Electric Vehicle Charging Infrastructure Study for Winchester City Centre and District

29th October 2018

horizon POWER & ENERGY

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1. Executive Summary & Recommendations

Of the c31.8 million cars on the U.K.'s roads today, only 0.2% (1 in 500) are battery electric vehicles. Despite the very low starting numbers, the number of battery electric vehicles is growing dramatically, and in 2017 almost 2% of new UK car sales were electric vehicles. The UK government are positively supporting the transition to electric vehicles, and have stated that all new cars sold after 2040 should be ultra-low emissions. Other countries, such as the Netherlands and Norway, have previously committed to the elimination of fossil fuel car sales by 2030 and 2025 respectively.

Changing Government policies, concerns over air quality and technology advances have resulted in major automotive manufacturers, such as Nissan and Jaguar, transitioning their manufacturing plants to electric vehicle production.

In anticipation of the above changes, Winchester City Council ran a competitive tender for a study to determine the near term charging infrastructure requirements for some areas of the district. Following the tender, Horizon Power and Energy were appointed to study the EV charging infrastructure requirements for;

- the Council's 34 car parks which incorporate 5,614 parking bays.
- the taxi operators which operate the 329 taxis in an around Winchester city.
- the 366 on-street parking bays in the Winchester Air Quality Management Area (AQMA)

As per the Council's request, our study has focused on the near-term requirement for charging infrastructure; the five-year period ending 2023. As a result of the short time horizon adopted, our infrastructure recommendations are modest and reflect the fact that electric vehicles are at the bottom of their growth curve. We believe that 57 charging bays, served by 46 chargers, should be sufficient to meet the user needs in the next five years;

- Taxi Charge Points — 4 Bays (2 x 50kW CHAdeMO / CCS / Type 2 Chargers)
- Winchester City Car Parks — 25 Bays (23 x 7KW/20kW Type 2 Un-tethered Chargers)
- Park and Ride Car Parks — 13 Bays (7 x 7kW Type 2 Un-tethered Chargers)
- Rural and Town Car Parks — 12 Bays (11 x 7/11KW Type 2 Un-tethered Chargers)
- On Street Parking in AQMA — 3 Bays (3 x 3kW Type 2 Un-tethered Pilot Project Installs)

The above estimates include the replacement of eight existing 'dumb' Rolec charging points with new 'smart' chargers which can handle billing, data capture and telemetry. We are also recommending that a minimum of three 20kW Type 2 un-tethered chargers are initially installed at the new Bar End Leisure centre and this is included in the figures above. The Council would be wise to consider installing additional power supply capacity into the leisure centre at the construction stage, and this would include increased transformer capacity and HV cable cross sections.

We are recommending that Winchester car park charging points are clustered into a limited number of car parks in Winchester city. Conversely, the charging points in the district's towns should be distributed between car parks, and this is due to the greater walking distance between these car parks.

The siting of taxi charging points will require greater input from taxi operators; however it appears that the first charger should be located near to the Winchester railway station, with a second charger subsequently being located near to the Winchester Guildhall or new Bar End Leisure centre.

The solutions associated with on-street charging are rapidly developing, and we are thus recommending that the Council undertake a small on-street charger pilot trial installation at this stage. It is widely expected that the majority of EV charging will occur at home, and some analysts anticipate that 80% of charging could occur at home. In the long term, the provision of on-street charging may become a significant challenge in some areas of the city, particularly to the east of the AQMA area and areas such as Hyde. In a future where all vehicles may need on-street charging facilities, it is important that the Council trial and select the correct long term solution. This measured approach will also provide time for alternative technologies (such as super fast charging stations) to emerge for vehicles which only have on-street parking.

We are recommending that all slow and fast chargers make use of un-tethered Type 2 connectors, as these connectors are emerging as a universal standard which almost all vehicles can use. The rapid chargers, which would service the taxi operators, would be an exception to this rule, and these chargers should be tethered and have the ability to connect to CHAdeMO, CCS or Type 2 charging ports.

We would recommend that all charging infrastructure makes use of open charge point protocols (OCPP) for data transfer and control functions, thus ensuring that the Council are not tied to one provider who operate proprietary, or closed, communication protocols.

At this time we estimate that the near-term requirement for charge points would require an investment budget of c£250,000, which includes a 10% design and project management fee allowance. As electric vehicle numbers grow, the need for charging infrastructure will increase accordingly, and additional investment will be required. We are making a firm recommendation that all charging infrastructure installed is ‘smart’, and has the ability to capture detailed utilisation data which can then be used to inform future decisions on infrastructure rollout and investment. We would thus recommend that investment is limited at this time, and that the temptation to invest ahead of the EV growth curve is resisted; additional chargers can always be added based upon utilization reports, whilst funds spent on excessive infrastructure cannot be un-spent.

A wide range of options exists to finance the infrastructure rollout. We have provided some detail on each of these options within our report, and we leave it to the Council to decide on their preferred investment strategy. If the Council decide to work with a private sector investor, it is likely that the Council will have to cede some control to the investor, who may have their own views regarding the future requirements.

It is important that the Council choose the charge point manufacturer and operator that can provide reliable after-sales support and a robust back office solution that can handle payments and reporting. The long term success of the charger programme will depend on good maintenance and the provision of good quality data that will inform future (much more substantial) investment decisions. The choice of supply partners is a strategic decision, and should ideally be viewed over the long term.

The electrification of transport will, in the long term, make a dramatic impact upon the air quality issues within Winchester city centre; however in the near term (5 years) the impact of electric vehicles will be negligible and should not be relied upon to address air quality issues within the AQMA.

Whilst we have addressed many of the technical issues regarding the rollout of the required charging infrastructure, there are a number of policy decisions which the Council now need to address. These include decisions on the following points;

- the policy regarding the charges for electric vehicle parking bays, and whether these should be free of charge, at preferential rates, normal rates or a rate which incorporates electricity charges.
- the policy regarding the recovery of electricity costs, and whether electricity should be provided free of charge, at a rate equal to domestic charges or at a rate which incorporates an element of cost recovery for the Council.
- will the Council allow residents of the AQMA area to charge their cars on a preferential basis in city car parks, either within normal working hours or otherwise?
- the policy regarding investment, and whether the rollout should be based upon the use of the council's own capital, PWLB borrowing, government grants or commercial investors.
- connected to the above, is it appropriate for the Council to invest in taxi charging infrastructure which will serve commercial businesses, and if so, on what basis.
- the procurement policy, and whether the council will make use of the Hampshire County Council EV Charger Framework Agreement, the ESPO Framework Agreement or a bespoke negotiated or procured agreement.
- connected to the above, do the Council wish to adopt a common solution with adjacent districts. This may extend to common payment mechanisms and equipment which may become familiar to drivers moving between districts.

We have provided our thoughts on each of the above points; however we recognise that the council will need to weigh many differing views when making policy in these areas.

In addition to the above recommendations, we would propose that the Council gives consideration to the electrification of the bus fleet within Winchester city. The electrification of busses could make an improvement to air quality, and the remaining term of the current bus supply contract could be used to investigate the economics and technical issues associated with electric busses and the high power charging infrastructure. Such investigation could be supplemented by Officer and Councillor visits to other Cities (such as Nottingham) which have adopted electric busses in order to improve air quality. This advanced investigation could then be used to inform the specification and procurement strategy well in advance of renewing the bus contracts.

2. The Policy Context

The increased use of electrical vehicles is being driven by a number of factors, ranging from air quality concerns, through to technological advancement and Government policy. Arguably it is Government policy which is likely to make the biggest impact on the market. It is Government policy which sends clear signals to large automotive manufacturers and the fuel retailers (and their investors), that they can confidently invest in making the switch from existing solutions. Governments in Europe are moving at different speeds on this issue, and it is generally accepted that countries such as the Netherlands and Norway that are leading the way. The UK Government is taking a rather more measured approach, however one should not underestimate the scale of the changes that will be required over the next 20 years in order to deliver on the Governments stated ambitions. Some of the key components of the current Government policy are as follows;

- The UK will end the sale of new conventional petrol and diesel cars and vans by 2040
- Government want to see at least 50%, and as many as 70%, of new car sales and up to 40% of new van sales being ultra low emission by 2030
- Government want to increase the supply and sustainability of low carbon fuels in the UK through a legally-binding 15-year strategy to more than double their use, reaching 7% of road transport fuel by 2032.
- Grants for plug-in cars, vans, taxis and motorcycles will continue until at least 2020. The plug-in car and van grants will be maintained at the current rates until at least October 2018, however the policy beyond this time is unclear at time of writing.
- Government propose to lead the way by ensuring that 25% of the central Government car fleet is ultra low emission by 2022 and that all new car purchases are ultra low emission by default. The Government is also committing to 100% of the central Government car fleet being ultra low emission by 2030.
- Government will be consulting on reforming Vehicle Excise Duty to incentivise van drivers to make the cleanest choices when purchasing a new van.
- The Government have committed to provide £246 million to research next generation battery technology through the Faraday Battery Challenge.
- The Government have also committed to launch a £400 million Charging Infrastructure Investment Fund to help accelerate charging infrastructure deployment.

More detail on the Government policy can be found in the Governments Road to Zero Strategy, published 9th July 2018 by the Department for Transport.

3. Electric Vehicle Growth Scenarios

Over the last 12 months it has become very clear that the growth in electric vehicles is going to accelerate. This assertion is evidenced by a wide range of factors, including:

- Changes in Government policy which will ensure that all cars sold by 2040 are low emissions.
- Significant investments on the part of major motor manufacturers, such as BMW, Jaguar and Nissan to move their manufacturing base to electric vehicles.
- Traditional large-scale oil and gas companies investing in electric vehicle charging technology, such as Shell acquiring the European supplier New Motion, and BP acquiring the UK supplier Charge Master.

Whilst the direction of travel is very clear, making precise predictions about electric vehicle growth rates is notoriously difficult. A large number of variables will affect the rollout of electric vehicles, many of which cannot be accurately predicted themselves. Some of the more significant variables which will affect the growth of electric vehicles are as follows:

- Capital cost of electric vehicles versus conventional internal combustion vehicles. Many commentators and analysts anticipate that EV vehicles will break even around 2025.
- Government policy and incentives. The growth in UK renewable energy has been extraordinary in the last 10 years, and almost 30% of the U.K.'s electricity is now generated by renewable energy. This growth has largely been driven by Government policy changes and supporting incentive schemes. Any changes in Government policy (and the associated grants) will have a dramatic impact on the growth of electric vehicles and the associated charging infrastructure
- Electric vehicle range. Hitherto, range anxiety has been cited as a significant reason why people have been reluctant to purchase electric vehicles. However, the improvement in battery technology and falling prices is likely to eliminate this anxiety in the coming years.
- Consumer choice. The range of electric vehicles available to consumers has been fairly limited. As manufacturing capacity increases, consumers will have more choice and will be able to purchase vehicles ranging from super-minis through to executive saloons.
- Second-hand market. Due to the small number of electric vehicles in circulation, the used vehicle market is very small. As more electric vehicles filter into the UK fleet, people will have access to an increasing number of affordable second-hand electric vehicles.
- Charging infrastructure. Concerns regarding available charging infrastructure have obviously been a consideration in the buyer's decision-making process; however the rapidly growing number of chargers across the UK is set to address this concern.
- Charging times. As battery technology advances, the required time to charge the battery on long journeys will be reduced. Some buyers will consider the current 30 minutes for an 80% charge (rapid charger) to be too long, however this is likely to reduce in the coming years.
- Consumer awareness. Many consumers still consider the purchase of an electric vehicle to be a risk. These concerns are many and varied, and include issues such

as battery life, range, resale value and reliability. As electric vehicles become more commonplace, consumers will become familiar with electric vehicles and more comfortable with the idea of purchasing one.

Many other variables will also affect the growth of electric vehicles, and these include the growing concern over air quality within our cities. In response to this unpredictability, many consultants and analysts will provide a range of scenarios, and will base their recommendations on one central scenario. This is the approach that we have taken, and our recommendations are based on the data in the following pages.

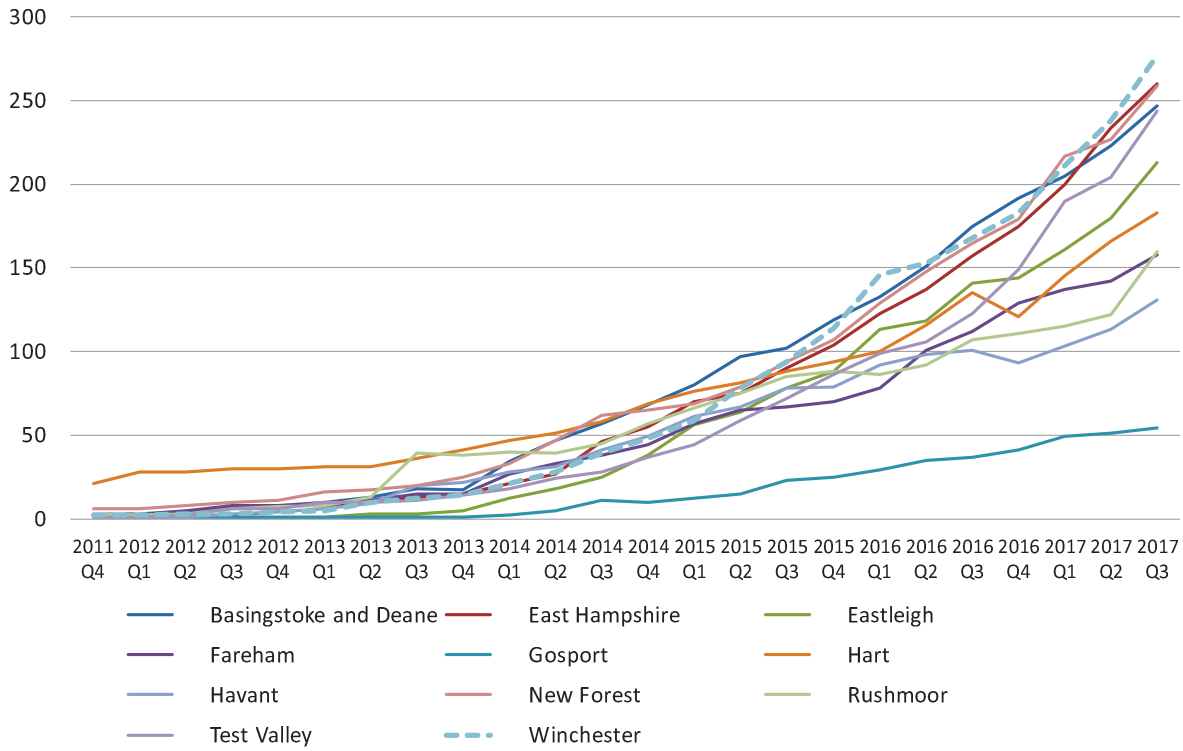
3.1 Current Vehicle Numbers

Data obtained from the Office of National Statistics (ONS) shows that there were 31,792,259 cars registered in the UK in 2016. The same dataset shows that 118,342 vehicles with plugs (0.37%) were registered in the UK in 2017 (note this includes pure electric vehicles (PEV) and plug-in hybrid electric vehicles (PHEV). We also analysed ONS data for the Hampshire districts, and this is shown in the table below. Within the Winchester district, approximately 0.4% of vehicles registered have plugs.

