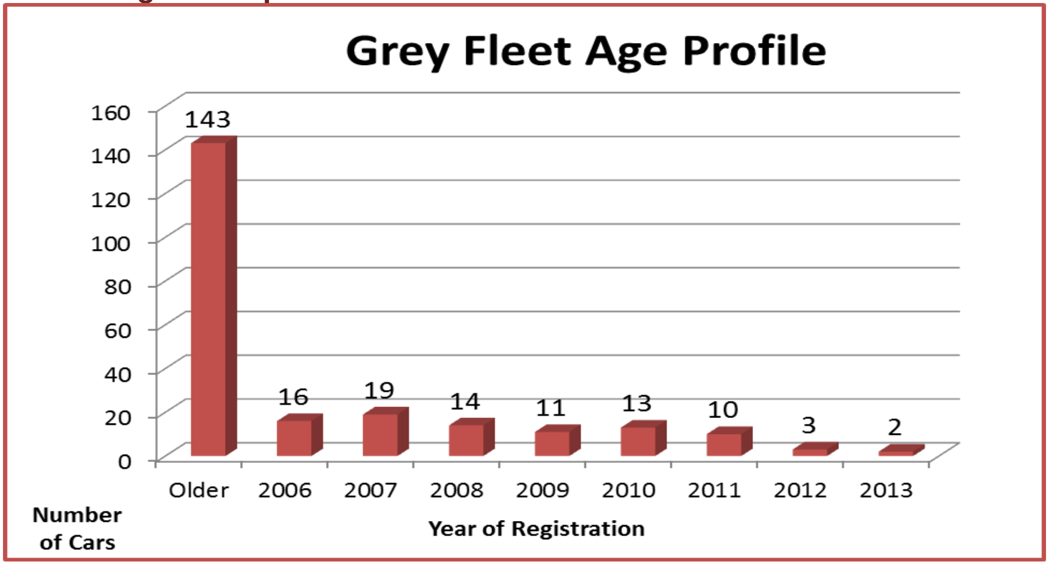
Type	Number	2012/13 Business Miles	2012/13 Cost	Carbon Footprint (tonnes)
Cash Allowance	48	20,942	£3,664.85	6.6
Essential Users	111	145,220	£68,108.18	45.5
Casual Users	74	25,164	£11,801.92	7.9
Total	**233**	**191,326**	**£83,574.95**	**59.9**

The Council did not supply any grey fleet individual vehicle data but is interested in the potential operation of EV pool cars to reduce the use of grey fleet. We have therefore provided the following in order to provide a guide as to the viability of such an idea.

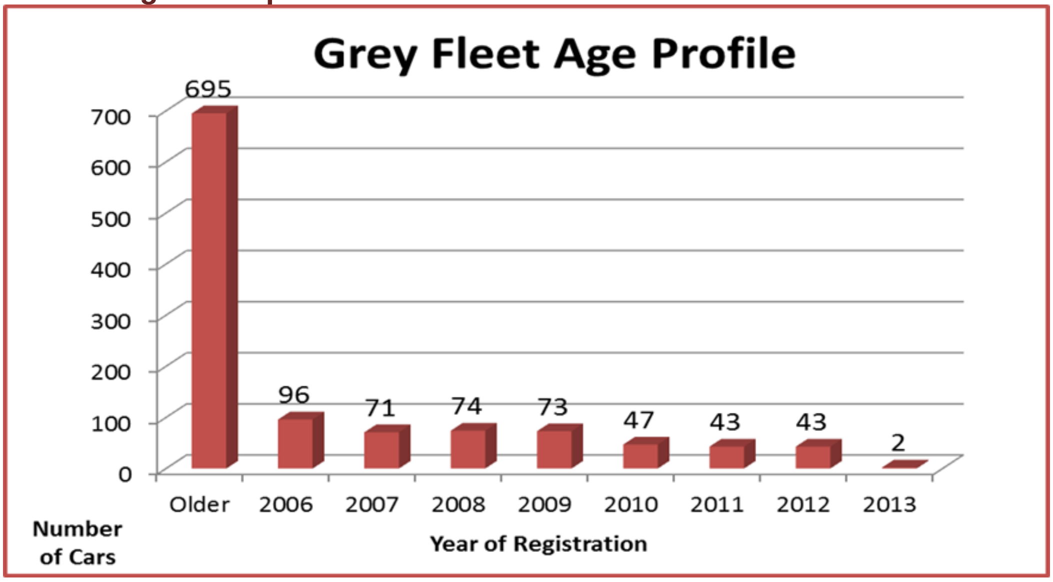
Whilst we did not receive individual CDC vehicle data, from our work with other public sector fleets we know the typical average age of a grey fleet vehicle is at least 7 years old and sometimes is above 9 years old. Consequently, use of such vehicles has a higher carbon impact than that of a more modern, employer provided vehicle.

In order to illustrate this point, we have presented three examples from other recent Council reviews where vehicle data was available to give an indication of the likely age profile of the CDC grey fleet as it will be significantly different to the age profile of the CDC owned fleets.

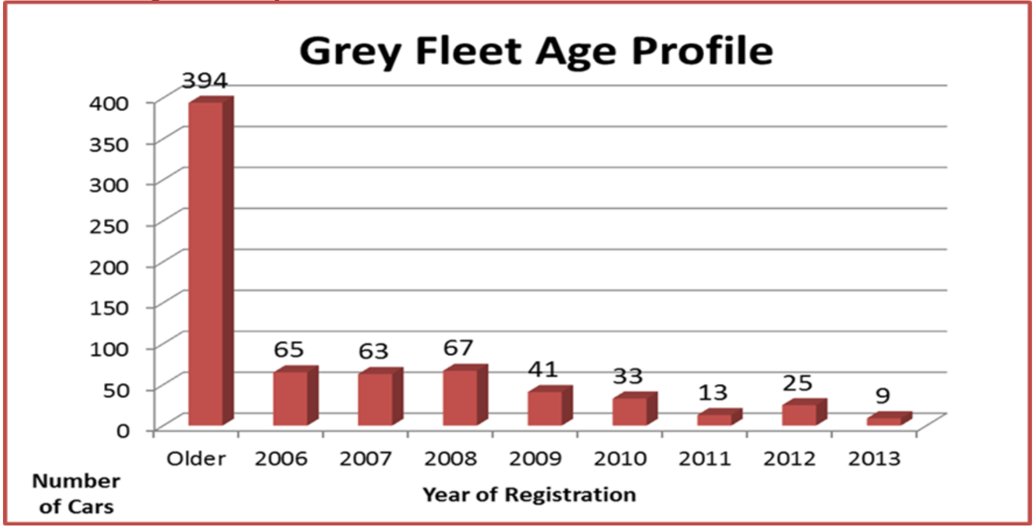
Council Age Example A



Council Age Example B



Council Age Example C



1.9 Potential grey fleet EV pool car alternatives

There are several vehicles currently available that could meet a potential pool car requirement at CDC and we have used two examples here that are commonly used for this purpose by other Councils.

Renault Zoe ZE

A small alternative would be the Renault Zoe, a dedicated EV supermini design recently launched. The high capacity lithium-ion battery provides a range of up to 130 miles and will cost from £13,990 (after Plug-in Car Grant). The battery is leased including VAT which may be reclaimed at 20%. The Zoe is capable of Mode 3 charging using a 3-phase AC supply; 80% 'fast' charge time is 30 minutes (similar to Mode 4 DC). The table below shows the monthly battery rental costs from Renault for the Zoe, inclusive of battery capacity warranty and recovery services to minimise the operator's risk of the battery degrading and failing to perform over time. These figures include VAT which can be reclaimed and we have factored this into the Whole Life Costs.

	Annual mileage			
Contract term	7,500	9,000	10,500	12,000
36 months and longer	£70.00	£77.00	£85.00	£93.00

Nissan LEAF

The larger LEAF is a mid-size 5-door hatchback and many are already on the road in the UK. The range of the LEAF is estimated at up to 124 miles with the 24 KWh lithium-ion battery pack. The LEAF is capable of Mode 2 ('standard' AC), mode 3 quick and 4 ('rapid' DC) charging. 'Standard' charge time 6-8 hours; 'rapid' charge (80%)

30mins using a DC unit. This is standard on some models but optional on the Visia in this analysis so CDC should check the specification as they do change.

The LEAF is also now offered on the same pricing model as the Zoe, the purchase price of the car is lower and the customer pays per month to lease the battery. For this analysis we used the outright purchase approach including the battery although we can supply the figures of purchasing the car but leasing the battery separately.

The table below shows the overview of 2 potential EV alternatives as an example in this Plugged-In Fleets project to represent different EV alternatives.

Model	Renault Zoe ZE Expression	Nissan LEAF Visia
Engine	Electric, direct drive	Electric, direct drive
Power	65kW	80kW
Lithium Ion Battery	22kW-h	24kW-h
Charging 'Standard'	6-9 hours	6 hours
Charging 'Fast'	80% / 30 min	80% in 30 min
Overall Length (mm)	4,084	4,445
Overall Height (mm)	1,652	1,550
Overall Width (mm)	1,730	1,770
Wheelbase (mm)	2,580	2,690
NEDC range	130	124
Range less 15%	111	105
On road P11d price	£18,388	£25,935
Purchase price (after Plug-in Car Grant)	£15,195	£20,935
Service, Maintenance & Repair PPM	2.92	2.86
Residual Value	£4,723	£5,938
Annual VED	£0	£0
Consumption Wh/km (NEDC)	146	150
Pence per kWh	9.5	9.5
Tailpipe Carbon Footprint (tonnes)	0	0

We used service, maintenance and repair (SMR) costs and residual values from Kee Resources using a typical 5 year, 50,000 mile profile. The purchase price for the Zoe and LEAF are based on the current advertised publicly available Renault and Nissan prices.

We included an insurance cost of £500 per vehicle per year but the Council can adjust this based on actual insurance costs if the figures are available.

The Council may be able to negotiate lower purchase costs using manufacturer and/or dealer discounts. If the Council obtains lower purchase costs, the difference can be subtracted from the total Whole Life Costs and the revised pence per mile figures calculated. EST can assist with this if required.

1.10 Grey fleet Whole Life Cost financial analysis

The table overleaf shows the WLC financial analysis from our calculations over 5 years. Most fleets replace cars by the time they reach 5 years old although some Councils like CDC operate their cars and vans for much longer periods.

We have used an electricity cost of 9.5 pence per kWh which is relatively typical for a public sector fleet. If CDC can supply their actual cost, EST can revise our calculations as any change will impact the results detailed below.

