Regulatory Committee

2.00pm, Monday 7 January 2019

Electric Vehicle Infrastructure: Business Case – referral from the Transport and Environment Committee

Item number	8.1
Report number	
Executive/routine	
Wards	
Council Commitments	

Executive Summary

On 4 October 2018 the Transport and Environment Committee considered a report by the Executive Director of Place which set out the business case for electric vehicle infrastructure. The report was referred to the Regulatory Committee to consider how electric vehicle uptake could be better supported through the Council's regulatory regime.

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Terms of Referral

Electric Vehicle Infrastructure: Business Case – referral from the Transport and Environment Committee

1. Terms of Referral

1.1 At its meeting of 7 December 2017, the Transport and Environment Committee had agreed that a business case for electric vehicle infrastructure should be developed.

1.2 Following this meeting, the Council in partnership with Transport Scotland commissioned the Energy Savings Trust to develop the business case which was presented to the Committee for approval on 4 October 2018.

1.3 The Transport and Environment Committee agreed:

1.3.1 To note the work carried out to date.

1.3.2 To approve the Business Case for Electric Vehicle Infrastructure across the city noting the suggested medium growth scenario.

1.3.3 To note that a detailed Work Programme would be submitted to Committee within two cycles that would detail final locations, delivery, timelines and costings.

1.3.4 To note that a report detailing any proposed tariff and connection charges would be brought to the Transport and Environment Commitment for consideration and referred to Full Council for approval.

1.3.5 To approve an application for infrastructure funding to Transport Scotland for £2m for the capital works up to 2020.

1.3.6 To approve a six-week consultation period.

1.3.7 To note that a further report on E-Cargo bikes would be submitted to the next Committee meeting.

1.3.8 To note that a further report would be presented to the Committee within two cycles on the use of lampposts as charging points for electric vehicles.

1.3.9 To refer the report to the Regulatory and Planning Committees for consideration of how electric vehicle uptake could be better supported through the Council's regulatory and planning regimes.

1.3.10 To agree that officers would check the fuel costs figures in paragraphs 3.44 and 5.4 were accurate.

1.3.11 To agree that a briefing note would be circulated to members on the assumptions related to how often people were using cars and how often they would charge them.

2. For Decision/Action

2.1 The Regulatory Committee is asked to consider how electric vehicle uptake could be better supported through the Council's regulatory regime.

Background reading/external references

Transport and Environment Committee, 7 December 2017

Transport and Environment Committee, 4 October 2018

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3. Appendices

Appendix 1 – Report by the Executive Director of Place

Transport and Environment Committee

10.00am, Thursday, 4 October 2018

Electric Vehicle Infrastructure: Business Case

Item number	
Report number	
Executive/routine	Executive
Wards	All
Council Commitments	C18

Executive Summary

Following a decision by Committee to approve the development of a Business Case for Electric Vehicle infrastructure, the Council in partnership with Transport Scotland commissioned the Energy Savings Trust (EST) to develop this for Edinburgh. The EST has proposed that by 2023, Edinburgh will need to install 211 charging points at a cost of £3.3m with running costs of £0.870m and a revenue of £1.3m. The majority of these charging points will be “fast chargers” for on street residential charging although there will also be some charging facilities for taxis and at park and ride sites.

A total of 68 locations hosting multiple charging points have been identified across the city creating strategic charging hubs for users. The predicted environmental benefits include carbon savings of 7,715 tonnes and savings in Nitrogen Dioxide of over 14 tonnes.

If approved, a work programme will be developed that will detail the final list of locations, costs, timelines and all associated works including liaison with Scottish Power as the Network Provider. This will also detail the delivery model and management of the project.

A six-week consultation period is proposed with a range of stakeholders.

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Report

Electric Vehicle Infrastructure: Business Case

1. Recommendations

1.1 The Committee is asked to:

1.1.1 note the work carried out to date;

1.1.2 approve the Business Case for Electric Vehicle Infrastructure across the city noting the suggested medium growth scenario;

1.1.3 propose the tariff rate and connection charges for users;

1.1.4 note that a detailed Work Programme will be submitted to Committee within two cycles that will detail final locations, delivery, timelines and costings;

1.1.5 refer the report to Council for approval of any proposed tariff and connection charges;

1.1.6 approve an application for infrastructure funding to Transport Scotland for £2m for the capital works up to 2020;

1.1.7 approve a six-week consultation period;

1.1.8 note that a further report on E-Cargo bikes will be submitted to the next Committee; and

1.1.9 note that a further report be brought to Committee in two cycles on the use of lampposts as charging points for electric vehicles.