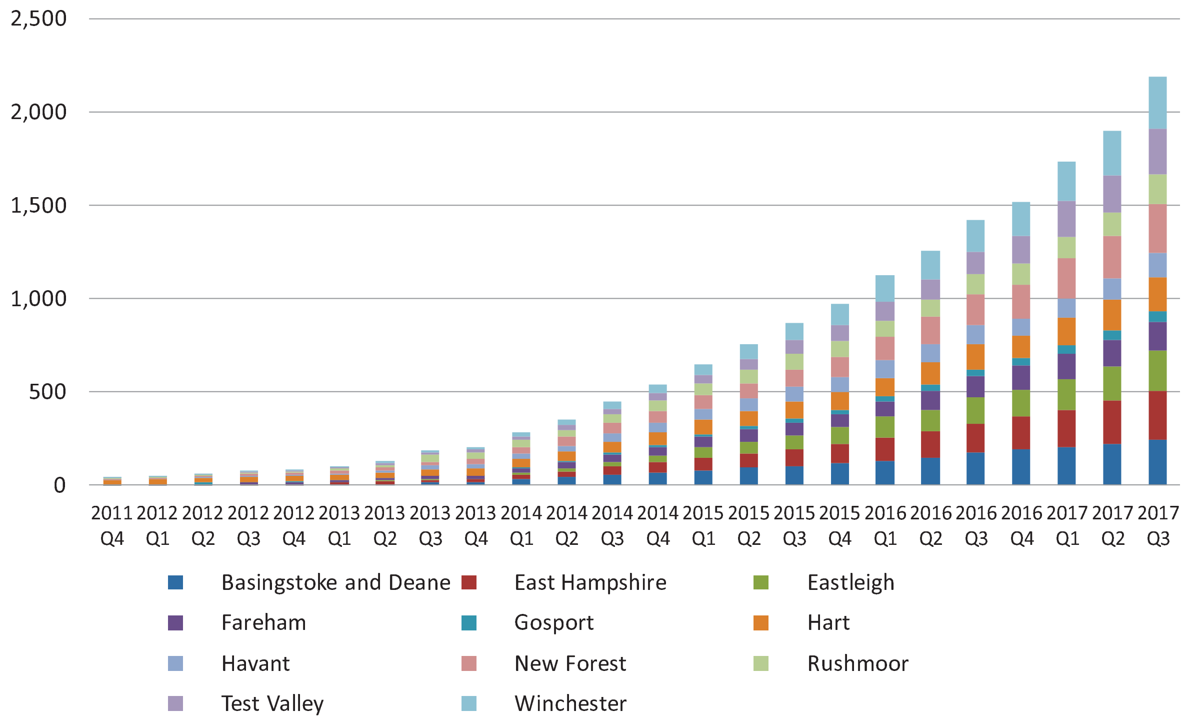
Region	Cars Registered (2016)	Plug Ins Registered (2016)	Plug Ins Registered (2017)	Percentage Plug In (2016 Data)	Percentage Plug In (2017 Data)
United Kingdom	**31,792,259**	**84,819**	**118,342**	0.267%	0.372%
Great Britain	**30,850,440**	**83,482**	**116,615**	0.271%	0.378%
England	**26,283,298**	**75,891**	**105,408**	0.289%	0.401%
Hampshire	**829,093**	**1,517**	**2,186**	0.183%	0.264%
Basingstoke and Deane	96,301	192	247	0.199%	0.256%
East Hampshire	74,351	175	260	0.235%	0.350%
Eastleigh	71,972	144	213	0.200%	0.296%
Fareham	65,885	129	158	0.196%	0.240%
Gosport	38,430	41	54	0.107%	0.141%
Hart	58,990	121	183	0.205%	0.310%
Havant	64,150	93	131	0.145%	0.204%
New Forest	107,996	179	259	0.166%	0.240%
Rushmoor	108,743	111	160	0.102%	0.147%
Test Valley	74,324	149	244	0.200%	0.328%
Winchester	67,719	183	277	0.270%	0.409%

Across the UK fleet of vehicles, pure electric vehicles constitute c0.2% of the vehicles on the road. Within Hampshire the growth of electric vehicles (both PEV and PHEV) has been dramatic, albeit the number of vehicles on the road is still small (see graphs below).

No Of Plug In Cars, Vans and Quads Registered By District



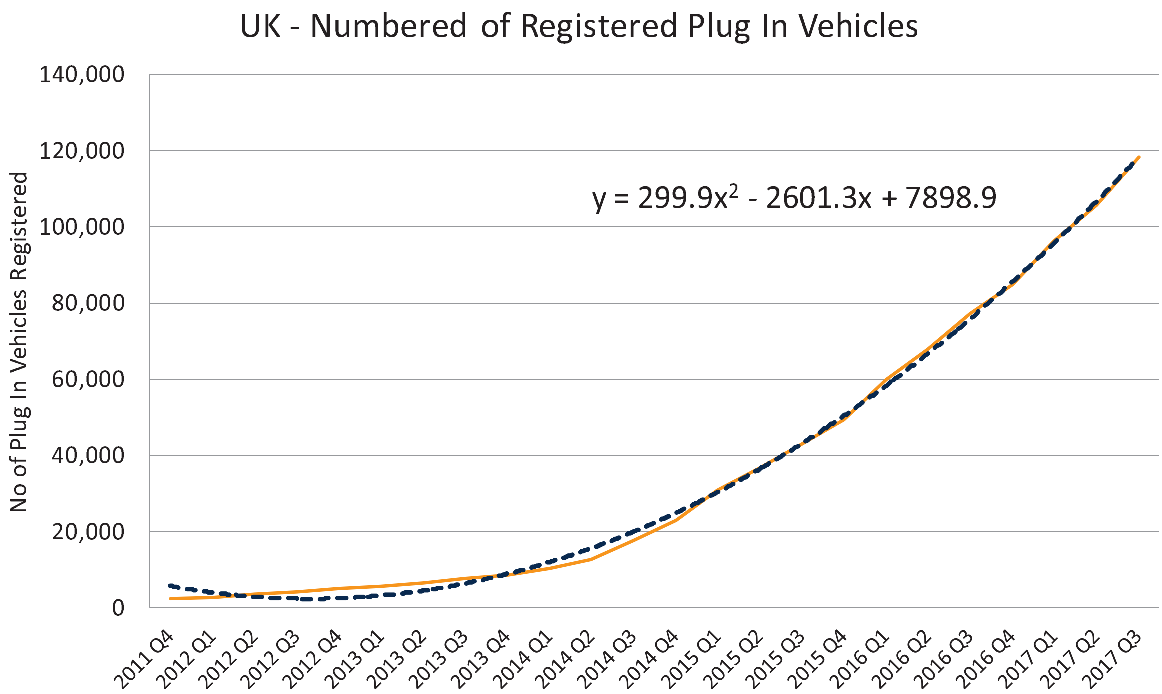
No Of Plug In Cars, Vans and Quads Registered in Hampshire



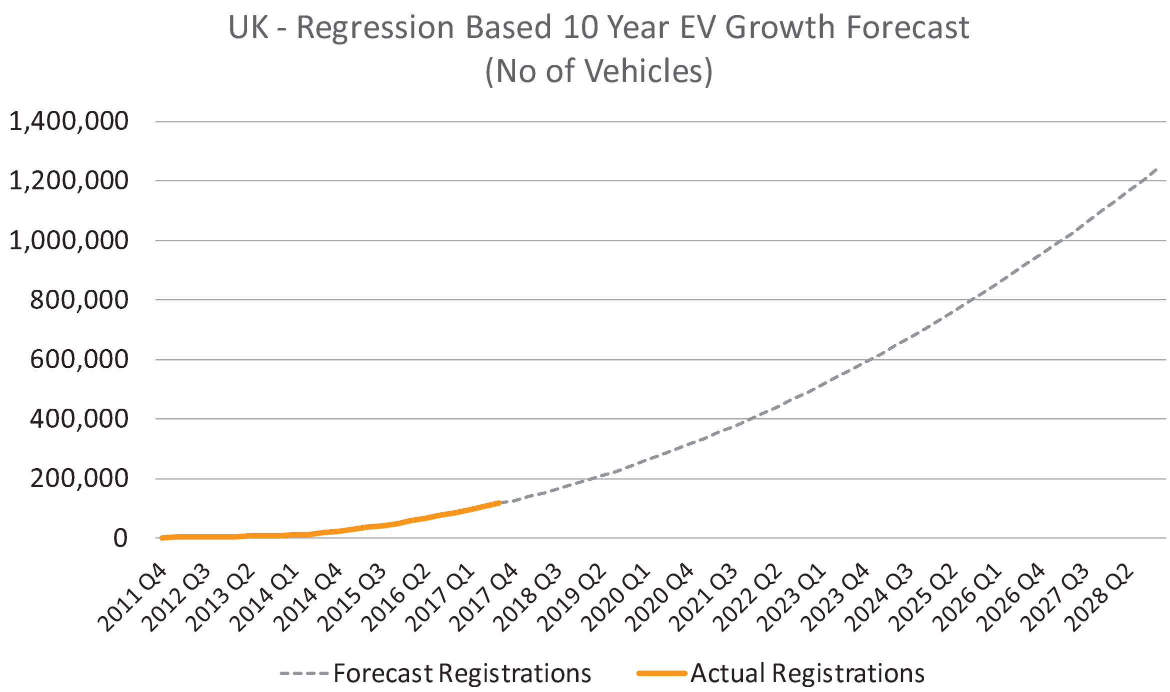
3.2 Growth Projections

In 2017 c2% of all new car sales were electric vehicles and this figure is set to increase in the coming years. However, when one factors in the life of a typical vehicle (13.9 years in 2015), it will take a significant period of time to replace the U.K.'s fleet of c31.8M cars.

In an attempt to determine the growth of electric vehicles in the district, and more broadly in the UK, we undertook a polynomial regression analysis which is based on the growth of electric vehicles since 2011. The fitted curve (the dotted line in the graph below) very closely matches the actual take-up (the yellow line in the graph below).



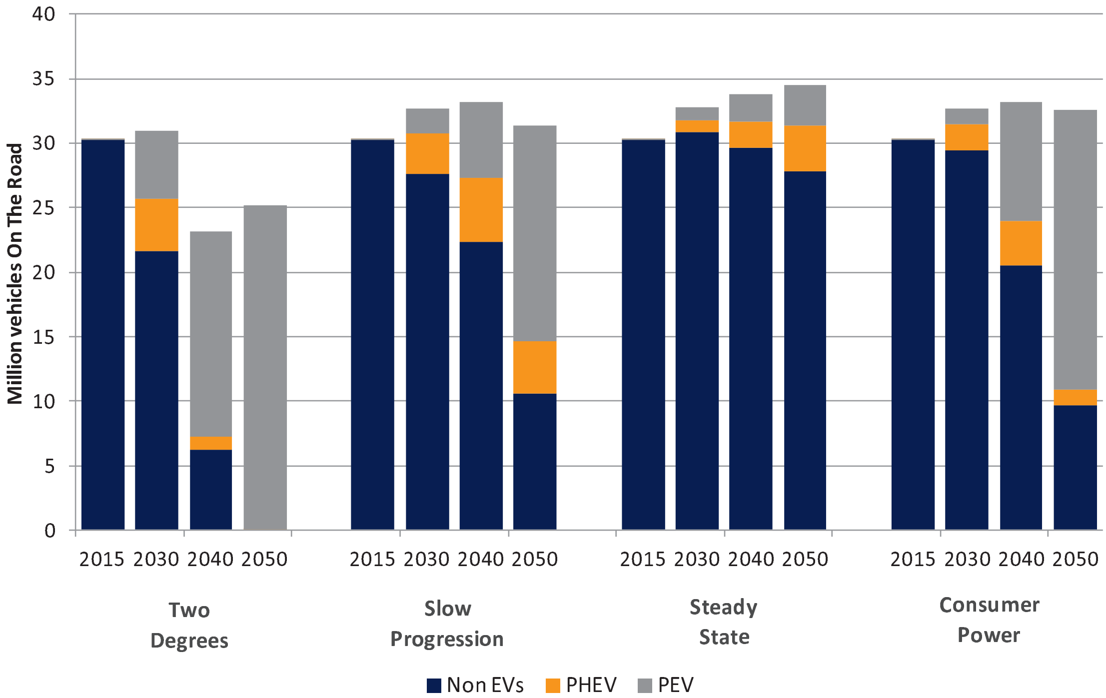
Based upon the line of best fit above, we produced a '*business as usual*' projection from 2018 to 2028 (see graph below). Without any further intervention or market developments, this forecast suggests that 1.2 million UK vehicles (4%) will have plugs by 2028.



Notwithstanding the above analysis, it is becoming clear that the *'business as usual'* scenario is likely to underestimate the number of electric vehicles on the road in the next 10 years. Falling prices and government intervention are likely to drive an increased level of electric vehicle take-up. In an effort to measure the impact of these interventions and trends, National Grid has produced four scenarios for electric vehicle rollout by 2030, 2040 and 2050 (see National Grid Future Energy Scenarios 2017). The assumptions associated with each of these scenarios are included at Annex A to this report. The extremes of the National Grid study demonstrate the variability of possible outcomes over the long-term. National Grid's steady-state scenario forecasts that 6.1% of vehicles will be electrified by 2030, and this is not dissimilar from our own 2028 forecast of 4%. At the other extreme, National Grid has modelled scenarios where 43.1% of vehicles are electrified by 2030. The intermediate scenarios are shown below.