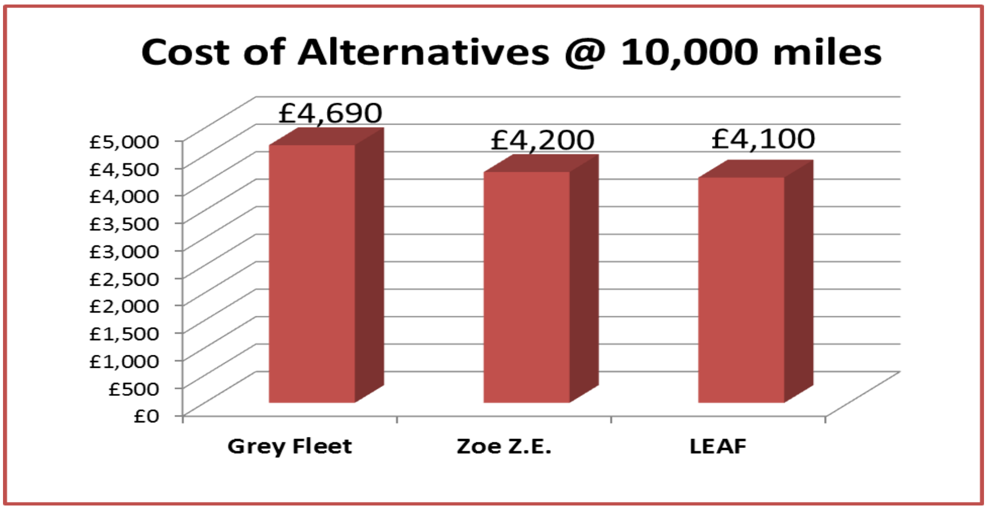
5 Years / 50,000 miles	Renault Zoe ZE Expression	Nissan LEAF Visia
On The Road Price (including PIVG)	£15,140.00	£20,935.00
Insurance (@ £500/year)	£2,500.00	£2,500.00
Total Electricity Costs	£1,283.22	£1,318.37
Battery Rental	£5,100.00	£0.00
SMR	£1,460.00	£1,430.00
FRF & VED over term	£55.00	£55.00
Less - Residual Value	£4,723.00	£5,938.00
Lifecycle Whole Life Costs (WLC)	**£20,815.22**	**£20,300.37**
Annualised WLC	**£4,163.04**	**£4,060.07**
WLC Pence Per Mile	**£0.42**	**£0.41**

The WLC PPM results above have been included in the table and graphs below. This shows the cost of grey fleet mileage at different mileage levels dependent on percentage substitution from grey fleet.

Grey Fleet Miles	Grey Fleet Cost @ 46.9 PPM	Renault Zoe ZE	Nissan LEAF	Potential Financial Saving
1,000	£469	£420	£410	£59
10,000	£4,690	£4,200	£4,100	£590

The graph below compares the cost of the EVs against grey fleet at a cost of 46.9 PPM. The Zoe is less costly to operate by 4.9 PPM at 10,000 miles per annum than grey fleet and the LEAF can be lower cost by 5.9 PPM.

Therefore, worst case scenario, a low carbon EV fleet will not incrementally cost the Council a large amount more and at best may save money , although the pool car management and booking system must ensure that utilisation remains around 10,000 miles per annum.



The analysis shows that running an EV over 10,000 miles per annum over 5 years can be cost effective compared to total grey fleet cost by up to £590 per pool car.

It is highly unlikely that CDC could replace the entire grey fleet with EVs, but there is a clear business case to consider adding some to the fleet so as to realise the benefits of a lower carbon fleet alongside conventional low emission pool cars. The Council could run a mixed fleet with some EVs and some conventional petrol or diesel pool cars so CDC will still have vehicles available that can cover the longer journeys that may be required.

Using CO_2e calculations that includes the carbon cost of the electricity generation, each EV at 10,000 miles produces 1.1 - 1.2 tonnes of carbon, well below the best case conservative grey fleet average of 3.0 tonnes at 160 g/km. A substitution of 10,000 grey fleet miles will still lead to a reduction of 1.8 – 1.9 tonnes each year.

The importance of vehicle utilisation on Whole Life Costs

The tables below show the impact that under-utilisation has on pence per mile rates of EV pool cars. We used 10,000 miles as this is achievable if the vehicle covers 40 miles per day. It is important that CDC introduces a strong travel hierarchy and pool car management system to maximise utilisation as it has a major influence on costs.

Whole Life Costs

Mileage	Renault Zoe ZE Expression	Nissan LEAF Visia
12,000	£21,364	£20,850
10,000	**£20,815**	**£20,300**
8,000	£20,267	£19,751
6,000	£19,718	£19,201

WLC Pence Per Mile

Mileage	Renault Zoe ZE Expression	Nissan LEAF Visia
12,000	£0.36	£0.35
10,000	**£0.42**	**£0.41**
8,000	£0.51	£0.49
6,000	£0.66	£0.64

This shows the importance of maintaining a high utilisation of pool cars as low mileage has a significant impact on cost. If the Council procures conventional or additional electric pool cars and these remain unused while the use of grey fleet remains the same, the financial business case weakens considerably and it becomes expensive.

1.11 Grey fleet carbon impact

As we did not receive any individual grey fleet vehicle data, we could only use Method 5 (UK averages) to estimate the CDC grey fleet carbon footprint at **53.4**

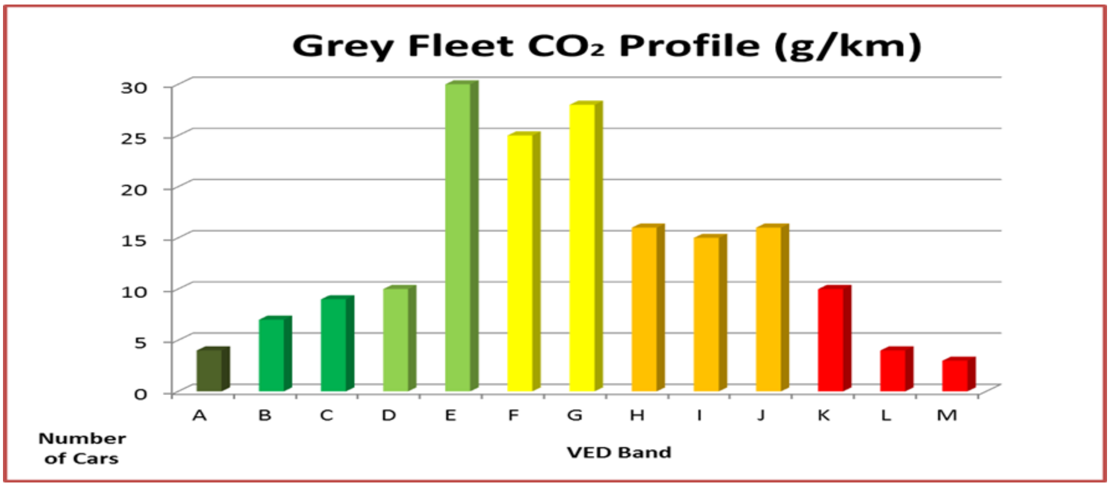
tonnes per annum. However, this should be used as a guide only due to the assumptions and estimates necessary.

Although we cannot construct the emission profile at CDC due to lack of individual vehicle detail, the average CO_2 of the more modern grey fleet vehicles used by Local Authorities is normally found to be around 160g/km. This is usually based on around two thirds of grey fleet vehicles used for which we can normally obtain this level of detail.

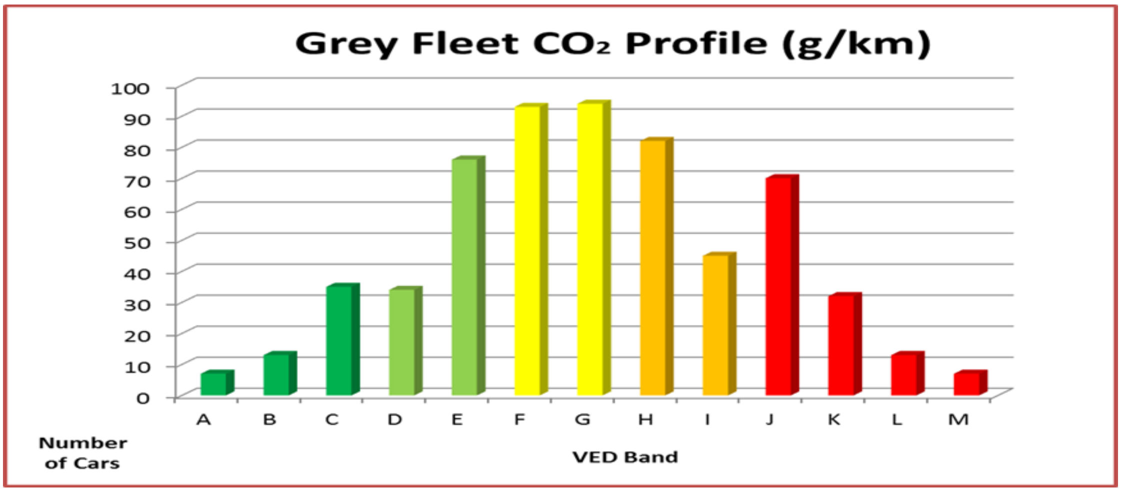
However, the significant difference between the carbon impact of grey fleet and pool cars is important so we have shown recent emission profile graphs from three other recent Council reviews below and overleaf to show the likely emissions profile of grey fleet.

Compared to a potential EV pool car fleet, these are always significantly less clean fleet with far higher emissions of both CO_2 and other gases that impact on air quality such as nitrous oxides and hydrocarbon PM10 particles.

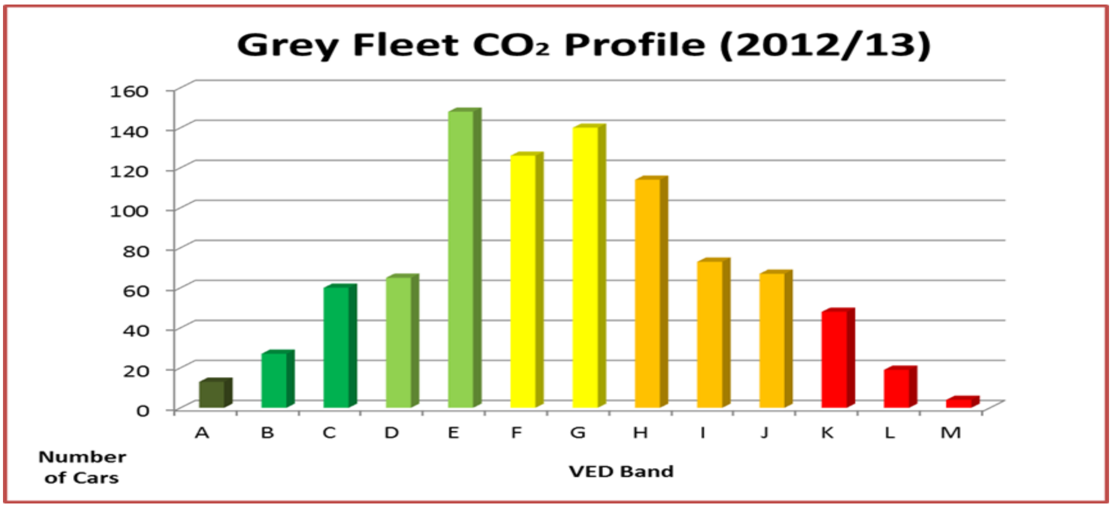
Council Grey Fleet Emissions Example A



Council Grey Fleet Emissions Example B



Council Grey Fleet Emissions Example C



When the data is available, we strongly recommend that CDC analyses both the actual age and emission profiles of their grey fleet as they are likely to be significantly different to those of any potential pool car fleet (regardless of the fuel type of the vehicles used), and likely very similar to the last three Councils reviewed and shown above.

There are also health benefits derived from locally improved air quality by operating an electric pool car compared to a petrol or diesel vehicle, particularly if it is public sector grey fleet.

3. Electric Vehicle Infrastructure

EDF Energy is the infrastructure partner for the Plugged in Fleets Initiative 100. This chapter gives an overview of infrastructure needs and available hardware options based on EDF Energy's experience working with the original 25 PiFi clients. Further information on infrastructure is available in Appendix D and Appendix E.

INTRODUCTION

EDF Energy is the largest generator and supplier of low carbon electricity in the UK. Its dedicated Electric Vehicles Team has been established for 4 years. In this time the Electric Vehicle Team has worked on government sponsored low carbon vehicle trials with Toyota and Mercedes Benz, and provided the technical recharging infrastructure expertise for the London 2012 Olympic BMW battery electric fleet. From July 2011 – April 2012 EDF Energy trialled 35 battery electric MINI E's within its own fleet.