- 6.1% of Stock is EV – National Grid 2017 FES – 2030 Steady State
- 11.1% of Stock is EV – National Grid 2017 FES – 2030 Consumer Power
- 18.6% of Stock is EV – National Grid 2017 FES – 2030 Slow Progression
- 43.1% of Stock is EV – National Grid 2017 FES – 2030 Two Degrees

A graphical representation of National Grid's longer term forecast is shown in the table below, and this indicates which vehicles may be pure electric vehicles (PEV) as opposed to plug-in hybrid electric vehicles (PHEV).



For the purposes of our analysis and forecast, we have adopted National Grid's consumer power scenario, and have therefore assumed that 11.1% of the districts cars will be electrified by 2030. Our recommendations regarding electric vehicle charging infrastructure have been based upon a growth curve to 11.1% in 2030 in order to predict electric vehicle take-up over the short term, ie by 2023 (which is the requested time horizon for our study).

We believe that it is prudent to install a minimal number of chargers in order to meet near term demand, whilst importantly collecting data on charger utilisation. The use of such an approach will ensure that any further investment in the roll out of charger infrastructure can be based upon robust usage data for each location.

4. Near Term Infrastructure Requirements

4.1 Data Collection and Analysis

Wherever possible, our recommendations have been based upon an analysis of available data or surveys. For this study we have obtained information as follows;

- WCC city car parking survey data for 2013 and 2018.
- an electronic survey of registered taxi drivers within the district
- site surveys of currently installed equipment
- site surveys of all roads and car parking bays within the AQMA area
- interviews with members of WCC management team
- car park information (fees and spaces) obtained from Winchester City Council's own website
- taxi fleet numbers provided by Winchester City Council licensing department

The data and feedback obtained has been analysed in sections 4.1 to 4.3 below, and is the basis of some of our recommendations.

4.2 Existing Charging Infrastructure

As part of our study we have undertaken a survey of all of Winchester's car parks which have charging infrastructure installed. At the current moment in time, five car parks are hosting 10 chargers as shown below:

- Friarsgate: 3 x 7KW Charger 1 at the car club bay and two in basement
- Middlebrook: 1 x 7 KW Charger - Enterprise Car Club bay.
- The Brooks: 2 x 7kW Chargers on the upper parking level B4/B5 bays
- Chesil Multistory: 2 x 7kW Chargers
- South P&R: 2 x 7kW Chargers near the bus stop

The two charges installed at the South Winchester Park and Ride are operated by Charge Point Genie on a commercial basis, and use a payment card obtained by setting up an account with the provider. The Charge Point Genie website shows that their standard charge is 50p per connection, and 30p per kWh used. It is not clear if Charge Point Genie also charge the £10 penalty for stays over 4 hours (as detailed on their website), or if a different arrangement has been put in place for the South Park and Ride.

The eight Rolec units in Winchester City Council’s central car parks are owned and operated by the City Council, and electricity is provided free of charge to the user. Whilst some metering has been fitted to a number of these existing charging points, no utilisation data is being collected. Without this data it is difficult to know whether the existing units are well used. As part of our work we have made repeated visits to each of the car parks and it would appear that the three units in the Friarsgate Car Park and one unit in the Middlebrook Car Park are seldom used. In contrast, we have witnessed some use of the charge points at the South Park-and-Ride site, Chesil Multistorey Car Park and the Brooks Car Park.

Our proposal assumes that the existing Rolec units will be replaced by smart charging outlets, which have the ability to handle billing and data transfer. This functionality is critically important if Winchester City Council are to adopt a data led investment and rollout programme.

As we are not privy to the contract for the provision of the two Charge Point Genie units, it is not clear to us whether these units should (or could) be replaced as part of the broader program, and this would require discussions with Hampshire County Council.

Existing 8 x Rolec 7kW dumb units as installed at four Winchester car parks

Existing 2 x Chargepoint Genie 7kW unit as installed at South Winchester Park and Ride

4.3 WCC Car Parks

WCC currently operate 34 car parks, with a total of 5,614 parking bays. It is expected that the new leisure centre will also have a further 350 car parking spaces, although this addition may be offset by the loss of 182 spaces at the River Park leisure centre. The car parks range in size from minor parking facilities such as Crowder Terrace (with 11 parking bays) to the largest car park; South Winchester Park-and-Ride (with 884 parking bays). A high level summary of the number of car parks and parking spaces is shown in the table below. A detailed breakdown of the car parks and the number of parking bays is included at Annex B to this report.

Car Park Location	No Of Bays	Percentage	No Of Car Parks	Percentage
Town Centre	2,930	49%	18	51%
Park & Ride Car Parks	1,861	31%	4	11%
New Leisure Centre	350	6%	1	3%
District Towns	823	14%	12	34%
TOTAL	**5,964**	100%	**35**	100%

In addition to the WCC car parks above, many businesses, public sector and educational establishments also own and operate car parks within Winchester city. Some of the largest car parks are shown below, and add significantly (+32%) to the total number of WCC car parks operated in or near the city AQMA area.

- Winchester School of Art 97 Spaces
- Winchester Station (Worthy Lane) 411 Spaces
- Winchester Station (Brassey Road) 450 Spaces
- Total 958 Spaces

Other organisations, such as the hospital, prison and university also add to the parking capacity on the Romsey Road stretch of the AQMA area.

Several options exist for the siting of charging infrastructure in any town, and these are as follows.

- Decentralized: a decentralised strategy would install EV chargers in every car park.
- Centralized: a centralised strategy would centralise all of the EV chargers in a town or city into one location.
- Clustered: a clustered strategy seeks to group adjacent car parks and provide EV chargers in one of the car parks within the group.

Each of the above strategies has advantages and disadvantages. In the early stages of the charger roll out programme, the use of a decentralised strategy is likely to allow the use of existing electrical supplies to ticketing machines or lighting columns. This is because the number of chargers in any one car park will be limited, thus allowing the use of some existing supply infrastructure. The disadvantage of this strategy (particularly in Winchester) is the increased likelihood that car park users will arrive at the charging post only to find that it is occupied, thus forcing them to rejoin the one-way system to find a vacant charging point.

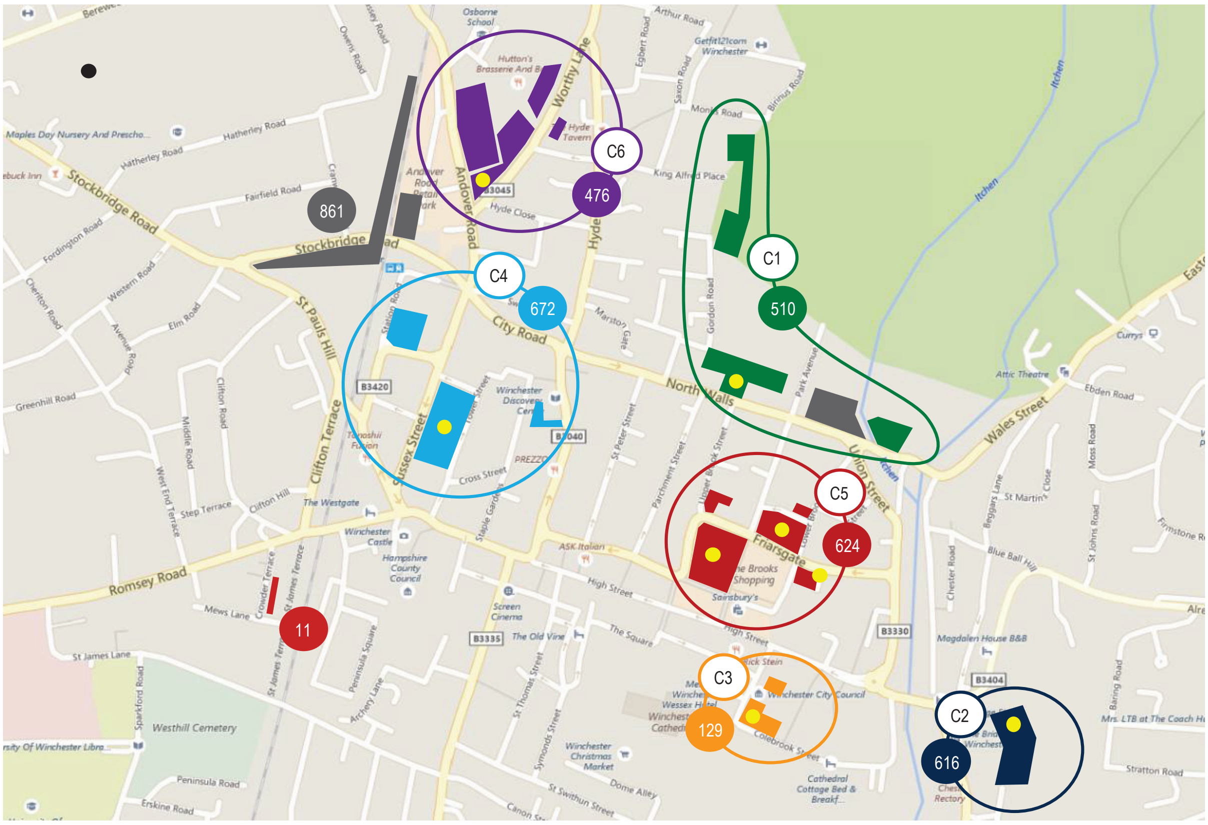
The use of a centralised strategy allows dedicated electrical infrastructure to be installed for all chargers, thus benefiting from economies of scale. This strategy may be attractive if the local authority wishes to make a statement. However, the inevitable low levels of charger utilisation in the early years will be very evident, and this may attract some commentary. From a user's perspective, a centralised strategy results in inconvenience and forces EV drivers park some distance from their preferred location.

The use of a clustered strategy seeks to address many of the issues identified above, whilst also seeking to limit capital costs associated with electrical connections. The clustered strategy would, for example, install one set of EV charging infrastructure in Worthy Lane car park, and this would serve those drivers which would typically visit the adjacent Lido, Coach Park and Cattle Market car parks.

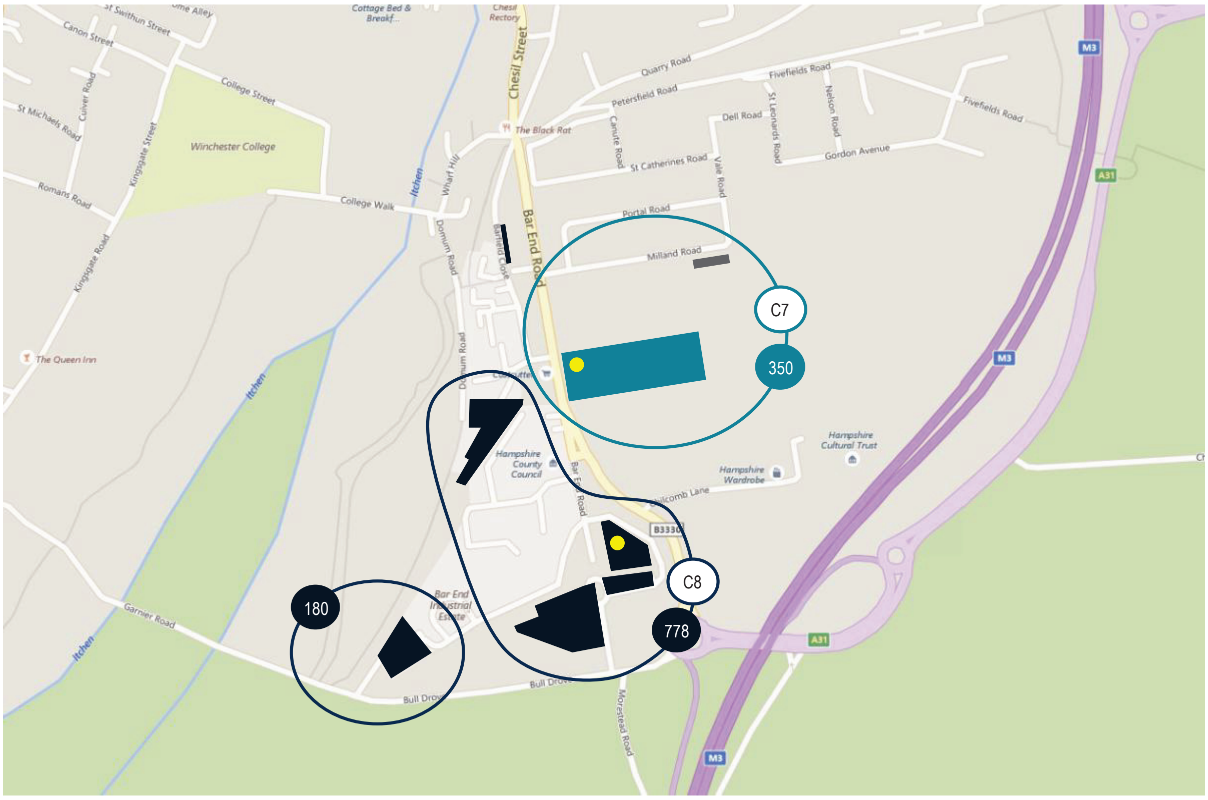
Our recommendation for Winchester city is to adopt clusters of infrastructure which are suited to different users needs, and we have based our calculations on this approach. In contrast, we are recommending a decentralised approach for the car parks in rural towns and villages, and this is due to the increased walking distances between car parks.

The clusters that we are proposing for Winchester city centre are shown below. Each cluster typically serves a different part of the city, and in many instances a specific user group. For example, cluster C6 (476 parking bays) predominantly serves rail commuters or other long-term users, such as visitors to the Winchester Hotel. This user group typically park for long periods of time, and can therefore use low-power chargers. In contrast, cluster C5 (624 parking bays) is predominantly used by visitors to the town centre, who typically park for two or three hours whilst shopping or dining.

The position of the yellow dot on the plans over page indicates the proposed location of chargers, and makes use of existing charger supplies to reduce capital cost.



Above - proposed car park clusters for Winchester city.



Above - Proposed car park clusters for Bar End.

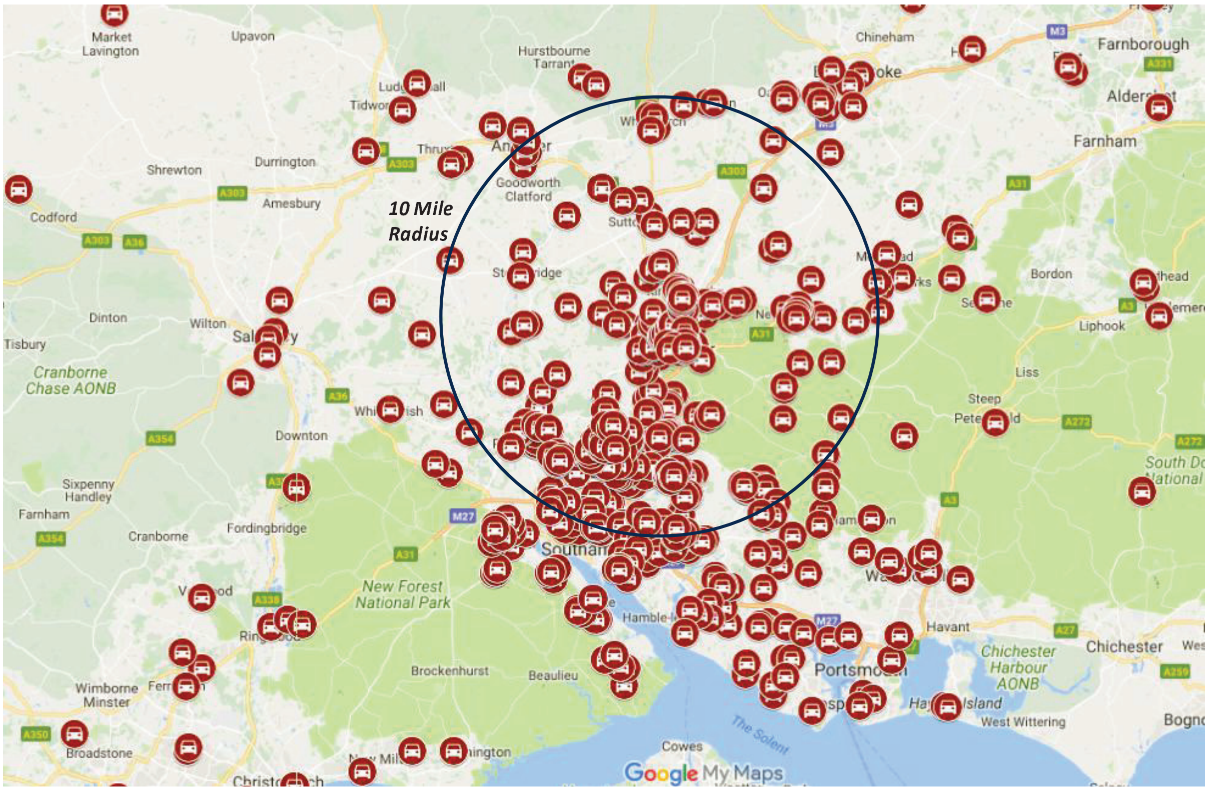
The number of EV chargers required for a car park depends upon several factors. Obviously two key factors are (a) the percentage of vehicles that are electrified, and (b) the number of parking bays within the car park. Both of these variables have been quantified earlier on in this report. Additionally, the car park utilisation also has a bearing on the required number of charge points. For the purposes of this study, we have based our calculations upon a full car park, and this is often the case during peak tourist times such as Christmas or The Hat Fair.

As well as the considerations above, we have evaluated the likely need for charging upon arrival at the car parks. This need for this destination charging is driven by (a) the state of charge when arriving at the car park, and (b) the drivers concern (real or imagined) about the ability to make the return journey. In order to determine the real need for charging upon arrival at the car parks, we analysed 1,042 visitor records from the 2013 WCC Car Park Survey. The analysis revealed that over 90% of visitors to the car parks had travelled a distance of less than 30 miles. Indeed, approximately 50% of drivers had travelled distance of less than 10 miles. A tabular breakdown of our analysis is shown below.

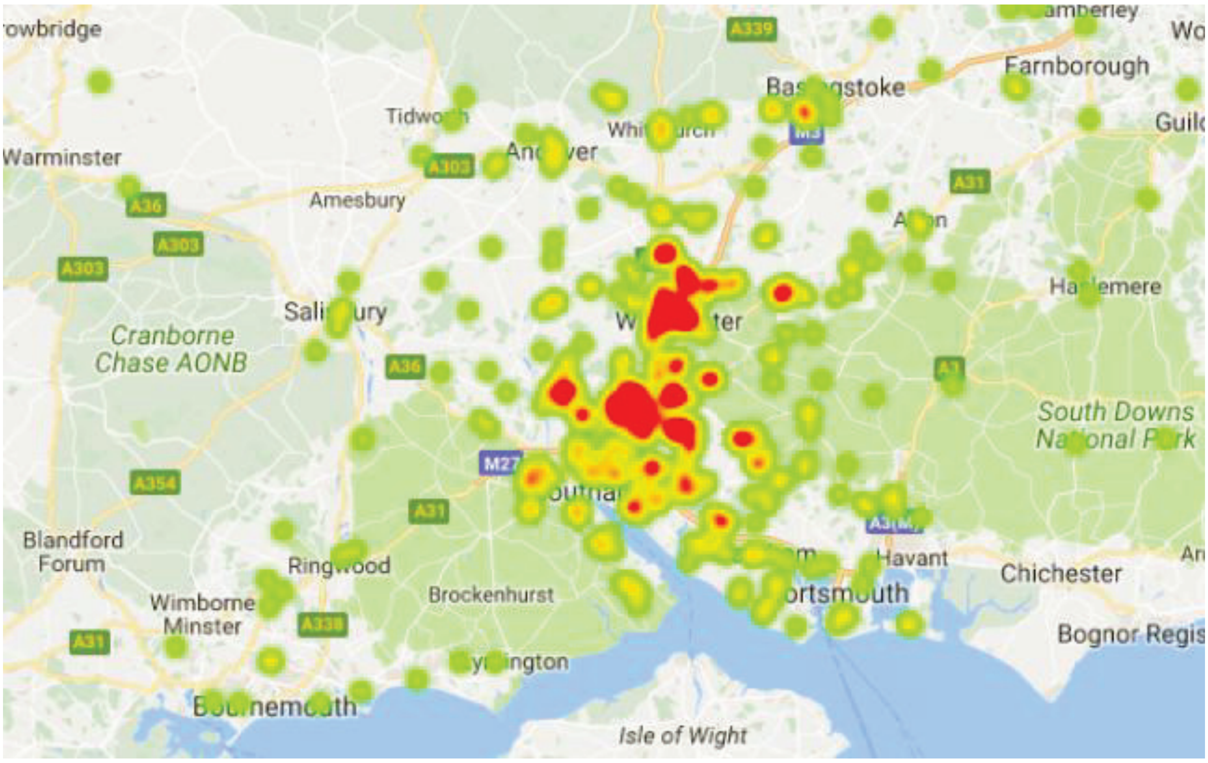
Central Winchester Car Parks		
Distance	Number	Percentage
<5 Miles	148	22.4%
< 10 Miles	336	50.8%
< 20 Miles	554	83.8%
< 30 Miles	604	91.4%
< 40 Miles	630	95.3%
< 50 Miles	637	96.4%
< 60 Miles	647	97.9%
<70 Miles	653	98.8%
< 80 Miles	657	99.4%
< 90 Miles	658	99.5%
< 100 Miles	658	99.5%
100 Miles +	3	0.5%

Park & Ride Car Parks		
Distance	Number	Percentage
<5 Miles	21	5.5%
< 10 Miles	180	47.2%
< 20 Miles	317	83.2%
< 30 Miles	358	94.0%
< 40 Miles	374	98.2%
< 50 Miles	378	99.2%
< 60 Miles	379	99.5%
<70 Miles	381	100.0%
< 80 Miles	381	100.0%
< 90 Miles	381	100.0%
< 100 Miles	381	100.0%
100 Miles +	-	0.0%

If the majority of visitors commence their journey with a fully charged battery (typical when leaving the home at the start of the day), it is unlikely that the driver will need to charge the vehicle on arrival at the car park. In an effort to determine if the car park users have access to home charging, we mapped the locations of over 1,000 car park visitors on the maps below. Whilst this exercise demonstrates the much of the traffic into the Winchester car parks originates from the south of the county, it was inconclusive when trying to demonstrate if EV drivers will have access to home charging.



Above - Journey start point – Winchester car park users 2013



Above - Journey start point heat map – Winchester car park users 2013

Based upon our analysis, we have assumed that 25% of all EV drivers visiting the car parks will make use of the charging infrastructure. This figure could vary significantly depending upon the council's policy for payment to use of the charging infrastructure and parking bays. In short, if the council continue to provide free electricity to EV users, it is likely that demand for chargers will be higher than projected, as car park visitors will take advantage of free electricity. Conversely if the charges for the use of the infrastructure are much higher than the cost of electricity available at home, then the likely utilisation of charging points may be lower.

Based upon the analysis above, we would recommend that 50 publicly accessible charging bays are provided in Winchester Council's Car Parks and the Park and Ride Car parks. This figure includes the replacement of the existing charge points with smart units that can handle billing and data capture and reporting.

Subsequent to our analysis, Winchester City Council undertook a car park user survey in 2018. An examination of the 2018 data revealed that average travel distances had not materially altered since 2013, and that the analysis based upon the 2013 data thus remained valid.

A breakdown of all charge point numbers is shown in the table over-page, and further detail is provided in the annexes to this report.

CAR PARK DETAILS			SPECIFICATION				
Site Ref No	CAR PARK	POSTCODE	Charger Rating	Tethered / Untethered	Wall / Post Mounted	No Of Charging Bays	No Of Chargers
	TAXI CHARGING						
1	Coach Park	SO23 7AB	50kW CHAdeMO / CCS / Type 2	Tethered	Post Mounted (3 Outlet)	2	1
2	Guildhall Area	SO23 9BE	50kW CHAdeMO / CCS / Type 2	Tethered	Post Mounted (3 Outlet)	2	1
						4	**2**
	WCC TOWN CAR PARKS						
3	St Peters Car Park	SO23 8DB	7kW Type 2	Untethered	Post Mounted (Double Outlet)	3	2
4	Chesil Street Multi Story Car Park	SO23 8BL	7kW Type 2	Untethered	Wall Mounted (Single Outlet)	4	4
5	Colebrook Street Car Park	SO23 3SA	7kW Type 2	Untethered	Wall Mounted (Single Outlet)	1	1
6	Tower Street Car Park	SO23 8DY	7kW Type 2	Untethered	Wall Mounted (Single Outlet)	5	5
7	Middle Brook Car Park	SO23 8ED	7kW Type 2	Untethered	Wall Mounted (Single Outlet)	1	1
8	The Brooks Shopping Centre	SO23 8QY	7kW Type 2	Untethered	Wall Mounted (Single Outlet)	2	2
9	Friarsgate (Tanner Street)	SO23 8AQ	7kW Type 2	Untethered	Wall Mounted (Single Outlet)	3	3
10	Worthy Lane Car Park	SO23 7BT	7kW Type 2	Untethered	Wall Mounted (Single Outlet)	3	3
11	New Leisure Centre		20kW Type 2	Untethered	Post Mounted (Double Outlet)	3	2
						25	**23**

CAR PARK DETAILS			SPECIFICATION				
Site Ref No	CAR PARK	POSTCODE	Charger Rating	Tethered / Untethered	Wall / Post Mounted	No Of Charging Bays	No Of Chargers
	PARK & RIDE CAR PARKS						
12	East Winchester Park & Ride (St Catherines	SO23 8RA	7kW Type 2	Untethered	Post Mounted (Double Outlet)	5	3
13	Pitt Park & Ride	SO22 5SP	7kW Type 2	Untethered	Post Mounted (Double Outlet)	2	1
14	South Winchester Park & Ride	SO212BB	7kW Type 2	Untethered	Post Mounted (Double Outlet)	6	3
						13	**7**
	RURAL CAR PARKS						
15	Bishops Waltham - Basingwell Street		7kW / 11kW Type 2	Untethered	Wall Mounted (Single Outlet)	2	2
16	Bishops Waltham - Lower Lane		7kW / 11kW Type 2	Untethered	Wall Mounted (Single Outlet)	1	1
17	Denmead - Kidmore Lane		7kW / 11kW Type 2	Untethered	Wall Mounted (Single Outlet)	1	1
18	Wickham - Wickham Square		7kW / 11kW Type 2	Untethered	Post Mounted (Double Outlet)	2	1
19	Wickham - Wickham Station		7kW / 11kW Type 2	Untethered	Post Mounted (Single Outlet)	1	1
20	Alresford - Arlebury Park		7kW / 11kW Type 2	Untethered	Post Mounted (Single Outlet)	1	1
21	Alresford - Alresford Station		7kW Type 2	Untethered	Wall Mounted (Single Outlet)	2	2
22	Alresford - Perins		7kW / 11kW Type 2	Untethered	Post Mounted (Single Outlet)	1	1
23	Harestock - Priors Dean Road		7kW / 11kW Type 2	Untethered	Wall Mounted (Single Outlet)	1	1
						12	**11**
	AQMA ON STREET PARKING						
24	366 On Street Parking Bays in AQMA		3kW Type 2	Untethered		3	3
						3	**3**
			TOTALS			**57**	**46**

4.4 Taxi Services

Whilst very few of the districts taxi services are electrified at this time, we have undertaken an analysis to determine the short term requirement needed to support taxi electrification. At this time many of the vehicles operated use diesel fuel, and this will obviously add to the air quality challenges within the city. Whilst the council's current policy encourages taxi drivers to turn off their engines when in use, there is no current policy regarding electric taxis.

Based upon the data received from the council's licensing department, there are currently 185 private hire vehicles operating within the district. 50% of these vehicles are registered with just four companies and 80% are registered with 21 companies. In addition to the private hire vehicles, there are 124 Hackney carriages which are licensed in the district. It is also believed that a number of taxis operate within the district whilst being licensed elsewhere. We have assumed that 20 taxis fall into this group, and have thus assumed that the total number of taxis operating within the district is 329 vehicles.