EDF Energy does not manufacture charge point hardware, and as such is able to provide an independent recommendation on hardware requirements. Working closely with the Energy Saving Trust and a wide selection of Plugged-in Fleets, EDF Energy has identified a number of considerations for organisations procuring charge point infrastructure that will ensure a timely, smooth and cost effective installation.

BEFORE YOU START

There are a large number of hardware providers in the UK, so before selecting a partner take some time to understand the technical standards and different recharging solutions currently available. Below is a short summary of key information:

Modes of Charging

Electrical safety and duty of care to employees should be the primary consideration for any fleet charging installation.

BSEN61851 defines different modes of charging. EDF Energy Recommends Mode 3 charging for the following reasons:

- Safe – electricity is not supplied until successful connection with the vehicle
- Bespoke – used for electric vehicle charging only and will deliver charge appropriate to the vehicle connected
- IP (Ingress Protection) rated socket and connector (min IP44)– robust and weather-proof
- Chargepoint can be Intelligent (allowing remote reporting without the need for additional hardware)
- Future capability of Smart Grid interaction

A further protocol (Mode 4) is defined for DC rapid charging. Note: a limited number of PIVs are currently compatible e.g. Nissan Leaf, Peugeot iOn, Citroen CZero and Mitsubishi iMiev. Additional rapid charge protocols are emerging, vehicles compatible with rapid AC and Combined Charging System equipment are being introduced into the UK during 2013/14.

Hardware Options

The range of Mode 3 charge point hardware is extensive. This ranges from single wall mounted units with no communication capability (suitable for dedicated parking for a particular vehicle), to floor mounted, dual socket posts, with communication capabilities which facilitate multiple vehicles charging. A large number of charge point manufacturers offer a wide range of products. EDF Energy is working closely with a number of these providers, and is able to provide an independent assessment of hardware requirements.

The table on the next page gives a brief overview of the types of hardware:

Product Overview	**Standard Unit Features**	**£ Cost** Standard unit (excludes installation) April 2013	**Smart Unit Features**	**£ Cost** Smart unit (excludes installation) April 2013
 **Single Socket Wall Mount** - Offers flexibility by allowing plug-in vehicles with different inlet types to recharge at the same unit - Suitable for charging one vehicle - Commercial use only	- 62196 inlet (Type 2) - Key operated lock - No data collection - Available in 16amp or 32 amp - Robust, weather-proof, safe and secure for outdoor use	16amp £470 (ex VAT) 32amp £600 (ex VAT)	- 62196 inlet (Type 2) - Unit contains smart meter - key operated lock - Available in 16amp or 32 amp - Robust, weather-proof, safe and secure for outdoor use	16amp £770 (ex VAT) 32amp £900 (ex VAT)
 **Dual Socket Wall Mount** - Offers flexibility by allowing plug-in vehicles with different inlet types to recharge at the same unit - Suitable for charging two vehicles simultaneously - Commercial use only	- 62196 inlet (Type 2) - Key operated lock - No data collection - Available in 16amp or 32 amp - Robust, weather-proof, safe and secure for outdoor use	Dual socket configuration: 2x16 amp 2x32 amp 1x16 amp and 1x32 amp £1640 (ex VAT)	- 62196 inlet (Type 2) – GPRS Data Enabled for remote reporting and fault identification - Unit contains smart meter - RFID access - Available in 16amp or 32 amp - Robust, weather-proof, safe and secure for outdoor use	Dual socket configuration: 2x16 amp 2x32 amp 1x16 amp and 1x32 amp 32 amp £3250 (ex VAT)
 **Double Socket Floor Mount** - Presents publicly visible branded point to promote sustainability values - Ideal where access to wall space is limited - Suitable for charging two vehicles simultaneously - Commercial use only	- 62196 inlet (Type 2) - Key operated lock - No data collection - Available in 16amp or 32 amp - Robust, weather-proof, safe and secure for outdoor use	Dual socket configuration: 2x16 amp 2x32 amp 1x16 amp and 1x32 amp £1640 (ex VAT)	- 62196 inlet (Type 2) – GPRS Data Enabled for remote reporting and fault identification - Unit contains smart meter - RFID access - Available in 16amp or 32 amp - Robust, weather-proof, safe and secure for outdoor use	Dual socket configuration: 2x16 amp 2x32 amp 1x16 amp and 1x32 amp 32 amp £3250 (ex VAT)
 **Home Charge Unit** - Suitable for domestic installation - Suitable for charging one vehicle	- Fixed cable that is dedicated to the households PM - Key operated lock - No data collection - Available in 16amp or 32 amp - Robust, weather-proof, safe and secure for outdoor use	16 or 32 amp £799 (inc VAT)	- GPRS Unit contains smarter meter - Key operated lock - Available in 16 amp or 32 amp - Robust, weather-proof, safe and secure for outdoor use	16 or 32 amp £799* (inc VAT) *some home charge units are eligible for 75% OLEV subsidy

4. Route Scheduling

Understanding the impact of scheduling and its effect upon vehicle utilisation can have a considerable impact on the use of EVs. Route optimisation software can help fleets understand how to combine the vehicle roles and optimise financial savings while meeting day to day business needs. By identifying where vehicle roles can be combined this offers cost savings to the company by removing one vehicle from the fleet. This also gives an opportunity to increase individual vehicle mileage (within range limitations) to use plug-in vehicles.

Route Monkey, our route scheduling partner in PiFi can provide routing analysis to PiFi participants where relevant and appropriate. Route Monkey is a scheduling company with considerable experience in improving the utilisation of vehicles and EVs in particular, through its scheduling software, and could provide Stove Shop with useful insight through analysis of fleet scheduling.

Route Monkey is confident that any costs incurred by CDC in engaging with Route Monkey would be mitigated by savings in fleet costs and carbon emissions.

Route Monkey is able to help fleet operators understand the opportunity for charging plug-in vehicles on route throughout the day, enabling the daily mileage of a pure electric vehicle to increase significantly. Thus, making pure EVs viable for more fleet purposes.

Their software focuses on getting the best from the vehicle in terms of energy consumption and then planning in charging opportunities whether they are the main ‘overnight’ charge or a short top up charge during the working day to ensure the duty cycle can be met or even extended.

Route Monkey does this through looking at the routes and optimising load against route. In a simple example, when a vehicle is fully laden it makes more sense for it to be scheduled to tackle a hill towards the end of the shift once it’s load has reduced if this suits the operational requirements of the company.

If you would like to get in touch with Route Monkey:

telephone: 0845 643 5731
email: contact@routemonkey.com
web: www.routemonkey.com

5. Staff Engagement

We are aware that any change to operations can pose issues of acceptance by staff, especially when a change to vehicle is involved. This is especially true when contemplating a change to EVs which do require a different style of driving. Coupled with the understandable concerns about being able to complete a day's work on one charge, often referred to as 'range anxiety'

To counter this, we encourage organisations to engage with staff to present the pros, and any possible cons, in an open way. While staff will need to take on board a different style of driving, the fact that the vehicles are automatic, quiet and easy to drive should be seen as a bonus.

Advice from EV manufacturers should be available to help ease any uncertainty and EST has itself developed an EV-specific version of its 'Smarter Driving' training course to overcome issues of 'range anxiety' by giving practical instruction on how to optimise the use of EVs. The results of the training to date are that range can be extended on average to 20%. Each training session lasts 2 hours.

We have outlined the salient points of this training in Appendix F below, but if CDC would like more information about driver training, it can contact Karl Anders at EST.

Appendix A – Glossary of Terms

Vehicle Glossary

Abbreviation	Full description	Explanation
EV	**Electric vehicle**: A generic term to cover the vehicles listed below.	A vehicle powered, in part or in full, by a battery that can be directly plugged into the mains. In short: any vehicle that can be plugged in.
PURE-EV	**Pure-electric vehicle** Alternative descriptions: • Electric • All electric • Battery electric vehicle (BEV) Fully electric	A vehicle powered solely by a battery charged from mains electricity. Currently, typical pure-electric cars have a range of approximately 100 miles.
PHEV	**Plug-in hybrid electric vehicle** Alternative descriptions: • Plug-in hybrid vehicle (PHV)	A vehicle with a plug-in battery and an internal combustion engine (ICE). Typical PHEVs will have a pure-electric range of over ten miles. After the pure-electric range is utilised, the vehicle reverts to the benefits of full hybrid capability (utilising both battery power and ICE) without range compromise.
E-REV	**Extended-range electric vehicle** Alternative descriptions: • Range extended electric vehicle (RE-EV) • Series hybrid	A vehicle powered by a battery with an ICE powered generator on board. E-REVs are like pure-EVs but with a shorter battery range of around 40 miles. Range is extended by an on board generator providing many additional miles of mobility. With an E-REV the vehicle is still always electrically driven.
HYBRID	Alternative descriptions: Hybrid electric vehicles (HEV): • Normal hybrid • Parallel hybrid • Standard hybrid	A hybrid vehicle is powered by, either or both, a battery and an ICE. The power source is selected automatically by the vehicle, depending on speed, engine load and battery charge level. This battery cannot be plugged in; charge is maintained by regenerative braking supplemented by ICE generated power. A number of fuels can power hybrid ICEs, including petrol, diesel, compressed natural gas, liquid petroleum gas and other alternative fuels.
	Full hybrid	A full hybrid has the same attributes as a hybrid (above) plus the ability to operate solely on battery power although the battery cannot be plugged in.
	Mild hybrid	A mild hybrid vehicle cannot be plugged in, nor driven solely on battery power.

	Micro hybrid	A micro hybrid normally employs a stop-start system and regenerative braking which charges the vehicle's 12 v battery.
	Stop-start hybrid	A stop-start system shuts off the engine when the vehicle is stationary. An enhanced starter is used to support the increased number of engine starts required in a stop-start vehicle.
ICE	**Internal combustion engine**	Petrol or diesel engine, including those adapted to operate on alternate liquid or gaseous fuels.

Battery and Charging Glossary

CHARGE TIMES	**Charge time** Alternative terms: • EV charge time • Recharge time	The time it takes to charge an EV. EVs require different lengths of time to charge according to the size of the battery, how much charge is left in the battery before charging and the type of charger used. The information below is based on the example of a pure-electric car to illustrate the most extreme charge time. PHEVs and E-REVs will take less time to charge.
	Standard charge (3kW) Alternative terms: • Slow charge • Normal charge	Standard charge is available in all UK homes. It will take approximately six to eight hours to charge the average pure-electric car.
	Fast charge (7kW) Alternative terms: • Faster charge	Fast charge will normally occur at dedicated charge bays rather than at home. This will fully charge an average pure-electric car in three to four hours.
	Rapid charge (20-50kW) Alternative terms: • Quick charge	Rapid charge will only occur at dedicated charge bays. This will charge the average pure-electric car in around 30 minutes.
	Opportunity charge Alternative terms: • Top up charge	Opportunity charging means the vehicle is charged whenever there is a chance to do so, allowing the battery to be topped up, for example, at a supermarket whilst you shop.
ALTERNATIVE CHARGING METHODS	**Battery exchange** Alternative descriptions: • Battery swap	Battery exchange systems allow a depleted battery to be quickly exchanged for a fully charged battery at a battery exchange (or swap) station. Vehicles must be specially designed to accommodate battery exchange technology.

Additional Terms

CHARGE TIMES	**Charge time** Alternative terms: • EV charge time • Recharge time	The time it takes to charge an EV. EVs require different lengths of time to charge according to the size of the battery, how much charge is left in the battery before charging and the type of charger used. The information below is based on the example of a pure-electric car to illustrate the most extreme charge time. PHEVs and E-REVs will take less time to charge.
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Source: SMMT Electric Car Guide 2011

Appendix B – Background to PiFI

Introduction to EVs

The cost structures of internal combustion engine (ICE) vehicles and EVs are very different. The only realistic way to compare these vehicles is to look at whole life costs (WLC). This is vital, as most EVs on the market cannot currently compete with the purchase price and range of conventional fossil fuel vehicles. They can, however, offer other key advantages; there is a significant drop in running costs, noise and tailpipe emissions when EVs are deployed in the right places. For example, it can cost a quarter of the price to refuel an EV compared to a conventional vehicle at today's prices. Over its lifetime, the WLC of an EV can be less than a conventional vehicle if deployed correctly.