We have estimated the near-term charge point numbers based upon the following assumptions.

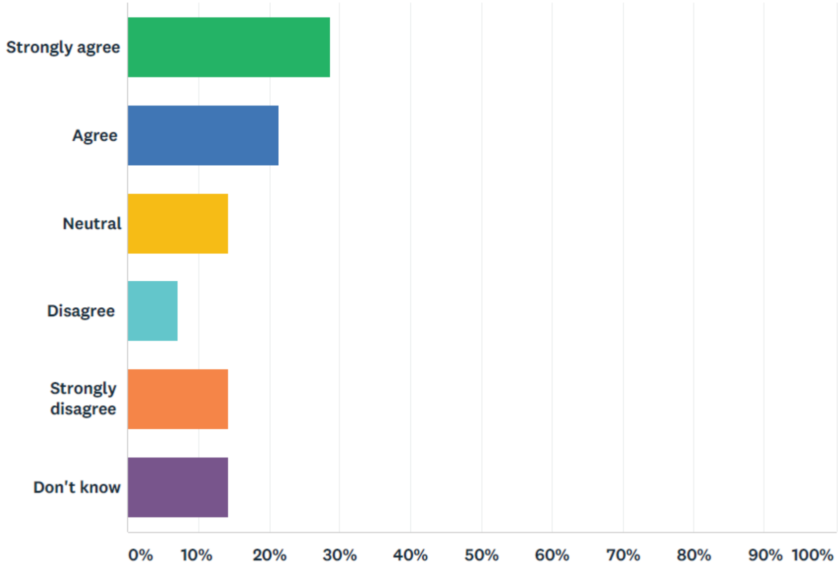
- An 11.1% EV penetration in the taxi market by 2030
- an annual mileage of 27,500 miles PA per taxi
- a usable winter taxi range of 100 miles before requiring recharge
- a 3 Hour charging window, when most operators will require a charge during the day
- a charging time of 30 minutes on charge in order to get an 80% recharge
- a charge a rating of 50 kW

In addition to our mathematical analysis, we also requested that all taxi operators complete an electronic survey which was sent out by the council's licensing department. Despite repeated attempts to engage with taxi operators, the number of responses was limited to just 14 operators. However, those that did respond operated 81 vehicles, or 26% of the licensed taxis operating in the district. The full results of the survey are included at Annex D to this report.

Some of the key responses from our taxi operator survey are shown below;

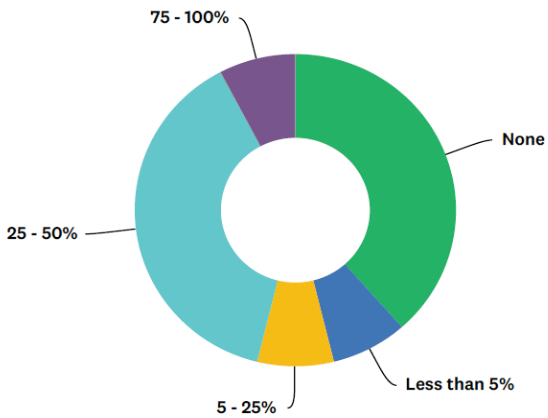
Q12 To what extent do you agree that the adoption of electrical vehicles is a realistic option for your business?

Answered: 14 Skipped: 0

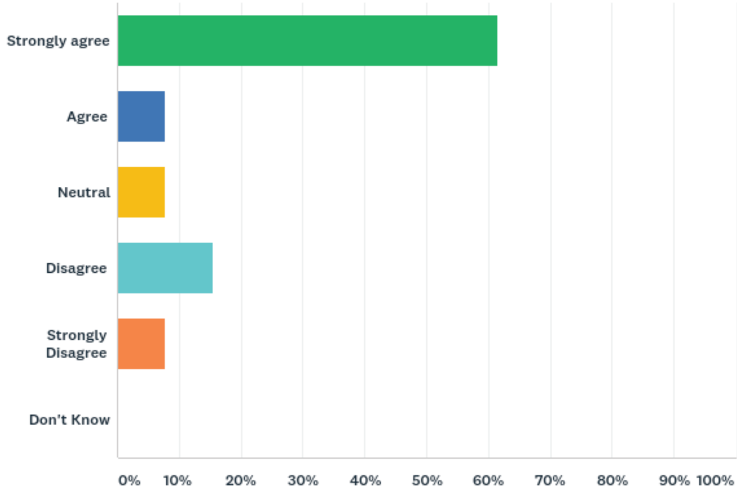


Q13 What percentage of your fleet do you expect to electrify in the next 5 years?

Answered: 13 Skipped: 1

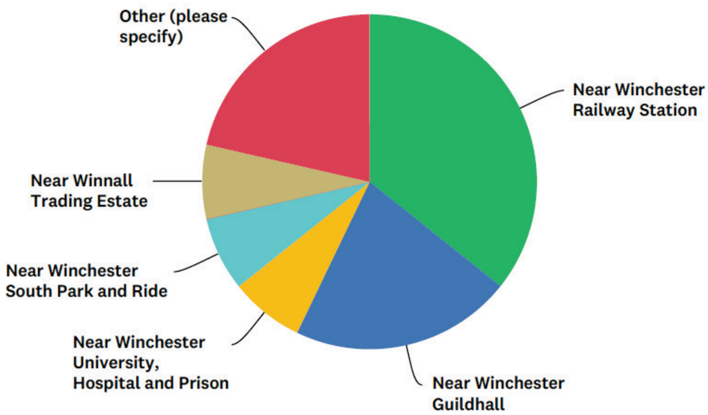


Q14 To what extent do you agree with the following statement? "The availability of EV charging infrastructure is currently preventing my move to electric vehicles."



Q10 Charging a modern EV typically takes 30 minutes. Where would be the most convenient place for a charge point to be located for you?

Answered: 14 Skipped: 0



Based upon the analysis above, we would recommend that Winchester City Council initially install a single 50 kW rapid charger in the vicinity of Winchester railway station. A possible location for this first Charger could be the Coach Park Car Park near Worthy Lane. Some taxi operators already use this car park to take their breaks, and it appears that there may be sufficient space and electrical infrastructure available at the entrance to the site. Once the city's taxi operators start to transition to battery vehicles, it is likely that a second charger will be required in the area of Winchester Guildhall. This Charger could be sited near the taxi feeder rank at the front of the Guildhall, although there may be concerns regarding aesthetics. Alternatively, a second charger could be located at the new Bar End leisure centre, and this would allow taxis to readily access the motorway and town, whilst also allowing the electrical infrastructure to be installed as part of the new build project.

A detailed breakdown of the taxi charge points is provided at Annex C to this report.

4.5 AQMA On-Street Parking

Large parts of Winchester city, such as Hyde, only have access to on-street parking. Such areas present a significant challenge for electric vehicle owners, their local authorities and the electricity distribution network operators (DNOs). According to 2018 research by PWC, 72% of UK vehicle drivers have access to off-street parking, and therefore home charging. In cities, this percentage drops, ranging from 48% in London, to 61% in Edinburgh and Cardiff. This means that many city residents do not have access to off street parking and home charging. Due to the large number of drivers that do not have access to off-street parking, it is imperative that practical and affordable charging solutions are developed for these situations. This situation is exacerbated by the fact that the majority of EV charging occurs at home; with some commentators estimating that 80% of charging will occur at home.

In response to the above challenge, different cities across the UK and Europe have been trialling a range of solutions and technologies to deal with on-street parking. Many of these trials have raised issues, a few of which are highlighted below:

- on-street charge points are blocked by conventional vehicles and are not available to EV drivers when needed
- in response to the above, EV drivers are trailing long extension leads in the gutter from the charge point to their vehicle
- narrow pavements are obstructed by the introduction of additional street furniture (charging posts)
- existing power supplies are limited, and only sufficient for a limited number of chargers
- data connection can be an issue in areas of poor 3G signal strength

The trials that are being undertaken include a range of solutions, the most common of which are:

- retrofitting slim-line charging points to existing street lighting columns and making use of their existing power supplies
- laying channels between the kerbstone and the residents house, thus allowing residents to tap into their own household power supply with a flexible cable
- installing dedicated charging posts and electrical supplies into the street

Each of the above solutions has their own benefits and drawbacks, and for this reason there is a great deal of debate about the best solution for on-street charging. New technologies, such as Ubitricity's smart charging cable, are also coming to the market and these developments will move the debate on. In light of the development work that is ongoing in this area of electric vehicle charging, we would recommend that Winchester City Council first implement a number of pilot projects based upon a limited range of solutions.

The implementation of three pilot installations will enable the Council to gain a greater understanding of the technology options that are available, and how these could integrate with the existing parking bay management.

The implementation of a limited number of pilot projects will also raise resident's awareness of electric vehicles and the potential for on street charging to be installed. If some residents have expressed an interest of switching to electric vehicles, it may be preferable to work with these individuals on the pilot projects.

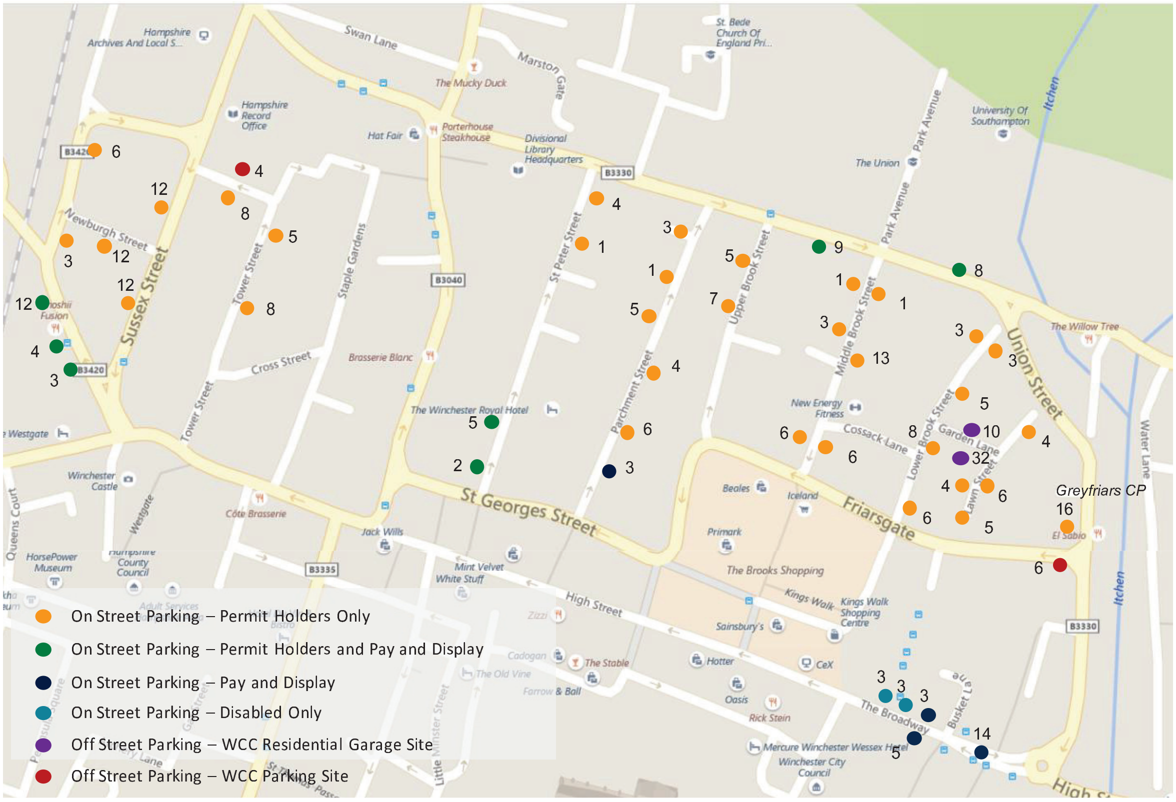
It would seem sensible that any pilot trials for on street charging are implemented within the AQMA area of the city, thus encouraging the uptake of electric vehicles in this sensitive area. Notwithstanding this, it is likely that many residents in this area may wait for the second-hand EV market to develop before purchasing an electric vehicle.

In an attempt to determine the near-term (five-year) requirement for on street charging within the AQMA area, we have surveyed and counted all of the parking bays within the AQMA. In total we identified 366 on street parking bays, of which 86 were on feeder roads within the AQMA, and the balance were in the city centre. The maps below show the location and number of parking bays in the city centre and on the feeder roads.

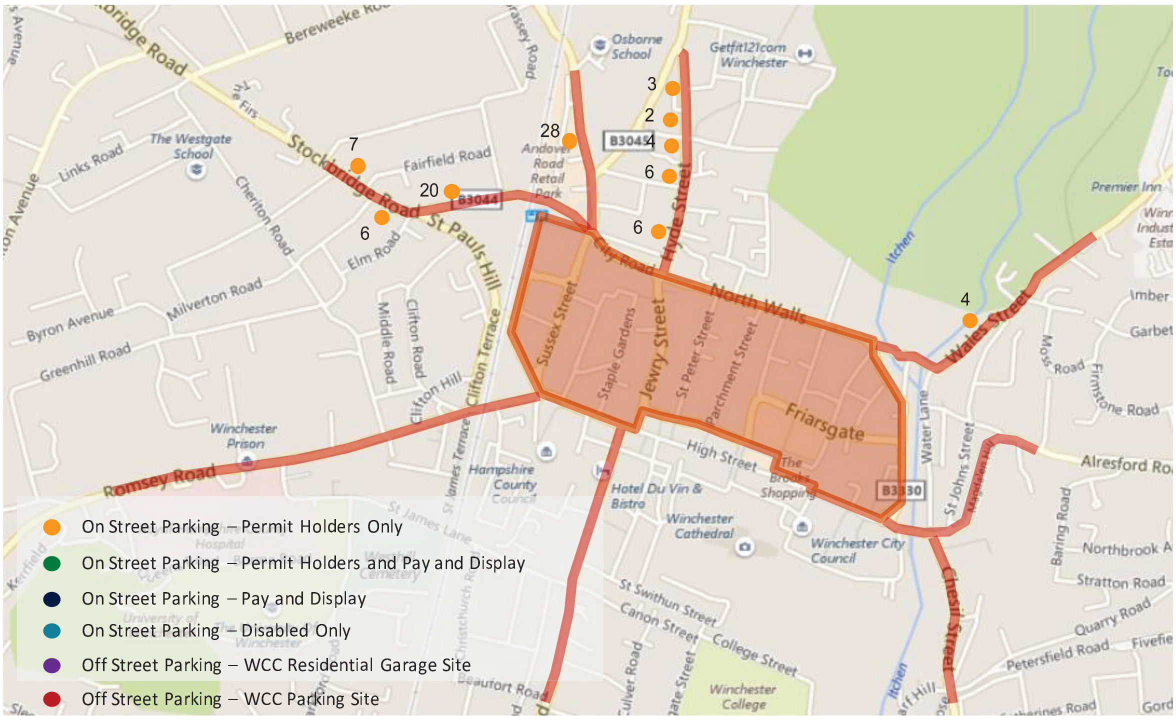
During our surveys we found that 98% of the parking bays were in use during two daytime surveys. If we assume that 11.1% of the 358 vehicles parked within these bays will be electrified in 10 years time, then chargers will be required for 40 vehicles. In practice the true number of chargers required will depend upon the solution adopted. If EV drivers have priority access to charging bays, then the number of chargers will be limited to a little over 40 in ten years. However, if EV charging bays are *'blocked'* by conventional vehicles, then additional charging points will be required.

The majority of EV home charging uses a 3kW trickle charger, often charging the vehicle overnight. This means that unlike car park chargers, many residential on-street chargers do not serve a large number of EV users. Indeed, some solutions are dedicated to one EV user. This lack of 'diversity' means that the number of EV chargers per EV is much higher in residential charging than in public car parks.

The addition of on-street charging infrastructure will need to be undertaken in partnership with (or by) Hampshire County Council, as the works will be on their estate. We would suggest that Winchester City Council and Hampshire County Council meet at an early stage to explore the possibility of working together on the pilot projects.



Above – On street parking bays in the Winchester AQMA area (numbers refer to number of parking bays)



Above – On street parking bays in the Winchester AQMA feeders (numbers refer to number of parking bays)

5. Infrastructure Technology

In addition to identifying the correct number of chargers and their location, it is important to make the right decisions regarding technology. EV charger technology is rapidly evolving, and there are a wide range of options available in the marketplace. We have evaluated Winchester City Council's requirements, and have made technology recommendations in sections 5.1 to 5.3 below. Our technology recommendations are of a general nature, and we have not made any comments regarding particular manufacturers or suppliers.

5.1 Charger Power Ratings

The speed at which an electric vehicle charges depends on a wide range of factors. Some of the most important variables are as follows:

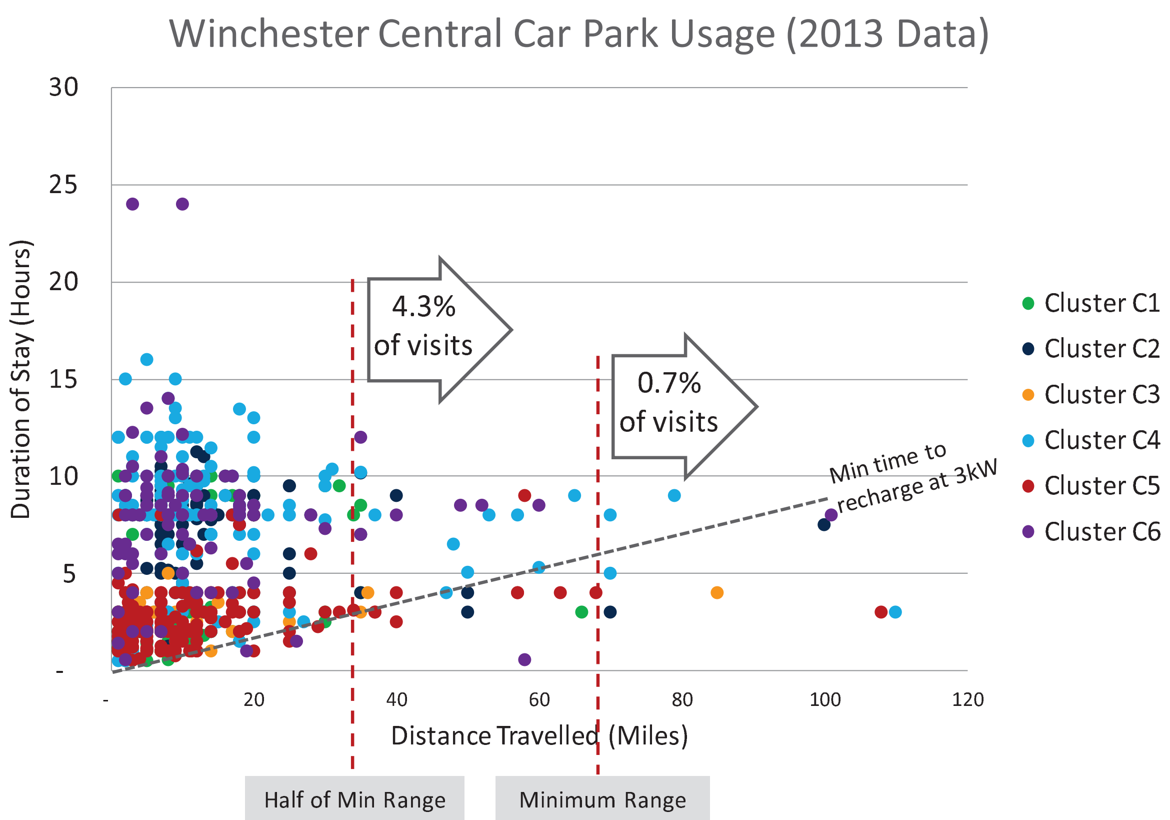
- Charging Post Rating: The power capacity of the charging post or outlet which is being used has a big impact on the rate of charge. These range from slow 3 kW residential chargers which will normally provide a charge overnight, through to rapid chargers which can provide an 80% recharge in 30 to 40 min.
- Vehicle Rectifier Capacity: When charging with A/C power (often used for slow and fast chargers), the vehicle's on-board rectifier has to convert this supply to DC power which can be used to charge the battery. In those instances where the vehicle rectifier has a lower kilowatt rating than the charging post, charging will be limited to the capacity of the rectifier. It does not necessarily follow that a larger capacity charging point results in faster charging for A/C supplied chargers.
- State of Charge: Electric vehicles generally charge as fast as possible whilst ensuring that the battery cells do not overheat. However, with many battery management systems the rate of charging is slowed down significantly once the battery is c80% charged. It therefore follows that a vehicle that is plugged in to a charger when it has a 75% starting charge is likely to receive insignificant amounts of power during the charging session. If the vehicle has left home with a full charge that has been received overnight, then there is little point in trying to recharge the battery after a 10 mile journey to the town centre.

The above factors, together with future likely developments in battery technology, need to be considered when selecting charger power ratings.

The size of charger required will also depend on the user's requirements. For example, a London commuter parking at Worthy Lane car park will typically leave their car on-charge for eight hours a day. In contrast, a visitor to the new leisure centre may only stay for one hour. Obviously the distance travelled also has a significant bearing on the need for charging. In order to understand the travel distance and duration of stay at each of the car parks, we have analysed the raw data produced from the 2013 Winchester car parking survey. The table below summarises the results of this analysis, and shows that the mean distance travelled by many car park visitors is well within the range of the most basic electric vehicles (assuming that they leave home with a full charge). The mean duration of stay in the car parks varies considerably, ranging from 2.4 hours in The Brooks shopping centre, to 9.6 hours at Gladstone Street.

Group	Car Park	No Surveyed	Total Distance (Miles)	Total Stay (Hours)	Mean Distance (Miles)	Mean Stay (Hours)	Usage
C1	C1 St Peters	30	308	106	10.3	3.5	Short Term
	C1 River Park	53	339	137	6.4	2.6	Short Term
	C1 Durngate	19	329	109	17.3	5.7	Long Term
C2	C2 Chesil Street	107	1,520	797	14.2	7.5	Long Term
C3	C3 Colebrook Street	26	354	75	13.6	2.9	Short Term
C4	C4 Jewrey Street	31	296	83	9.5	2.7	Short Term
	C4 Tower Street	110	1,913	838	17.4	7.6	Long Term
	C4 Gladstone Street	36	284	344	7.9	9.6	Long Term
C5	C5 Middle Brook Street	27	255	72	9.4	2.7	Short Term
	C5 The Brooks Shopping Centre	53	416	129	7.8	2.4	Short Term
	C5 Upper Brook Street	21	264	68	12.6	3.2	Short Term
	C5 Cossack Lane	17	130	51	7.6	3.0	Short Term
	C5 Friarsgate	40	822	116	20.6	2.9	Short Term
C6	C6 Worthy Lane	45	719	354	16.0	7.9	Long Term
	C6 Cattle Market	39	424	318	10.9	8.2	Long Term
	C6 Coach Park	8	89	49	11.1	6.1	Long Term
P&R	P&R East Barfield	76	924	661	12.2	8.7	Long Term
	P&R East - St Catherines	116	1,692	837	14.6	7.2	Long Term
	P&R South	191	2,506	1,393	13.1	7.3	Long Term
		1,045	**13,584**	**6,537**	**13**	**6**	

When the data for travel distances and parking duration are combined (see graph below), we can determine the charger capacity that is suited for the various car parks.



The charger ratings that we are recommending are as follows;

City Car Parks: This analysis shown in the chart above, and shows that 7kW chargers should be sufficient to meet the needs of all Winchester city car parks.

Rural Town Car Parks: For the purposes of this study, we have assumed that 7kW chargers would also be sufficient to meet the needs of users within the rural town car parks. Unlike Winchester City centre car parks, we do not have car park survey data for the rural towns (such as Bishops Waltham) and we are thus unable to calculate the distances travelled and parking durations. It is possible that the duration of stay is shorter at these locations as the towns do not have as many retail outlets and dining venues. It is also possible that the journey distances are also slightly longer, thus reflecting the rural nature of the district. Whilst we feel that 7kW chargers should be sufficient in rural towns, the Council may wish to give consideration to installing 11kW chargers in the rural locations. 11kW chargers can add about 40 miles of range in one hour, compared to 7kW chargers which can add about 25 miles in the same period.

Bar End Leisure Centre: We anticipate that the duration of visits to the new Bar End leisure centre will be relatively short, and we would therefore recommend that 20kW chargers are considered as part of the new leisure centre design.

On Street Parking: On street parking within the AQMA is largely limited to residents, and it is likely that vehicles will be parked overnight in these areas. For this reason we would recommend that the on-street charger trials make use of 3kW slow chargers. These smaller chargers may also allow the use of electrical supplies that may feed the existing lighting columns.

Taxi Charging: We would recommend that the taxi charging infrastructure makes use of rapid chargers, which are typically rated between 45 and 50kW. These chargers will, subject to battery size, typically provide an 80% charge in 30 to 40 minutes. This faster charging time will encourage the use of electric vehicles by taxi operators and will enable drivers to charge was taking a break. The faster charging rates also increases the utilisation of any charging point, thus reducing the number of charge points required.

The proposed charger ratings for each site and application are included at Annex C to this report. We have also included examples of slow, fast and rapid charger points in the images below.

Example of Ovo energy / Ubitricity 3kW lamp post mounted residential slow charger

Example of Pod Point 7kW car park fast charger

Example of Pod Point 50kW Ecotricity rapid charger

5.2 Plug Technology

A wide variety of electric vehicle plug technologies are currently in use. This variation in design has been driven by a wide range of factors. Two power supply options exist for charging vehicles, and these are:

Alternating current (AC): using single phase 220 V supplies or three-phase 400 V supplies and the following connector types

- UK 3-pin (BS 1363)
- Industrial Commando (IEC 60309)
- American Type 1 (SAE J1772)
- European Type 2 (Mennekes, IEC 62196)

Direct current (DC): faster chargers typically use DC power and use the following connector types

- Japanese JEVS (CHAdeMO)
- European Combined Charging System (CCS or 'Combo')
- Tesla's proprietary supercharger connector

The range of AC connectors is shown in the image below. With the exception of the rapid chargers used for taxis, we would recommend that all charging infrastructure makes use of the European Type 2 (Mennekes, IEC 62196) connector. This type of connector is rapidly becoming a universal standard across the UK, and it is highly likely that most EV drivers (including Tesla drivers) will carry a Type 2 cable and connector in their vehicle.