A whole life costing approach is required to take into account a large number of variables beyond simply the purchase price of a vehicle, including some costs that will alter over time. Vehicle taxes, subsidies, fuel and electricity use, battery lifetime, service maintenance and repair (SMR) and length of ownership are the major factors that should be taken into account.

The purchase of EVs also provides branding benefits for fleets. Businesses are competing in an ever more environmentally conscious world. The market is changing as consumers are demanding greener products and services and showing a preference for brands with stronger environmental credentials.

The Government already provides taxation benefits and upfront grants for the purchase of EVs. These clearly strengthen the business case for their deployment into fleets. Infrastructure for charging is now being installed across cities, driven by governments both locally and nationally. Public private partnerships are also coming together and expanding on this early investment, so businesses with fleets will not have to rely just on their own infrastructure to cover their complete business needs. These fiscal incentives, plus the new infrastructure and vehicles coming onto the market, will all make deployment of EVs in fleets more attractive.

The drive behind EVs

Many companies are already looking closely at the business opportunities related to operating EVs. This is being driven by the need to reduce energy consumption, increase environmental performance and future proof against rising oil prices. Information and data is also becoming more readily available and companies are willing to share their experiences of EV deployment.

In 2010, UK carbon dioxide (CO_2) emissions rose by 2.8% to 582.4 million tonnes; 25% of which are accountable to transport[1]. There is considerable evidence that combining the electrification of transport with decarbonisation of the electricity grid represents one of the most promising solutions to cutting carbon emissions to combat climate change. As the electricity used to charge the EV comes from an increasingly less carbon intensive energy mix, then the well to wheel (WTW) carbon emissions for an EV will decrease. Even with today's UK energy mix, EVs are part of the solution for carbon reduction.

[1] uk.reuters.com/article/2011/03/31/us-emissions-idUKTRE72U2ZL20110331

The Department of Energy and Climate Change (DCDC) aims to ensure that three quarters of the UK's electricity comes from low carbon sources by 2030[2] by reforming the energy market. This will have a dramatic and beneficial effect on the WTW emissions of EVs. Switching from petrol and diesel to electricity can also address the challenges of energy security and urban air quality. In the long term EVs will play an essential part in meeting the UK's emissions targets.

Although carbon reduction may not be the main driver for change within fleets, emission reduction targets do help drive collaboration and innovation, and protect future business value. The focus of this document is, however, more directed towards developing a business case using duty cycle and whole life cost analysis.

The role of fleets

Fleet sales in the UK in 2011 accounted for 58% of annual new cars and 63% of all new sales, including light commercial vehicles (LCVs). That equates to 1.1 million cars and 0.3 million LCVs[3]. The size of market share and the fact that fleets have a higher turnover of vehicles means they can help EVs to achieve rapid market penetration. We believe using a sound business case to support fleet decision makers in understanding where EVs can be most effectively used will positively affect the scale and speed of EV market growth.

Deploying EVs in fleets is likely to increase the uptake in the consumer market too, because positive user experiences within fleets will build wider confidence.

A factor which has been absent in much of the debate is the fact that EVs are extremely pleasant to drive. The quiet, smooth and relaxing drive regularly wins drivers over. Those who experience an electric car or van in an urban environment may be reluctant to return to a diesel powered vehicle.

What is a 'Plug-in Vehicle?[4]

The term 'plug-in vehicle' is used to describe a wide variety of different technologies that use electric drive to power, or assist in the powering of, a vehicle. The term plug-in vehicle is used as a generic term to describe Battery Electric Vehicles (BEV), Plug-in Hybrid Electric Vehicles (PHEV) and Extended-Range Electric Vehicles (E-REV).

The diagram overleaf illustrates these technologies for a passenger car but they are equally applicable to vans, heavy goods vehicles and powered two-wheelers.

In a BEV, a battery pack and electric motor replace the petrol tank and internal combustion engine of a conventional vehicle. BEVs rely entirely on electricity for fuel.

A PHEV combines both a battery pack and electric motor with an internal combustion engine. Both the electric motor and the internal combustion engine can drive the wheels. The battery pack is much smaller than in a BEV, tending to only drive the wheels at low speeds or for limited range, with the internal

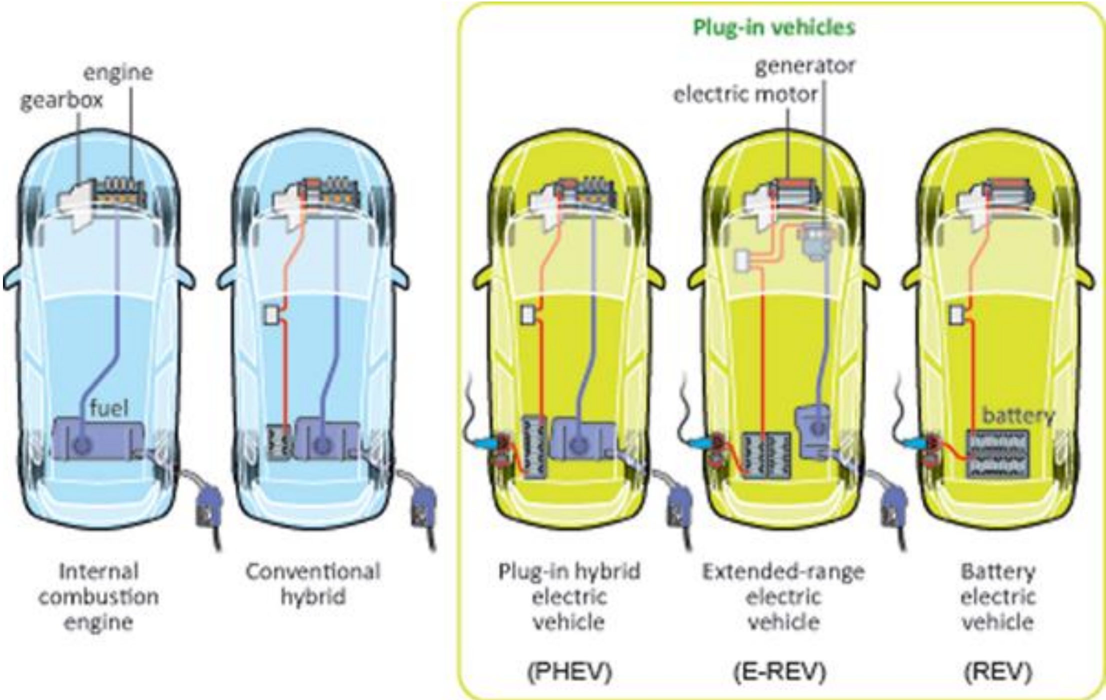
[2] www.dCDC.gov.uk/en/content/cms/news/pn10_130/pn10_130.aspx
[3] https://www.smmt.co.uk/members-lounge/member-services/market-intelligence/vehicle-data/monthly-automotive-data
[4] Source: Office for Low Emission Vehicles "Making the Connection – The Plug-In Vehicle Infrastructure Strategy", June 2011.

combustion engine driving the wheels when the battery is depleted or when extra power is required.

An E-REV also has a battery pack and an electric motor, as well as an internal combustion engine. The battery pack tends to be larger than in a PHEV but smaller than in a BEV. The electric motor always drives the wheels, with the internal combustion engine acting as a generator to recharge the battery when it is depleted.

E-REVs and PHEVs can use a number of low carbon technologies to provide their additional range and power, such as highly efficient internal combustion engines, sustainable biofuels or hydrogen.

All these vehicles are capable of being plugged into mains electricity. This differentiates them from a conventional hybrid, which also uses electricity to help drive the wheels but cannot be plugged into the mains, generating electricity only through regenerative braking.



Range anxiety

Range anxiety is a phenomenon which is experienced by those that are new to driving EVs, and who are used to vehicle ranges of 400 miles or more, commonplace in conventionally fuelled vehicles. To pretend that no accommodation is needed to drive and use a pure EV in particular is nonsense, there has to be adaptation to the vehicle technology and its limitations in this area. However there are many business duty cycles which fall well within the range capabilities of pure EVs and the smooth relaxing driving experience and technology of the vehicles soon win drivers over.

Effective driver training at the outset of any new technology pays dividends. In the case of electric vehicles an appreciation of the technology, in particular the regenerative braking, lower power modes and cabin pre-heating or cooling where fitted will enable drivers to get the most out of the driving experience and battery range. Electric vehicle Smarter Driving training from EST covers these areas and has been shown to improve real world driving range, on average, by 20%. See Appendix E for further information.

Batteries

The latest lithium-ion technologies and the Battery Management Systems controlling them are largely responsible for the leap forward in EV performance exhibited by the latest vehicles including those eligible for the plugged-in vehicle grants. Questions are frequently asked around the longevity of the batteries and electric vehicle batteries are typically considered to have reached the end of their life when their capacity has reduced to 70- 80%. This does not mean however that the vehicle can no longer be driven. If, when new, a vehicle is capable of driving 100 miles, 80% capacity will still provide up to 80 miles of range and for future owners this may well be adequate for their needs. They will still benefit from the low fuel and maintenance costs inherent in EV ownership.

The actual speed of degradation of the battery is predominantly determined by the number of full charge and discharge cycles it is subject to. The regular use of rapid charge points may degrade the battery at a faster rate, however rapid charge could be the key to the vehicles success in some applications and so it is likely that any reduced battery life will be compensated by benefits elsewhere. Furthermore, recent experience from Japan where many more rapid chargers are in regular use suggests that the battery deterioration is at a lower rate than expected, as long as standard charge rates continue to be used during which battery conditioning can take place. The advice from the vehicle manufacturer should always be followed however to ensure adherence with vehicle and battery warranty terms and conditions.

One of the eligibility criteria for the Plug-In Car Grant is a three year minimum vehicle warranty including the battery and the electric drivetrain. In addition the battery warranty must include the option to be extended to five years. Some manufacturers are extending battery warranties further than this.

Vehicle choice / upcoming developments

In this report we focus on cars and vans eligible for the Plug-in vehicle grants at the time of writing. These vehicles have minimum performance and warranties which are in line with the aims of this project. We understand however, that vehicles outside the plug-in grant criteria may be suitable for niche applications as may be commercial vehicles with gross vehicle weights above 3,500kg. Where these opportunities are identified they will be acknowledged in the report but analysis of their duty cycles or whole life cost implications will not be carried out.

Cars

Following a series of consumer trials the latest generation of electric vehicles from mainstream manufacturers became available for general purchase in early 2011.The first models available were the Mitsubishi i-MiEV, followed by the Nissan Leaf and i-MiEV derived models from Peugeot and Citroen. The Smart fortwo was available only for extended trials with selected consumers and fleets. MINI E's and TATA Indica Vista models featured in trials in recent years; however the MINI was not intended to be a series production model, it is part of BMW's electric vehicle test regime culminating in the i3 and i8 models the first anticipated from 2013. Tata after participating in trials have not offered their model for sale. Out of scope of this report and now out of production, the Tesla roadster deserves mention, for breaking down misconceptions about the driveability of plug-in vehicles and generally enhancing their image in this early market phase.

Vehicle choice has increased significantly throughout 2012 and 2013; MIA and the Renault Fluence joined the pure-EVs already available with Plug-in Grant support. The Vauxhall Ampera and Chevrolet Volt extended-range EVs together with the Toyota Prius plug-in hybrid give access to plug-in motoring for those for whom the range of a pure-EV is unviable. The Renault Zoe pure-EV will add a "super-mini" when launched this year.

In 2013 and beyond, most mainstream manufacturers have plug-in models planned. The strategies employed are diverse, with models resembling the petrol and diesel models they are derived from, such as the VW Golf to EV specific designs such as the BMW i-series cars.

Vans

A wide range of electric vans and commercial vehicles has been available for a number of years; however the scope of this report deals primarily with vehicles which qualify for the UK plug-in vehicle grants. Vehicles currently available range from the MIA U city van through to the Smiths Edison Ford Transit conversions, including chassis cabs and associated body conversions. Payloads are lower than equivalent diesel models, the weight of the traction batteries increasing the unladen weight of the vehicles. It is possible never the less to specify a panel van with a payload approaching 1,200kg depending on exact specification. In 2013 further models are anticipated from Nissan, Peugeot, Citroen and other manufacturers.

Sourcing / leasing

Plug-in vehicles carry a premium over their petrol and diesel powered peers, primarily due to the increased cost of the batteries and lower production volumes. The Plug-in grants for both cars and vans help to bridge some of the gap during this early market phase, and for organisations purchasing a vehicle outright the grant is applied at the time of sale with the administration and claim procedure handled by the supplier. In our vehicle cost comparison section we take the taxation incentives into account (company car and van tax exemption or reduced rate until 2015 and associated national insurance savings), estimated fuel and servicing costs, VED, and where applicable parking and London Congestion Charge discounts.

Leasing vehicles where future values and maintenance costs are unproven has a number of benefits, and using leasing rates as a starting point to calculate WLC, takes into account the purchase price, maintenance, funding, vehicle excise duty and capital allowance variables. By fixing costs, (and EV lease rentals are invariably higher than conventional equivalent rates) leasing can offer a relatively risk free solution to the deployment of EVs in a fleet, as the uncertainty of future residual values and maintenance costs will ultimately be borne by the leasing company. Each provider will assess the risk differently, particularly in the market's early days and until track records of maintenance and residual values are established.

Many leasing companies are willing to quote for and supply plug-in vehicles and some early concerns, for example battery leasing, are being resolved.

The use of WLC

Whole life cost modelling demonstrates that there is a vast difference in the distribution of costs between conventionally fuelled vehicles and EVs. Under current purchase scenarios, EVs have high upfront costs and much lower running costs than conventional vehicles.

Although purchase costs of EVs are higher largely due to battery cost, operational costs are less due to the lower fuel cost of electricity. Maintenance costs are also expected to be lower as EVs have fewer moving parts, and electric motors require less maintenance than the current combustion engines on the market.

There are a number of parameters that should be considered when making an accurate calculation of the whole life cost of a vehicle. Focusing on these costs will help to establish the feasibility of EVs for a fleet. This will provide a basis to make direct cost comparisons between different types of vehicles where the purchase price may be very different.

When comparing whole life costs it is important to use costs from a single source. Sourcing and analysing the information can be a challenge, but there is information available from manufacturers, lease and independent companies specialising in whole life costing.

Insurance

There have been some reports of high initial insurance quotation. Insurers in common with many other parts of the vehicle industry are settling into this new market and there are likely to be a wider range of view within the industry of the level of risk plug-in vehicles present. For fleet users however, it is likely that existing policies won’t be greatly affected and early conversations with insurers will ensure that any amendment to terms can be taken into consideration.

Market Growth

The following table provided by the Society of Motor Manufacturers and Traders (SMMT) shows the growth in registrations by alternative fuelled car registrations in the last 11 years. Of particular interest is the growth of the petrol/electric hybrids for which sales have increased from dozens in 2000 to around 24,000 in 2011. Although the plug-in market may develop in a different way, this does however demonstrate that new vehicle technology, of which the market was initially sceptical, can become mainstream.

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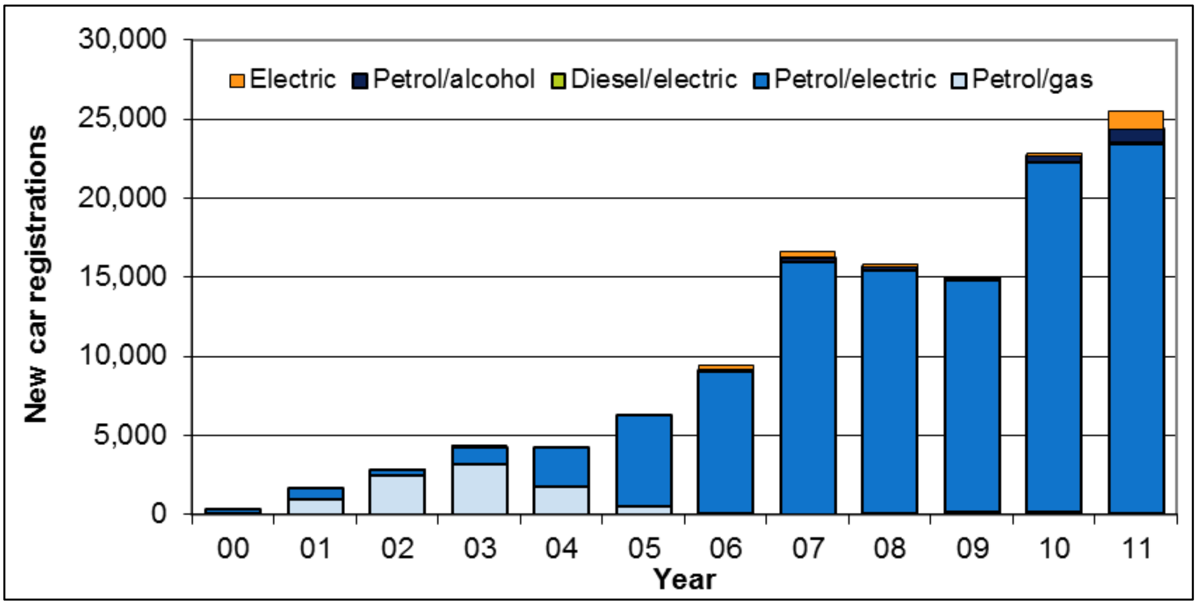

Electric
Petrol/alcohol
Diesel/electric
Petrol/electric
Petrol/gas
New car registrations
30,000
25,000
20,000
15,000
10,000
5,000
0
00
01
02
03
04
05
06
07
08
09
10
11
Year

Appendix C – Electric Vehicle Grants

The following information has been taken from the DfT website:
www.dft.gov.uk/topics/sustainable/olev

Meeting the UK's longer-term climate goals will require road transport to be largely decarbonised by 2050. To help achieve this aim, the Government has announced provision of over £400 million to support measures designed to promote uptake of the next-generation of ultra-low emission vehicle technologies. Electric, plug-in hybrid, and hydrogen fuelled vehicles can all help to reduce emissions from road transport, whilst allowing drivers to retain all the benefits associated with private car usage.

The Plug-in Van Grant

The following information has been taken from the DfT website:
www.dft.gov.uk/topics/sustainable/olev/plug-in-van-grant

Motorists purchasing a qualifying ultra-low emission van can receive a grant of 20 per cent towards the cost of the vehicle, up to a maximum of £8,000.

The Government is adopting a 'technology neutral' approach to reducing emissions from transport. This means that any van which meets the criteria below will be eligible for the subsidy.

The Plug-in Van Grant has been designed to help make the whole-life costs of a qualifying van more comparable with petrol or diesel equivalents. Over time, as manufacturers begin to make these vans in greater volumes, the costs of production should begin to fall. This will help to make an ultra-low carbon van a realistic option for anyone looking to buy or lease a van.

Both private consumers and businesses can benefit from the Plug-in Van Grant when purchasing a qualifying ultra-low emission van and registering it in the UK.

The vans currently eligible for the Plug-in Van Grant are:

Make and Model
BD Otomotiv eTraffic
Citroen Berlingo
Daimler Mercedes-Benz Vito E-Cell
Faam ECOMILE
Faam JOLLY 2000
Mia electric Mia U
Peugeot ePartner
Renault Kangoo ZE
Smith Electric Smith Edison

Van eligibility

Vehicles must have been confirmed by Government as eligible under the rules of the scheme in order to receive subsidy:

Criteria type	Explanation
Vehicle type	Only new vans are eligible (vehicle category ‘N1’ with a gross weight of 3.5 tonnes or less). This includes pre-registration conversions (normal, internal combustion engine vans that were converted to battery or hybrid versions by specialist convertors before the van’s first registration).
Carbon dioxide exhaust emissions	Vehicles must emit less than 75 grams of carbon dioxide (CO_2) per kilometre driven.
Range	Eligible fully electric vans must be able to travel a minimum of 60 miles between charges. Plug-in hybrid electric vehicles (PHEVs) must have a minimum electric range of 10 miles.
Minimum top speed	Vehicles must be able to reach a speed of 50 miles per hour or more.
Warranty	Vehicles must have: a 3-year or 60,000-miles vehicle warranty (guarantee) a 3-year battery and electric drive train warranty, with the option of extending the battery warranty for an extra 2 years ‘Drive train’ means the parts that send power from the engine to the wheels. These include the clutch, transmission (gear box), drive shafts, U-joints and differential
Battery performance	Vehicles must have: either a minimum 5-year warranty on the battery and electric drive train as standard or extra evidence of battery performance to show reasonable performance after 3 years of use
Electrical safety	Vehicles must comply with certain regulations (UN-ECE Reg 100.00) that show that they are electrically safe.
Crash safety	To make sure vans will be safe in a crash, they must either have: A minimum EC regulatory standards for volume production or evidence that the van demonstrates high levels of safety as judged by international standards. For example, crash testing for other internationally recognised consumer information programmes or regulatory standards, that offer a comparable level of safety stringency as EC minimum regulatory standards for volume production

The Plug-in Car Grant

The following information has been taken from the DfT website:
www.dft.gov.uk/topics/sustainable/olev/plug-in-car-grant

Motorists purchasing a qualifying ultra-low emission car can receive a grant of 25 per cent towards the cost of the vehicle, up to a maximum of £5,000. The 2010 Spending Review confirmed that Government has made provision to support the Plug-in Car Grant for the life of this Parliament.

The Government is adopting a 'technology neutral' approach to reducing emissions from transport. This means that cars with tailpipe emissions of 75g CO_2/km or less, including electric, plug-in hybrid and hydrogen-fuelled cars, are all potentially eligible for the subsidy. However, consumers will find that hydrogen vehicles are, as yet, less available on the open market than electric and plug-in hybrid options.

The Plug-in Car Grant has been designed to help make the whole-life costs of a qualifying car more comparable with petrol or diesel equivalents. Over time, as manufacturers begin to make these cars in greater volumes, the costs of production should begin to fall. This will help to make an ultra-low carbon car a realistic option for anyone looking to buy a car.

Both private consumers and businesses can benefit from the Plug-in Car Grant when purchasing a qualifying ultra-low emission car and registering it in the UK.