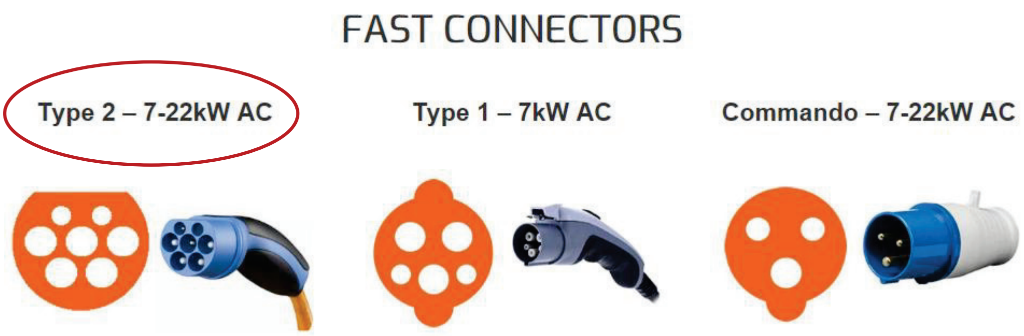
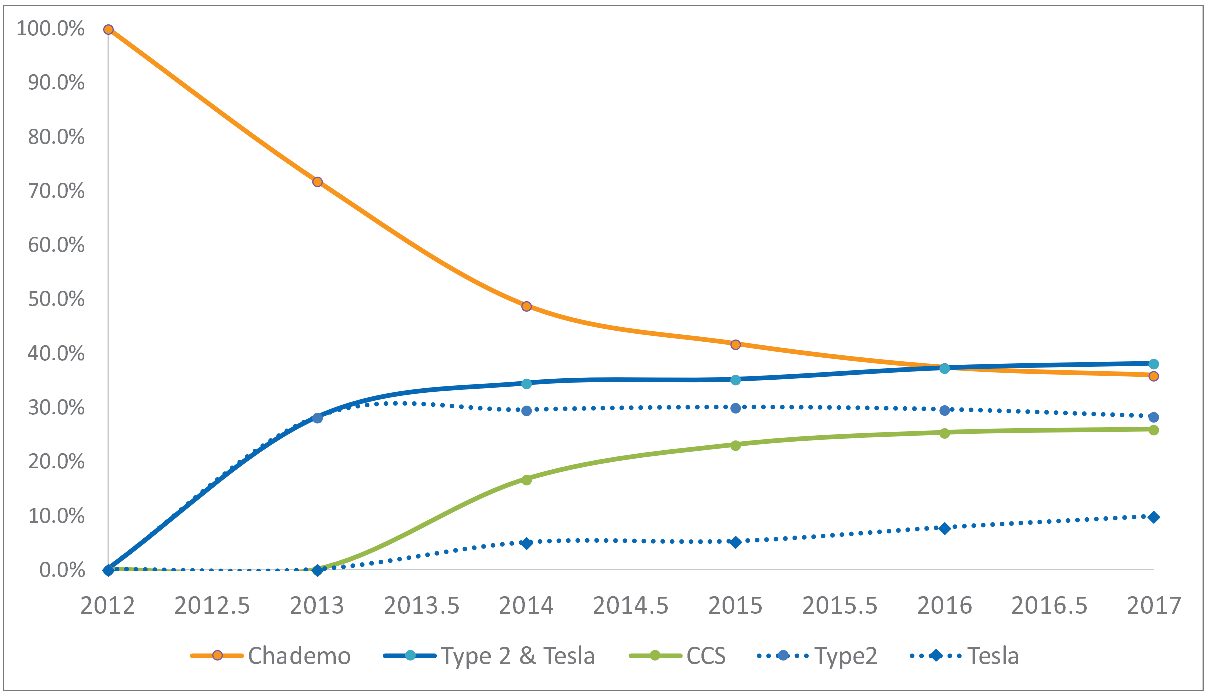


Image Credit – Zap Map 2018

The situation regarding DC charger standards is still evolving, and for this reason many rapid DC chargers include three tethered outlets on each charging post. The evolution of rapid charger connectors is shown in the graph below:



In order to ensure that the rapid chargers can be used by any vehicle, we would recommend that each rapid charger is fitted with the following tethered connectors:

- Japanese JEVS (CHAdeMO)
- European Combined Charging System (CCS or 'Combo')
- European Type 2 (Mennekes, IEC 62196)

The configuration of these three connectors is shown in the image below.

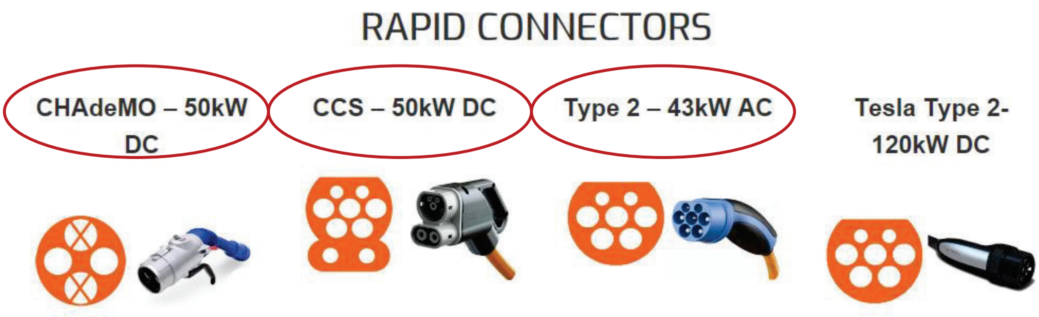


Image Credit – Zap Map 2018

5.3 Software Protocols

Apart from the most basic units, many public chargers incorporate sophisticated electronics and software systems required to manage charge point access, user billing, utilisation statistics and charge point status. These smart charge points communicate with a central management system (a server) via the use of the General Packet Radio Service (GPRS), and share their data in real-time or near real time. The data transmitted to the central server is encoded using a protocol which can be decoded by the server. We would recommend that Winchester City Council only procure charge points which use the Open Charge Point Protocol (OCPP). This common protocol allows data exchange between different charge point manufacturers and different charge point operator's management systems. Adopting the OCPP protocol will ensure that;

- the Council have the freedom to install charging points from different manufacturers in the future (provided they utilise OCPP)
- have the freedom to appoint a different charge point manager in the future (most of whom utilise OCPP)
- the Council are not held captive to one supplier who utilise a closed protocol which is inaccessible to other suppliers

In addition to the points above, OLEV will often specify that any systems receiving grant funding must utilise the OCPP protocol.

6. Mid to Long Term Infrastructure Requirements

As per the Council's request, our study has focused on the near-term requirement for charging infrastructure; the five-year period ending 2023. As a result of the short time horizon adopted, our infrastructure recommendations are modest and reflect the fact that electric vehicles are at the very bottom of their growth curve. However, as the transition to electric vehicles gains momentum, the UK will need to install significant amounts of charging infrastructure. There are almost 68,000 cars registered in Winchester district, many of which may require access to charging (or hydrogen) in the low carbon future.

Based upon current behaviours and battery technologies, it is widely anticipated that the majority of EV charging will occur at home. Many homes with off-street parking can install their own charging facilities, and this is currently supported by Government grants. It will however be important for the City Council to address the long-term requirement for on-street charging in areas such as Hyde and the AQMA. For example, if all parking bays within the AQMA alone were occupied with electric cars in 30 years time, some 358 vehicles would need access to charging. The inclusion of areas such as Hyde would add hundreds or thousands of vehicles to this requirement.

Despite current trends, we cannot be certain that emerging technologies such as affordable superfast charging, battery change-out schemes or hydrogen fuels will become a reality. In light of the uncertain future, we would recommend that the City Council take a measured approach as it rolls out charging infrastructure in the coming decades. A critical underpinning of this approach is the acquisition of usage data to inform future policy and investment. In support of this approach, we would strongly recommend that all charging infrastructure has the ability to provide utilisation data, which can be reviewed on an annual basis by the Council. This data will allow the council to identify user demand, and to ensure that investment decisions are in line with growing user demand. Such a measured approach will also ensure that the council does not invest ahead of the technology development curve, and avoids the risk of holding redundant or out of date charging assets.

7. Power Supply and Grid Constraints

At this moment in time we do not anticipate that there will be significant problems with meeting the power demands for the recommended car park charger installs. The number of chargers required is modest, and the use of 7kW and 11kW chargers increases the probability that current supply infrastructure can be utilised to some extent.

The higher power ratings used for rapid charging of taxis may however presents some challenges, as each charger typically draws up to 50 kW from the grid. Through working with the DNO at the design stage, we would hope that the cost of connections for rapid chargers can be minimised by careful siting of the chargers. For example, the provisional location of the charger in the Coach Park Car Park, is adjacent to an existing SSE substation and feeder pillar.

We have provided details of the existing SSE LV electrical supplies for each charger site in Annex G to this report. The locations identified in Annex G are indicative only, and the next stage in the scheme development would involve a survey of all potential charger sites in order to identify likely connection points and capacity constraints. Once this a detailed work has been undertaken, applications can be made to the DNO for a connection. Once they have received the formal connection applications, the DNO will be able to advise regarding existing circuit capacities and the associated costs for the connection works. This will in turn allow charging point suppliers to firm up their costs for installation.

8. Capital and O&M Cost Estimates

Whilst it is not clear whether the Council will invest in the electrical charging infrastructure, or whether you will seek a commercial investor, we have endeavoured to estimate the likely level of capital required to implement our recommendation. We would estimate that the capital cost (net of VAT) should be budgeted at £250,000, and this would break down as follows:

Item	Budget £
2 x 50kW Rapid Chargers for Taxis	£60,000
50 x 7/11kW Fast Chargers for Car Parks	£159,000
3 x 3kW Pilot On Street Slow Chargers	£6,000
Capital Works	**£225,000**
Design and Project Management	£25,000
TOTAL (Net of VAT)	**£250,000**

As part of our work, we have provided informal supplier estimates to the Council, and these incorporate estimated back-office costs and maintenance costs. Whilst these estimates are subject to survey and detailed design, we have omitted them from this report in order to maintain commercial confidences. At this time, it may be prudent for the Council to budget circa £10,000 per annum to cover such O&M costs. It may also be prudent to allow for some additional staff time to manage the scheme, depending upon the extent that the Council elect to use external consultants, installers and back office providers.

Many options exist to finance the cost of any installation, and we have provided some suggestions regarding funding options in section 9 of our report.

9. Funding Options

Several options exist for the Council to finance the installation of electric vehicle charging infrastructure. To a large extent, the choice of funding strategy will depend upon the amount of control that the council wish to have over their own EV charging strategy, and this is explained further below.

9.1 Council Funds

The use of the Council's own funds will allow you to retain control of your EV charging strategy. In contrast to a commercial investor, this approach will allow the Council to invest in charging infrastructure for reasons that extend beyond return on investment. Some local authorities have taken this approach as it allows them to demonstrate their support for EV drivers, whilst being seen to tackle air quality issues. An investment approach which is not based on profit may also allow the Council to provide charging infrastructure in those locations which may not make sense for a commercial investor.

If the council decides to invest its own money in EV charging infrastructure, this investment could be treated as a sunk cost, or could be recovered as part of the charging methodology. If the latter approach is taken, the Council should expect very low asset utilisation in the early years whilst EV usage increases. As an example, one 2017 study by the RAC of a large charger rollout (1,133 charge points with 2,089 sockets) identified that 22.5% of the charge points were not used once in the month examined. On average the charge points used 288 kWh of electricity per month, which is £28 worth of electricity a month at an assumed charge of 10p per kWh. If low utilisation continued for a long period, then payback periods will also be very long. However, the study also identified a 43% year-on-year growth in charging sessions.

9.2 Grant Funding

Grant funding is also available for electric vehicle charging infrastructure via several schemes.

On-street Residential Charge Point Scheme

This grant funding is provided by the Office for Low Emissions Vehicles (OLEV) and is administered by the Energy Saving Trust (EST), who process the grant applications. OLEV have set aside £2M and £2.5M in grant funding for the years 2018/19 and 2019/20 respectively. The grant funding can be used to finance up to 75% of the capital cost of on-street charging infrastructure. Applications can be made for up to £100,000 per bid, with a maximum allowance of £7,500 per charge point. OLEV place limitations on the type of technology that can be installed and in particular they are limiting the installed chargers to 22 kW per charge point and have specified that Type II connectors must be used. We believe that Winchester City Council could use the above funding mechanism to install several on-street pilot projects and, subject to a successful trial outcome, further charge points could be installed whilst funding is available in 2019/20.

This funding allowance has previously been undersubscribed, and it may well be in the City Council's interest to investigate the use of this mechanism.

Workplace Charging Scheme

Whilst not relevant to the scope of our study, the workplace charging scheme contributes up to £300 per socket installed on company sites. The fund is limited to 20 sockets per applicant, and all costs above the grant allowance must be met by the applicant. Charging infrastructure installed must be dedicated to employee parking, and the fund is open to businesses, charities and the public sector. The scheme can only be used for the installation of 3 kW slow chargers, which are generally suitable for employee vehicles which are parked up for long periods of time. The payment of the grant is via a voucher scheme, whereby a voucher is issued to a registered installer who receives the funding on behalf of the customer. Once vouchers have been issued by OLEV, they have to be used within 120 days.

EV Home Charging Scheme

The EV home charging scheme is also outside of the scope of our study, however we have included it here for completeness. This scheme is available to homeowners who can demonstrate that they have purchased an electric car. The scheme contributes up to 75% of the cost of installing a home charger, with a maximum contribution of £500. As with the workplace charging scheme, the EV home charging scheme uses registered installers who claim the funding directly from the government on behalf of the home owner.

9.3 Commercial Investors

The choice of funding solution may have some impact upon the roll out plans that the Council adopt. If the entire infrastructure installation is funded by the Council, you will of course have the freedom to install exactly what you want and where you want it. However, if the council chooses to work with a commercial investor, it is likely that they will understandably take a view on which charge points are likely to be commercially viable. If a commercial investor is carrying the risk, then they may elect to install a limited number of chargers in those locations where they can be confident of receiving a return on their investment. The commercial investor will also have a view on which manufacturer’s equipment is used, how it is serviced and what back-office systems are used. In particular, they will want to choose equipment the balances capital cost with reliability, and will also want to appoint a proven maintenance company that will protect their capital investment.

If the council are willing to cede some elements of control to a commercial investor, there are a large number of suppliers which will be willing to work with the Council to finance elements of the project and deliver the ongoing management. Each supplier has their own commercial model, and we have given some examples of pricing that we have obtained as part of our study. We have not included the names of suppliers in order to maintain supplier confidentiality.

Supplier A – Pay as you go model

- Capital Cost — Winchester City Council
- Electricity Costs — Vehicle Owner @ Cost
- Transaction Fee — 5% of Electricity Cost
- Back Office Data — £125 for 3 Years / Charge Point

Supplier B – Pay as you go model.

- Capital Cost — Supplier invests
- Electricity Cost — Vehicle User @ Cost
- Connection Cost — £1.20 / Connection

Supplier B – Hourly charge model

- Capital Cost — Supplier invests
- Electricity Cost — Vehicle User @ £1.50 / Hour
- Connection Cost — £1.20 / Connection

The commercial offer for Supplier A, above, assumes that Winchester City Council will invest the capital required to install the charging infrastructure. This approach leaves the Council in control of their charge point strategy, whilst procuring a management service from their supply partner.

In contrast, the offer from Supplier B, above, assumes that the supplier will invest capital into the project, and will then recover their investment through user charges (either for electricity or for time on charge).

If using a commercial investor to install and operate the infrastructure, the Council should ensure that the supply agreement is clear regarding the 'end of contract' arrangements. The Council may elect for the supplier to remove and reinstate, or may state that the equipment is transferred to the Council's ownership at the end of the supplier contract. If the equipment is being transferred, this can be achieved via number of mechanisms which may involve an option and small payment at the contract end, a lease arrangement or simple transfer of the assets. It is important that balance sheet impacts are considered prior to the arrangement being finalised.