The cars currently eligible for the Plug-in Car Grant are:

Make and Model
BMW i3
Chevrolet Volt
Citroen CZero
Ford Focus Electric
Mia Electric Mia
Mitsubishi iMiEV
Mitsubishi Outlander
Nissan Leaf
Peugeot iON
Porsche Panamera S E-Hybrid
Renault Fluence
Renault ZOE
Smart fortwo electric drive
Tesla Model S
Toyota Prius Plug-in
Vauxhall Ampera
Volkswagen e-up!
Volvo V60

Car eligibility

Vehicles must have been confirmed by the Office for Low Emission Vehicles (OLEV) as eligible under the rules of the scheme in order to receive subsidy:

Criteria type	Explanation
Vehicle type	Only new cars are eligible (vehicle category 'M1'). This includes pre-registration conversions (normal, internal combustion engine cars that were converted to battery or hybrid versions by specialist convertors before the car's first registration). Motorbikes and quadricycles are not covered.
Carbon dioxide exhaust emissions	Vehicles must emit less than 75 grams of carbon dioxide (CO_2) per kilometre driven.
Range	Electric vehicles (EVs) must be able to travel a minimum of 70 miles between charges. Plug-in hybrid electric vehicles (PHEVs) must have a minimum electric range of 10 miles.
Minimum top speed	Vehicles must be able to reach a speed of 60 miles per hour or more.
Warranty	Vehicles must have: a 3-year or 60,000-miles vehicle warranty (guarantee) a 3-year battery and electric drive train warranty, with the option of extending the battery warranty for an extra 2 years 'Drive train' means the parts that send power from the engine to the wheels. These include the clutch, transmission (gear box), drive shafts, U-joints and differential.
Battery performance	Vehicles must have: either a minimum 5-year warranty on the battery and electric drive train as standard or extra evidence of battery performance to show reasonable performance after 3 years of use
Electrical safety	Vehicles must comply with certain regulations (UN-ECE Reg 100.00) that show that they are electrically safe.
Crash safety	To make sure cars will be safe in a crash, they must either have: EC whole vehicle type approval (EC WVTA, not small series) or evidence that the car has appropriate levels of safety as judged by international standards

Appendix D – EV-related Infrastructure

Charging points are being installed across the UK and the current status will be available on the National Charge point Registry. The opportunity to use public charging infrastructure for fleet vehicles will vary between businesses and duty cycles. It is likely that most fleet operators will need to have access to their own recharging provision.

The cost of the charging infrastructure needed to run a fleet of EVs must be considered as vehicles are brought into a fleet. Domestic charging could be a valuable secondary location but must be metered or reported on to allow the employee's costs to be claimed.

Infrastructure provision is also a significant consideration in terms of whether a vehicle can perform its required duty cycle with or without opportunity charging provision. A balance between battery size or range, vehicle numbers and charging infrastructure is an important consideration when mapping out the solution. Optimising this parameter will ensure the lowest cost of running an EV fleet.

Charge times are dependent on the power that a circuit supplies; a standard UK circuit is likely to take in the region of seven hours to charge a vehicle fully from flat. However, top up charging times will be significantly reduced and will be the norm in most situations. On top of that, much shorter charge times are possible with dedicated high power charging systems.

See Appendix C for an introductory guide to EV charging and infrastructure courtesy of the British Electrotechnical and Allied Manufacturers Association.

Local infrastructure

The Office of Low Emission Vehicles (OLEV) has announced a £37 million funding package for home and on-street charging and for new charge points for people parking plug-in vehicles at railway stations.

The coalition government will provide 75% of the cost of installing new charge points. This can be claimed by:

- people installing chargepoints where they live
- local authorities installing rapid charge points to facilitate longer journeys, or providing on-street charging on request from residents who have or have ordered plug-in vehicles
- train operators installing new charge points at railway stations.

The £37 million funding for the package comes from the government's £400 million commitment to increase the uptake of ultra-low emission vehicles and is available until April 2015.

POLAR – a division of Chargemaster Plc., a provider of electric vehicle charging infrastructure – is now building the UK's first electric vehicle charging system.

The initial twelve-month POLAR network rollout from September 2011 will cover over 100 towns and cities and complement the eight areas already in the Government's Plugged-In-Places programme.

POLAR charging points will be in public car parks, residential developments, office car parks, workplaces, shopping centres, airports, stations, leisure centres, roadside restaurants and on popular main routes.

For consumers, that means a nationwide network of charging points in prime locations in a long, quickly-growing list of British towns and cities.

POLAR also offers exciting opportunities to the business community in the hosting of POLAR sites.

More information can be found at www.polarnetwork.com

The following guide to EV charging and infrastructure has been taken, with kind permission, from the British Electrotechnical and Allied Manufacturers Association [BEAMA] "Guide to Electric Vehicle Infrastructure". See Appendix G for more details.

Charging Modes

There are 4 key modes (as defined in the standard BS EN 61851-1) for the charging of an electric vehicle, as summarised below:

Mode 1 charging: **non-dedicated outlet – BS 60309-2[5] and BS 1363 – 3pin[6]**

Mode 2 charging: **non-dedicated outlet – BE EN 60309-2 and BS 1363 – 3pin with 'in cable' RCD protection**

Mode 3 charging: **dedicated outlet – Type 2, 3 – IEC 62196-1 (BS EN 62196-1)[7]**

Mode 4 charging: **rapid, DC charging**

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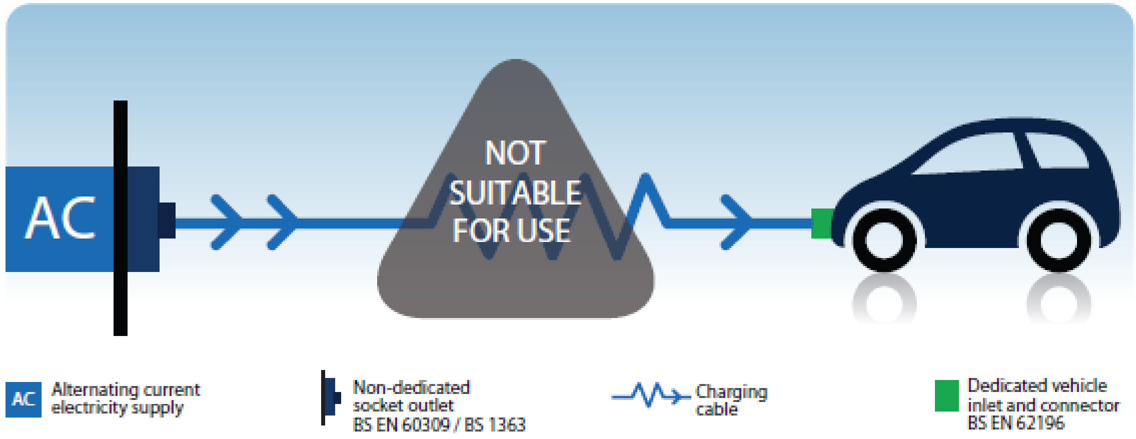
[5] BS EN 60309-2: 1999 – Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact tube accessories
[6] BS 1363:1995 – 13A Plugs, socket-outlets, adaptors and connection units.
[7] BS EN 62196-2: 2011 – Plugs, socket-outlets, vehicle couplers and vehicle inlets. Conductive charging of electric vehicles. Dimensional interchangeability requirements for a.c. pin and contact-tube accessories.

MODE 1: Non-dedicated circuit and socket-outlet

The electric vehicle is connected to the main 230V AC supply network (mains) via a fixed, non-dedicated standard BS 1363, 13A, 3-pin socket-outlet or a single phase 16A BS EN60309-2 socket-outlet located on the power supply side.
The electric vehicle is connected to the main AC supply network (mains), and is supplied with a current not exceeding 13A from a BS1363 domestic socket-outlet, and not exceeding 16A from the BS EN 60309-2 industrial socket-outlet
There is no in-cable control box; therefore it cannot be assumed that RCD protection is provided during charging.



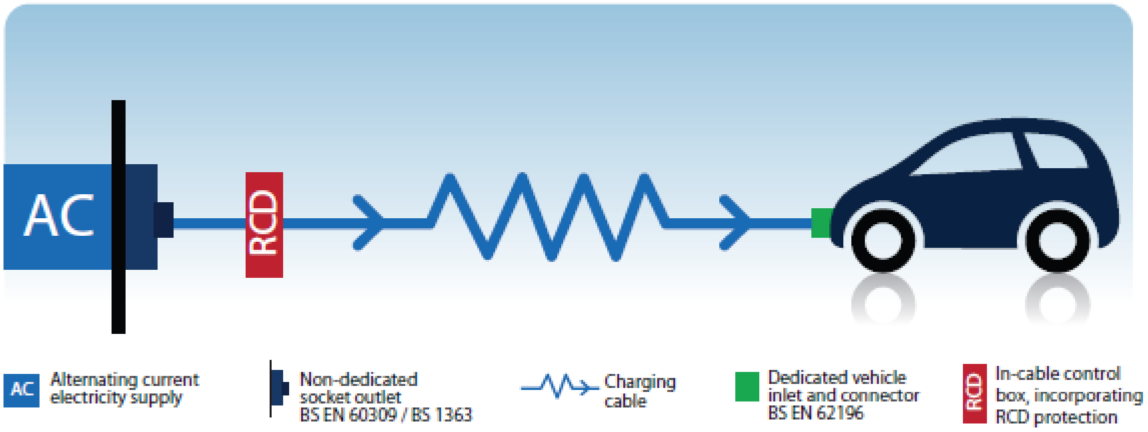
MODE 2: Non-dedicated circuit and socket-outlet, charging with cable-incorporated RCD

The electric vehicle is connected to the main 230V AC supply network (mains) via a fixed, non-dedicated standard BS 1363, 13A 3-pin socket-outlet or a single-phase 16A or 32A BS EN 60309-2 socket-outlet located on the power supply side.

Specific vehicle models will have guidelines, developed by the vehicle manufacturer, which must be followed. These guidelines will recognise the specific needs of that vehicle. Some vehicle manufacturers de-rate the domestic Mode 2 charging system to 10A. In the interest of having one harmonised household charging current across Europe this may be appropriate.

Control and protection functions are permanently installed for personal protection from electric shock within the charging cable. An in-cable control box incorporates built-in RCD protection and pilot signal functions to provide basic communication. The inline control box is positioned along the charging cable within 0.3m of the plug, and sets and adjusts the specific charging power.

The safety of the equipment and the user is dependent on the state of the pre-existing electrical network and compliance with the latest standards.



Provided vehicles are supplied and operated with only Mode 2 cables, Mode 1 is not required. Mode 2 cables are provided with an in-cable control box (including RCD), set and adjusted to a specific charging power, guaranteeing the provision of RCD protection during charging.

Mode 2 can be used for the charging of an electric vehicle, in locations where there is no dedicated charging installation (Mode 3 or 4, see below), and for use by legacy vehicles.

The pre-existing electrical installation in the property must be checked by a competent person and should be compliant with current industry standards and regulations. Specific guidelines developed by vehicle manufacturers for electric vehicle models must also be followed.

Mode 2 Pros and Cons

Pros	Cons
Low installation cost	Slow charge of 8-12 hours (depending on the current rating of the charging system, 13A or 10A)
Interoperable across UK residential properties	No communication / 'smart function'
RCD protection guaranteed	Susceptible to the misuse of extension leads and adaptors not capable of withstanding the current of an EV charge.

MODE 3: Fixed and dedicated charge point

The electric vehicle is typically connected to a 16A or 32A single phase AC supply network (mains) using a dedicated connector and dedicated circuit. The connection can be three phase.

In both cases additional conductors are incorporated into the charging cable to allow communication between the vehicle and the charging equipment.

Communications functions are a major part of the Mode 3 charging system in light of the roll-out of smart meters and the future smart grid in the UK, with the emphasis on providing measures for off-peak charging and energy management for the consumer charging at home. The functionality for this is already built into the Mode 3 charger, future-proofing the installation for future ‘smart’ applications.

Control and protection functions (load controller, contactor, Surge Protective Device, RCD) are permanently installed within the charge point which is permanently connected to the AC supply network (mains).

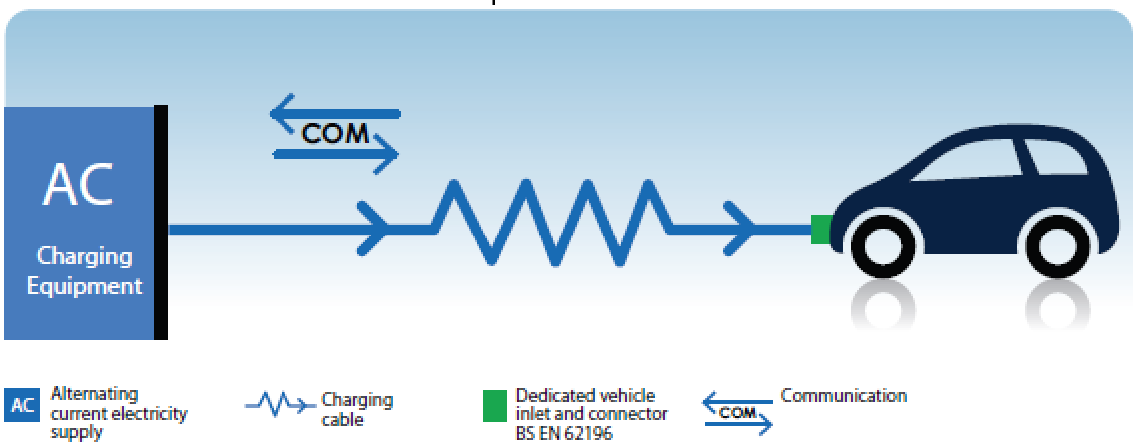
Mode 3 includes a socket-outlet incorporating a pilot wire which ensures that the conductive parts and connectors connection is well established. Mode 2 has the same function in its cable. However due to the fact that the additional protection is part of the cable system there is no guaranteeing that if the cable is damaged this function will not be affected.

In practice, Mode 3 chargers are designed in two different configurations. They can be found with either a tethered cable which is common in, but not limited to, domestic installations or with the dedicated socket-outlet, most commonly found in UK public charging infrastructure. The public, Mode 3 charger will have the ability to measure energy used, allowing for electricity billing for electric vehicle charging to take place.

Mode 3 public charging equipment can be installed with an energy meter which supports billing/Pay-As-You-Go transactions based on energy consumption when used by a customer to charge an electric vehicle. This is also required for energy management purposes.

Specific vehicle models will have guidelines, developed by the vehicle manufacturer, which must be followed. These guidelines will recognise the specific needs of that vehicle.

The safety of the equipment and the user is dependent on the installation, the connected electrical network and compliance with the latest standards.



Mode 3 can be used for the charging of an electric vehicle. This is the preferred solution in the long term, recognising industry’s move towards the use of dedicated charging systems[8] allowing for ‘smarter’ charging capabilities, in line with industry’s objectives for improved energy management.

[8] Making the Connection: The Plug-In Vehicle Infrastructure Strategy, Office for Low Emission vehicles
http://www.dft.gov.uk/publications/plug-in-vehicle-infrastructure-strategy

The installation must be installed by a competent electrician and should be compliant with current industry standards and regulations.[9] Specific guidelines developed by the vehicle manufacturers for electric vehicle models must also be followed.

Mode 3 Pros and Cons

Pros	Cons
Fast charge (1 – 4 hours)	Additional cost of fixed installation
Communication between the vehicle and the charge point	If domestic installations provide a tethered charging cable, the vehicle connector will be specific to the owners vehicle and the inlet on the car side
Provides the functionality for 'smart charging'	Private Mode 3 chargers can only be installed in certain types of buildings. Off-street parking or a garage is required.
Compatibility and connection with the Smart Grid	
Control and protection functions permanently installed.	
Load Controller	
Suitable for domestic and public installations	

MODE 4: Rapid, dedicated charge point, DC connection

The electric vehicle is indirectly connected to the main AC distribution network through a standard external charger.

AC single phase or three phase current is converted to DC inside the charging equipment using rectifiers.

They operate at a much higher voltage and current, 500V and 125A, providing a rapid charge to the battery.

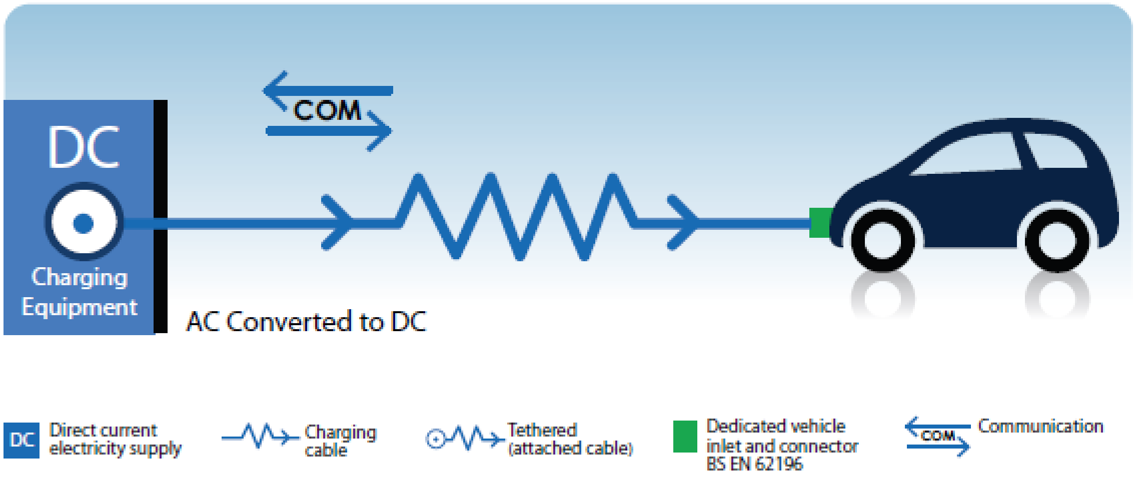
The DC current is supplied to the electric vehicle through a charging cable permanently attached to the dedicated DC Mode 4 charge point.

Control and protection functions are permanently installed.

Due to the high current required for rapid charging, Mode 4 charge points are not suitable for domestic installations.

Mode 4 public charging equipment can be installed with an energy meter which supports billing/ Pay-As-You-Go transactions based on energy consumption when used by a customer to charge an electric vehicle. This is also required for energy management purposes.

[9] IET Code of Practice on Electric Vehicle Charging Equipment Installation http://www.theiet.org/resources/standards/ev-charging-cop.cfm



This is a necessary service function for rapid charging, for use as roadside assistance and service station charging on long journeys. The electrical installation must meet current industry standards and regulations and specific guidelines developed by the vehicle manufacturers for electric vehicle models must also be followed.

Mode 4 Pros and Cons

Pros	Cons
Rapid charge (20mins approximately)	Not suitable for domestic installations
Control and protection functions permanently installed	Higher cost of installation
Communication between the vehicle and the charge point	Higher load on a local electricity network.

The use of cable reels, extension leads and adapters

Under Standard HD 60364-7-722:2012, 'Requirements for special installations or locations – Supply of electric vehicle', the use of 'portable socket-outlets are not permitted' for the charging of electric vehicles.[10] Therefore the use of cable reels, extension leads and adaptors is strongly ill advised.

Plugs and Sockets

The following plugs and socket-outlets can be used for the charging of an electric vehicle. Their characteristics are documented below and specific use cases outlined. The electrical installation must be compliant with current industry standards and regulations.

TYPE 1, IEC 62196-2 (BS EN 62196-1)
Single phase
Maximum current 32A
Maximum voltage 250V
5 pins/socket tubes

Type 1 plug and socket-outlets can only be used with single phase supplies for the charging of electric vehicles.

TYPE 2, IEC 62196-2

Single or three phase
Maximum current 70A single phase, 63A three phase
Maximum voltage 500V
7 pins/socket tubes

OLEV is committed to funding only Type 2 infrastructure for publicly accessible chargepoints as part of the Plugged-In Places projects. Effective from April 2012.

TYPE 3, IEC 62196-1
Single phase or three phase
Maximum current 32A (single and three phase)
Maximum voltage 500V
5 or 7 pins/socket tubes

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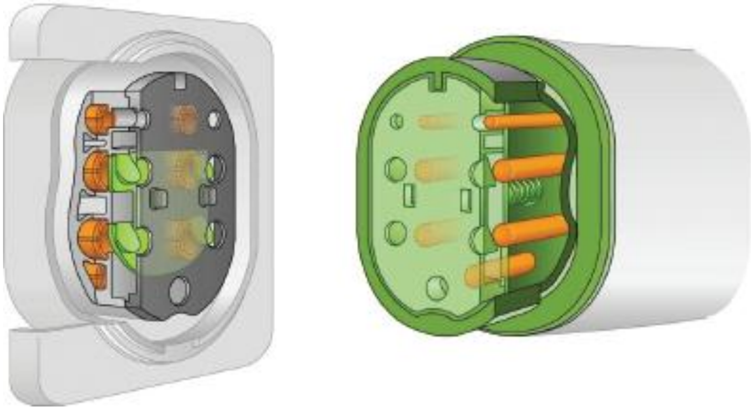
10 *Ratified and to be published shortly*

Developed by the EV Plug Alliance
With shuttered plug pins and socket-outlet contacts
IP4X and optional IP55



UK Existing Plug and Socket Systems

In order to facilitate the market penetration of electric vehicles, the availability of the existing electrical infrastructure (BS 1363 and BS EN 60309-2) must be ensured. With regards to existing plug and socket-outlet systems such as those complying with BS EN 60309-2 or BS 1363:

Existing systems are safe provided they comply with their standard and are used in accordance with specific guidelines developed by electric vehicle manufacturers.

For electric vehicle charging, both shuttered and un-shuttered socket-outlets are safe in the appropriate circumstances; that is, domestic or public applications.

BS 1363 domestic plug and socket-outlet

The normal domestic AC power plugs and socket-outlets used in the UK
With shuttered socket-outlet contacts and sleeved plug pins
Maximum current 13A

Household plugs and socket-outlets can be used for the Mode 2 charging of an electric vehicle in domestic properties where there is no available dedicated charging infrastructure (Mode 3 or 4). They can also be found in some public dedicated charging points, for use by legacy vehicles, motorcycles and quadricycles.

BS EN 60309-2 industrial plug and socket-outlet

BS EN 60309-2 socket-outlets normally provide solutions for industrial applications including construction sites, camp sites and marinas, but electric vehicles can also be safely charged from the BS EN 60309-2 socket-outlets using Mode 2 or Mode 3.

The rated voltage of the plug is identified by colour. The most common colour codes are blue and red, with ‘blue’ signifying 200 to 250V and ‘red’ signifying 380V to 480V.

Appendix E – Plugged in Places

The government provides funding to the Plugged-in Places programme. The Plugged-in Places programme offers match-funding to consortia of businesses and public sector partners to install electric vehicle charging points.

Data from the Plugged-in Places programme about how drivers wish to use and recharge their electric vehicles will provide the necessary evidence base to help the industry create a UK network of recharging points that meets the needs of plug-in vehicle drivers.

The Plugged-in Places programme has been instrumental in supporting the uptake of plug-in vehicles and ultra-low emission vehicles in the UK. We aim to work with the industry to provide infrastructure that delivers greater interoperability, better accessibility and helps with longer journeys.

Charging points are also being installed by some councils across the UK and by private sector providers.

By the end of March 2013, over 4000 chargepoints had been provided through the 8 Plugged-in Places projects. About 65% of these Plugged-in Places chargepoints are publicly accessible. Using data provided by chargepoint manufacturers, it is estimated that non Plugged-in Places organisations may have also installed about 5000 chargepoints nationwide.

Details on the 8 PIFI regions are below.

The Source London network, which was announced by the Mayor Boris Johnson in May 2011, is the network that will bring together London's new and existing public charge points into one network.

As part of the 2009 Electric Vehicle Delivery Plan, the Mayor's aim is to make London the electric vehicle capital of Europe. The installation of 1,300 publicly accessible charge points by 2013 is part of the longer term aspiration of every Londoner to be within one mile of an EV charge point and having 100,000 EVs on the road as soon possible.