10. Supply Chain Options

Several options exist for the delivery of the charging infrastructure, and these are as follows;

Hampshire County Council (HCC) Framework Agreement. HCC previously published a tender invitation in OJEU in order to appoint a framework supplier for Hampshire County and the surrounding areas. During the tender process, suppliers were asked to price a number of installation scenarios, and based upon the tenders returned, HCC awarded the contract to JoJu Limited. The HCC contract is a flexible framework that allows projects to be costed by reference to the scenarios that were included in the tender document. The agreement allows customers to purchase their own charging infrastructure, or to explore financed solutions.

The HCC framework is available for use by all public sector departments, and it is the County Council's hope that the use of the one framework supplier will deliver a consistent approach across the region. If this aspiration is realised, the users of charge points would have access to one payment mechanism and would become familiar with the installed equipment base. Notwithstanding this fact, the framework does allow the customer freedom to specify which equipment they would prefer.

East Shire's Purchasing Framework (ESPO). Whilst initially for use by local authorities served by ESPO – being a Central Purchasing Body as defined by the Public Contracts Regulations 2015, the framework may also be open for use by any "public body", defined in the Local Authorities (Goods and Services) Act 1970 that also falls within one of the following classifications of user throughout all administrative regions of the UK:

- Local Authorities, and certain
- Central Government Agencies and Ministries
- NHS and Emergency (Blue Light) Services
- Schools, Academies, Colleges and Universities
- Registered Charities
- Registered Social Landlords

The suppliers on the ESPO framework are as follows:

- BMM Energy Solutions Ltd,
- Charge Your Car Ltd,
- Chargemaster PLC,
- E.ON Energy Solutions Ltd,
- Flexisolar Ltd,
- Joju Solar (+ Juuce Ltd),
- Phoenix Renewables Ltd – T/A The Phoenix Works,
- POD Point Ltd,
- Siemens Intelligent Traffic Systems,
- Smart Parking Ltd,
- SSE Enterprise Contracting Ltd,
- Swarco UK Ltd,
- The New Motion (+ Actemium)

In addition to using the two existing frameworks above, the City Council of course have the option to specify and procure their own equipment, and this could be achieved via a competitive tender, or through a negotiated agreement with an investment partner.

11. Near Term Emissions and Air Quality Impact

As part of our study we have given consideration to the near-term air quality impacts of electric cars in the city of Winchester. Our near term analysis suggests that c1% to 2% of cars within Hampshire may be battery electric in 5 years time. The WCC 2017 Air Quality Action Plan indicates that a road NOx reduction of c40% may be required in order to meet acceptable targets (see extracted table from that report below).

Site ID (Name)	Monitored annual mean NO2 (µg/m3)	Calculated road NOx (µg/m3)	Reduction in NO_2 to meet objective µg/m3 (and %)	Reduction in road NOx to meet objective µg/m3 (and %)
Site 8 (St Georges St TC)	50.2	68.0	10.2 (20%)	25.4 (37%)
Site 9 (St Georges St LAD)	52.6	74.4	12.6 (24%)	31.8 (43%)
Site 24 (Romsey Rd)	48.8	64.3	8.8 (18%)	21.8 (34%)
XDT8 (Romsey Rd Pump House)	53.2	76.0	13.2 (25%)	33.4 (44%)
XDT8 (Toy Cupboard)	50.8	69.6	10.8 (21%)	27.0 (39%)

Whilst the medium to long term electrification of cars will have a dramatic impact on air quality in the AQMA, the near term (5 year) impact will be negligible, and should not be relied upon to address near term air quality concerns.

A 2014 WCC NOx apportionment study found that 10% to 20% of NOX was attributable to buses in three streets studied in Winchester. In light of this, we would propose that the Council gives consideration to the electrification of the bus fleet within Winchester city. The electrification of busses could make an improvement to air quality, and the remaining term of the current bus supply contract could be used to investigate the economics and technical issues associated with electric busses and the high power charging infrastructure. Such investigation could be supplemented by Officer and Councillor visits to other Cities (such as Nottingham) which have adopted electric busses in order to improve air quality. This advanced investigation could then be used to inform the specification and procurement strategy well in advance of renewing the bus contracts.

12. Electricity Charges

At the present moment in time Winchester City Council provide electricity free of charge to the users of the eight Rolec chargers located in the city centre car parks. Users of the two charging points at the South Winchester Park-and-Ride facility pay for electricity use.

The continued provision of free electricity at many sites will no doubt encourage the use of any charging infrastructure installed; if something is free people will tend to use it. Conversely, if the council were to adopt a policy which charges for electricity use, it may discourage the use of charging points, and encourage EV drivers to charge at home. In this connection, the electricity charging policy will have an impact on the number of chargers required.

There is some evidence that the provision of free electricity and free parking for EV users has proved unsustainable for some operators. Ecotricity ceased providing free electricity via its network of rapid chargers, and this was resulted from concerns over the increasing costs of electricity supply. Newcastle City Council also reversed their free EV parking and electricity charging policy due to problems with the sustainability of their earlier policy. As a result, it was reported that some residents who had purchased an EV felt that they may not have done so if they knew the policy was to be changed. Both of the above policy changes received a lot of media coverage.

For the above reasons, it is important for Local Authorities to strike the balance between policies which support EV take-up, whilst also ensuring the policy remains financially viable in the long term, i.e. when EV penetration will be substantial or one hundred percent.

At this moment in time we have assumed that the Council will charge for electricity use as part of a sustainable long term policy, at that such charges will be based upon the following rates:

> Public Car Parks (including park-and-ride) - electricity to be charged at the nominal domestic rate (or similar) that people pay in their homes.
>
> Taxi Charging Infrastructure - electricity to be charged at cost, plus an additional sum to cover equipment depreciation, back-office operations, equipment maintenance and supplier profit.
>
> On Street Parking - electricity charges will depend upon the technology adopted, and who pays the capital cost of the charger installation.

Based upon the above assumptions, we have assumed that electricity for the car parks would be charged at 16.7p per kilowatt hour consumed. This figure is based upon the July 2018 figures for domestic electricity supply on a direct debit contract. This charging policy would allow people to use the car park charging infrastructure without suffering any financial loss when compared to charging at home, albeit WCC may wish to include an administration and maintenance charge in the unit rate charged.

We have anticipated that the taxi charging infrastructure will be installed by a commercial operator, and electricity charges would be set by that operator in conjunction with the Council. According to a recent study undertaken by Zap Map, the typical cost of using a rapid charger is in the region of 25p to 35p per kilowatt hour. Based upon a charging period of 35 min and a 50 kW charger, this would mean that a typical taxi may pay c£7.29 to £10.21 per charge. A breakdown 2018 charging costs as reported by Zap Map, is shown in the table below.

	ecotricity	engenie	Genie Point	INSTAVOLT	POLAR	Shell Recharge
Cost	30p/kWh	36p/kWh	30p/kWh + £1 conn fee	35p/kWh	£6/30mins	25p/kWh
Access	Pay-as-you-go app access	Contactless card access	Pay-as-you-go app access	Contactless card access	Pay-as-you-go app access	Pay-as-you-go app access
Notes	15p/kWh for Ecotricity energy customers	Currently on free vend	£1.80 connection fee inside M25	Currently on free vend CCS & CHAdeMO only	Polar Plus members - 10.8p/kWh + membership fee	49/kWh from June 30th

The council will need to give consideration to it's charging policy, and the impact that this will have on user behaviours. If the council wish to continue with its provision of free electricity, we would recommend that the future liability is costed in advance of confirming such a policy. Whilst we cannot predict future energy prices and how extensively chargers will be utilised, we have provided some basic calculations below which may be of some assistance.

The table below shows the annual cost of electricity for operating the circa 50 x 7kW fast car park chargers and 2 x 50kW rapid chargers recommended in this report. Obviously the annual cost will depend upon a range of factors, and we have shown our assumptions at the top of the table. The bottom half of the table shows the annual electricity cost, and how this varies depending upon the utilisation of each charge point.

	7kW Fast Charger City Car Parks	50 KW Rapid Charger Taxi Charging
Number of Chargers	50	2
Assumed Charge Session Duration	2.5 Hours	35 Minutes
Days Used Per Week	6	5
Weeks Used Per Year	51	51
Unit Electricity Cost Per kWh	11p	11p

7kW: Charge Sessions Per Day[1]	7kW: Annual Electricity Cost	50 KW: Charge Sessions Per Day[1]	50 KW: Annual Electricity Cost
0.1	£2,945	1	£1,627
0.25	£7,363	2	£3,254
0.5	£14,726	3	£4,881
0.75	£22,089	4	£6,508
1	£29,453	5	£8,135
2	£58,905	6	£9,761
3	£88,358	7	£11,388
4	£117,810	8	£13,015
		9	£14,642
		10	£16,269
		11	£17,896
		12	£19,523

Note 1 - Utilisation Measured as Charge Sessions Per Day Per Charger Installed

We anticipate that the electricity costs in the early stages of the programme rollout will be very modest, and this is a reflection of the small number of electric vehicles currently on the road. However, as the table above illustrates, the electricity costs can rapidly escalate as charger utilisation increases over time.

Consideration also needs to be given to the impact of electricity purchases on the Councils own carbon footprint. Whilst the carbon intensity of grid supplied electricity is falling, the current carbon intensity of grid supplied electricity is 351g CO_2e per kWh consumed. Fully charging a 40kWh Nissan Leaf battery would result in carbon emissions of 14kg of CO_2e. Put another way, if a Nissan Leaf was fully charged 71 times, it would produce one tonne of CO_2e emissions.

Obviously the carbon footprint associated with vehicle charging will vary greatly, depending upon the number of vehicles charging, the duration of charge, frequency of charging and battery state at connection. It is therefore impossible to calculate the likely carbon footprint associated with future EV charging. However, by way of illustration, if each of the circa 50 public chargers were used every day for 2.5 hours per day every day, the resulting annual carbon footprint may be 118 tonnes.

13. Policy Considerations

Whilst we have addressed many of the technical issues regarding the rollout of the required charging infrastructure, there are a number of policy decisions which the Council now need to address. These include decisions on the following points;

- Policy 1 - the policy regarding the charges for electric vehicle parking bays, and whether these should be free of charge, at preferential rates, normal rates or a rate which incorporates electricity charges.
- Policy 2 - the policy regarding the recovery of electricity costs, and whether electricity should be provided free of charge, at a rate equal to domestic charges or at a rate which incorporates an element of cost recovery for the Council.
- Policy 3 - will the Council allow residents of the AQMA area to charge their cars on a preferential basis in city car parks, either within normal working hours or otherwise?
- Policy 4 - the policy regarding investment, and whether the rollout should be based upon the use of the council's own capital, PWLB borrowing, government grants or commercial investors.
- Policy 5 - connected to the above, is it appropriate for the Council to invest in taxi charging infrastructure which will serve commercial businesses, and if so, on what basis.
- Policy 6 - the procurement policy, and whether the council will make use of the Hampshire County Council EV Charger Framework Agreement, the ESPO Framework Agreement or a bespoke negotiated or procured agreement.
- Policy 7 - connected to the above, do the Council wish to adopt a common solution with adjacent districts. This may extend to common payment mechanisms and equipment which may become familiar to drivers moving between districts. EV drivers have historically carried a number of swipe cards and key fobs, and they Council may choose to minimise this by using a common solution to others in the region.

We recognise that many of the above policy decisions are complex, and will have consequences which go well beyond the scope of our study. Notwithstanding this, we have offered some potential solutions to policies 1 to 4 below, and this will perhaps aid discussion.

- Policy 1 - electric vehicle parking bays are charged at the same rate as all other parking bays, thus avoiding any criticism that electric vehicle drivers are being cross subsidised by other car park users.
- Policy 2 - electricity charges for car park users are recovered at a rate in line with domestic electricity charges or similar (nominally 16.7 pence in 2018), thus ensuring that neither the Council or EV drivers are economically disadvantaged by the charging policy.
- Policy 2 - electricity charges for taxi drivers using rapid chargers are based upon a commercial agreement which pays for all electricity and infrastructure costs (nominally [25p]), whilst not seeking excessive profits from taxi drivers who make the switch to electric vehicles. This approach will avoid criticism of the Council subsidising taxi operators, whilst also ensuring that the required infrastructure is provided at a fair cost.

- Policy 3 - domestic residents within the AQMA area are allowed the overnight use of car park charging infrastructure, which would be charged at domestic electricity rates under policy item 2.
- Policy 4 - rapid chargers which serve the business community are funded by a commercial partner, which recover their investment from taxi operators which use the charging points.
- Policy 4 – 70% of on-street charging infrastructure trials are paid for via grant funding which is currently available from OLEV, and the remaining balance is funded by the City Council.
- Policy 4 - the Council investigate self financed and commercially financed installation of car park chargers, to discover what costs the Council and users may carry under each scenario.

Annex A

National Grid – 2017 Future Energy Scenarios

The National Grid Future Energy Scenarios (2017) as mentioned in report section 3.2 are as follows.

Two Degrees has the highest level of prosperity. Increased investment ensures the delivery of high levels of low carbon energy. Consumers make conscious choices to be greener and can afford technology to support it. With highly effective policy interventions in place, this is the only scenario where all UK carbon reduction targets are achieved.

In Slow Progression low economic growth and affordability compete with the desire to become greener and decrease carbon emissions. With limited money available, the focus is on cost efficient longer-term environmental policies. Effective policy intervention leads to a mixture of renewable and low carbon technologies and high levels of distributed generation.

In Steady State business as usual prevails and the focus is on ensuring security of supply at a low cost for consumers. This is the least affluent of the scenarios and the least green. There is little money or appetite for investing in long-term low carbon technologies.

In a Consumer Power world there is high economic growth and more money available to spend. Consumers have little inclination to become environmentally friendly. Their behaviour and appetite for the latest gadgets is what drives innovation and technological advancements. Market-led investments mean spending is focused on sources of smaller generation that produce short- to medium-term financial returns.

Annex B

Winchester City Council Operated Car Parks

Annex C

Proposed Charge Point Infrastructure Details

Annex D

Winchester Taxi Operator Questionnaire Results

Annex E

Electrical Infrastructure and Indicative Charge Point Locations