More information is available at: www.sourcelondon.net

EValu8 Transport Innovations is a not for profit organisation running the Government supported PiP project in the East of England.

The vision of the EValu8 project is to install an operationally effective electric vehicle charging network across the East of England, using it as a test bed and innovation platform to build upon the region's significant innovation capabilities and help stimulate the new global EV economy.

The total value of the project is £7m, and the project will be delivered over the 2 years from March 2011. EValu8 will fund up to 75% of eligible costs for the installation of 600 double headed recharging posts (1,200 recharging points) across the East of England.

More information is available at: http://evalu8-ti.org.uk

Plugged-In Midlands (PiM) which is jointly managed by Cenex and Central Technology Belt, combines the roll-out of electric vehicle infrastructure with the development of regional capabilities associated with the electrification of road transport.

Over two years, the project will develop a regional network of more than 500 electric vehicle charging points across both the East and West Midlands that will be fully compatible with the charging points being installed across the country under the wider scheme.

More information is available at: http://pim.pod-point.net/

As part of the Milton Keynes plan to place 1,000 EVs on the road by 2013, a consortium of partners, including the Open University, and Invest Milton Keynes were awarded £2.3 million through the PiP scheme in February 2010.

The Milton Keynes project aims to install 150 charging points over 3 years which will be interoperable with similar EV schemes in Cambridge and Oxford.

These schemes are operated by Chargemaster Plc: www.chargemasterplc.com
Launched in 2010, Charge your Car is the North East's PiP project funded by One North East, OLEV, public and private partners.

Over 60 partners in the North East including all twelve Local Authorities, private businesses, transport providers, academia, NHS, retailers, business park operators, fleet operators and electricity distributors/suppliers are already signed up to host chargers.

The aim of the project is to have installed over 1,000 publicly accessible charging points by 2013.

More information is available at: http://www.chargeyourcar.org.uk

The Greater Manchester Electric Vehicle scheme (GMEV), is a new electric vehicle charging point network and pay as you go programme, led by Transport for Greater Manchester (TfGM). The project aims to establish a network of 250 fast and rapid charge points across Greater Manchester.

TfGM is working with the Greater Manchester local authorities to identify locations and install a range of charge points for electric vehicles, which was launched in July 2013. The locations are across the ten districts of Manchester, providing commuters with a wide-spread and reliable infrastructure to charge electric vehicles.

Private sector partners, such as NCP, Manchester Central, Manchester Metropolitan University, Salford University and Intu Trafford Centre are included, providing their own charging points to supplement the network.

The GMEV scheme is operated by Charge Your Car (CYC) a leader in electric vehicle charging networks. CYC will manage the payments and access to the GMEV scheme on behalf of TfGM.

A consortium from Greater Manchester has secured £1.7million of support through the Office for Low Emission Vehicles (OLEV) funded 'Plugged In Places' scheme. The scheme has also received a further £1million from the combined authorities allocated transport budget.

The Northern Ireland ecar project, jointly led by the Department for Regional Development and the Department of Environment, is made up of a consortium of six local Councils and a number of private sector companies.

The project which runs from April 2011 for two years aims to install charging points in six towns and cities across Northern Ireland as well as at other strategic locations.

More information is available at: http://www.nidirect.gov.uk/ecar

TRANSPORT SCOTLAND

The Central Scotland PiP project, led by Transport Scotland, aims to create a network of 200 charging points across key commuter areas such as Edinburgh, Glasgow, Fife, Lanarkshire and Falkirk.

The Scottish scheme will also link up with charging points in the North East of Scotland, North East of England and Northern Ireland, by providing six quick charging units, capable of fully recharging an electric vehicle in 30 minutes. This quick charging network will enable a continuous journey by electric vehicle from Newcastle through southern and central Scotland, and onwards to Tayside, Aberdeen and Belfast via Stranraer.

Appendix F - EV Smarter Driving

EST has been providing smarter driving training for conventional ICE vehicles (cars and vans) subsidised by the Department for Transport for a number of years. The 50 minute course is proven to cut fuel bills and emissions by an average of about 15%.

Following work undertaken by Millbrook and Cenex, examining the effects of different driving styles on the performance of electric vehicles, EST jointly developed an EV driver training course that reduces the electricity consumption by 16% which equates to a 20% increase in range.

The key to extending range in an EV is the use of ‘regenerative braking’ – the process by which kinetic energy from the movement of the vehicle is converted into electricity that charges the battery when the driver takes their foot off the accelerator.

The technique in an EV, just as it is in a conventional vehicle, is to avoid unnecessary acceleration or braking. By anticipating the road ahead, easing off the accelerator earlier and coming to a stop much more smoothly (and possibly avoiding the need to come to a stop at all) the battery in an EV continues to receive a charge. The resulting smooth, flowing driving technique is much less stressful too.

Interestingly, although the aim is to achieve a smooth driving technique, hard acceleration in an EV is actually less of a drain than in a conventional car.

As well as regenerative braking, extending the range available on a single charge can be achieved in other ways as well.

Just as it does in a conventional vehicle, higher speeds increase fuel consumption, but in an EV the impact is magnified. In both EVs and conventional vehicles, air resistance increases with speed, meaning the engine has to work harder and, in doing so, draws on its energy source. Drivers of conventional vehicles can compensate, to a certain extent, for the air resistance by moving through the gears. EVs, however, don’t have that ability and so when the speed increases so does the drain on the battery. Although the latest EVs can cruise at motorway speeds, if they’re driven at speed for a long time then that time is unlikely to be as long as the driver hopes or expects.

Similarly, turning the heating or the air conditioning can significantly impact on an EVs range. Some models can be pre-heated or pre-cooled whilst still on charge which not only extends the range but also provides a much more comfortable environment in which to start the journey.

EVs are enjoyable to drive and undertaking specialist driver training in a controlled environment gives drivers the skills and confidence to embark on longer journeys, therefore maximising the benefits that can be achieved from the use of an EV.

For more information on EST Smarter Driving training for either conventional vehicles or EVs then please contact your EST Fleet Consultant, Karl Anders.

Appendix G - Additional Guidance

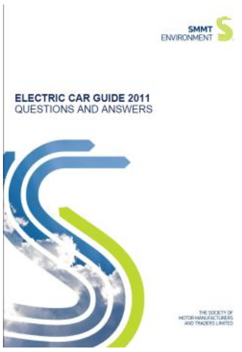
'Plugged in Fleets Initiative: Charging Forward' was published in January 2013 and showcased the results of the original PIFI analysis with 20 fleets. The report includes case studies with participating fleets including Boots UK, Forrest construction, Urban Planters, Rydon, Wiles Greenworld, OMM and Schneider electric. The report concludes that the majority of the fleets we worked with had a clear business case to adopt EVs today.

You can read the report here

A research partnership between Transport for London, The Climate Group, Cenex, Energy Saving Trust and TNT, in February 2012, published 'Plugged in Fleets – A guide to deploying electric vehicles in fleets'.

The report identifies a number of practical tools that fleet decision makers need to assess the benefits EVs can deliver.

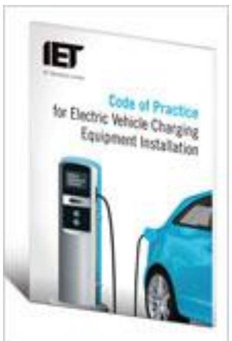
You can read the report here



The Society of Motor Manufacturers and Traders [SMMT] has updated and published their 'Electric Car Guide 2011'

The guide is designed to help motorists make informed choices and covers all those tricky questions such as financial incentives, emissions, range, charging time and infrastructure. There is also information on batteries, repair and the costs associated with running electric vehicles.

The guide is free to download here from the SMMT website:



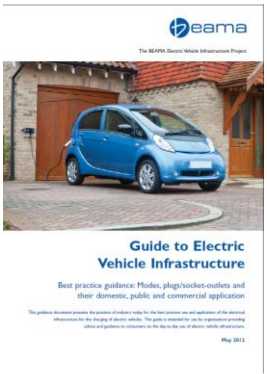
The Institute of Engineering and Technology [IET] have published in January 2012 a 'Code of Practice for Electric Vehicle Charging Equipment Installation'.

This Code of Practice aims to provide expert guidance on EV charging equipment installation, an important emerging area which is not covered in detail by the current edition of the Wiring Regulations (BS 7671) or the IET's Guidance Notes.

Aimed at experienced electricians interested in understanding a wide range of equipment and systems available, it covers the specialised installation requirements of electric vehicle charging equipment in public, private and commercial locations.

The Code of Practice provides detailed on-site guidance and recommendations on all aspects of the installation from the origin of the electrical supply, through distribution and final circuits, installation of the charging equipment itself to the cable between the charging equipment and vehicle's electrical inlet. Also included are related issues of site layout and planning and subsequent inspection, testing, certification and maintenance of installations.

The Code of Practice is available for purchase here from the IET website:

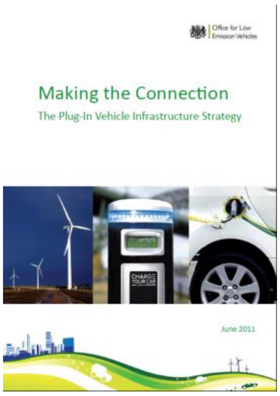


The British Electrotechnical and Allied Manufacturers Association [BEAMA] is the independent expert knowledge base and forum for the electrotechnical industry for the UK and across Europe.

BEAMA, in collaboration with a number of other organisations, published a “Guide to Electric Vehicle Infrastructure” in May 2012. This guidance document provides a view on the current availability and best practice use of charging infrastructure in the UK.

This guide is intended for use by organisations providing advice and guidance to consumers on the day-to-day use of electric vehicle infrastructure.

This guide is free to download here from the BEAMA website:



Published in June 2011 by the Office for Low Emission Vehicles, “Making the Connection – the Plug-In Vehicle Infrastructure Strategy” sets out the Government framework for the development of recharging infrastructure to support Plug-in vehicles in the UK.

This report is free to download here from the DfT Website:

Appendix H - Alphabet

Where vehicle lease prices (if relevant) have not been available directly from the client we have used pricing from Alphabet.

As a leading provider of employee mobility solutions, Alphabet takes sustainability very seriously. They are one of the UK's largest and most progressive fleet service companies. Their success is built on long term relationships with customers, based on sustainable pricing, excellent service and forward-thinking advice.

Delivering sustainability is one reason why they are very happy to be working alongside the Energy Saving Trust in the Plugged-in Fleets Initiative. Helping fleets begin their transition to tomorrow's mobility arrangements is one of their main strategic goals.

It is one of many good reasons for talking to Alphabet about your fleet's future. For one thing, they are much more than just a vehicle supplier. For instance, their AlphaCity car-sharing solution is an innovative alternative to pool cars, short term rental and the use of taxis or private vehicles for business journeys. Managed properly, it can bring cost efficiencies, improve safety and provide a flexible mobility solution for all employees. It also makes it easier to integrate plug-in vehicles into your fleet when the time comes.

Alphabet supply all makes as well as all types of fleet vehicle. This includes all plug-in hybrid and electric vans and cars. Alphabet can provide pricing advice or help you to get your hands on a demonstrator.

With over 115,000 vehicles in their UK leasing portfolio, Alphabet is a well-established presence in the private and public fleet sectors. As well as car and commercial vehicle funding and management expertise, they offer a wealth of experience in affinity and salary sacrifice schemes and a comprehensive portfolio of products and services ranging from daily rental to accident and risk management.

To talk to Alphabet about any of your fleet needs or plans, call 0870 50 50 100, email alphabet@alphabet.co.uk or visit www.alphabet.co.uk.