2. Background

2.1 The Council's Electric Vehicle Action Plan was approved at Transport and Environment Committee on 7 December 2017. This Plan set out the Council's approach to the development of Electric Vehicles (EVs[1]) with one of the key tasks being the development of a Business Case to identify the anticipated growth in EVs across the city. Currently Edinburgh has just over 700 registered EVs and 40 publicly accessible charge points.

2.2 In partnership with Transport Scotland, the Energy Savings Trust (EST) was commissioned to develop the Business Case. The development of EVs is seen as a contributor to the sustainable transport objectives of the Council which is to

[1] The term 'EV' is used throughout this report to include all types of plug in vehicles.

encourage cleaner vehicles. The key objectives remain as modal shift to more public transport and the promotion of active travel solutions.

2.3 The consultants worked over a period of eight months with service areas of the Council and a number of external partners to produce the Business Case which cost £0.050m split equally between the Council and Transport Scotland. It was agreed that the Business Case once completed would be presented to Committee.

2.4 This report details the Business Case and recommended next steps.

3. Main report

Aims of the Business Case

3.1 The profile of EVs is growing and becoming an important element of UK and Scottish Government climate change and transport policies. The Scottish Government has indicated a major expansion across Scotland of this infrastructure by 2022 coupled with a phasing out of all new fossil fuel engines by 2032.

3.2 Many cities are now embarking on programmes to develop EVs infrastructure including London, Manchester and Dundee. In Europe one of the leading cities is Amsterdam which has a major network of charging points. A key issue for the city now is the development of smart charging networks. In the future Amsterdam's EV drivers will be able to choose to charge their vehicle with affordable, 100% sustainable energy without overloading the electricity network. With temporary storage of energy ensuring more efficient use of solar energy, smart charging will become a significant factor in this agenda going forward.

3.3 The statistics are supporting the growth of EVs in the city and the fact that over 23% of all licensed EVs in Scotland are in the Edinburgh city region means that there is a need to establish additional charge points to support the demand. This also needs to be supported by providing information to potential buyers and users of EVs to encourage uptake.

Aims of the Business Case

3.4 The EST was commissioned to look at two distinct timelines for Edinburgh namely 2020 and 2023, setting out:

- a baseline study in terms of EV numbers and charging infrastructure;
- the merits of the current zonal approach as outlined in the EV Action Plan;
- the infrastructure demand in the city across different vehicle categories;
- maps of charge point locations and charger types;
- a detailed financial assessment of the capital investment required to develop a network of charging hubs;
- the revenue generating opportunities; and
- the predicted reductions in carbon and pollutant emissions (NO_2).

3.5 The aim of the study was to create an investment grade Business Case that would enable the Council to accelerate the growth of EV charging in the city, responding to both the market and the increasing number of residents and business requests for charging infrastructure. Another key aim is to develop a plan for EVs that can help dissuade drivers from having to bring their vehicles into the city centre.

3.6 The study carried out by the EST is the first of its kind for a local authority in Scotland and due to the strategic approach taken, puts Edinburgh at the forefront of EV work in Scotland, if not the UK. Transport Scotland has been very complementary about the Edinburgh study and is now looking to replicate this approach across other Scottish councils.

3.7 Appendix 1 details the Business Case for the development of EV infrastructure in Edinburgh.

Methodology

3.8 Forecasts in the growth of EVs have been made to 2020 and 2023 as the consultants have indicated that forecasting any sooner than 2020 would be of limited use as realistically there would not be enough time to take action. Forecasting any later than 2023 would be unreliable. Essentially, 2020 is seen as a phase 1 and 2023 as a phase 2.

3.9 The Consultants worked over a period of eight months to produce the Business Case engaging with a wide range of internal and external stakeholders and collating considerable data sets.

3.10 In developing the Business Case, the EST consulted with relevant Council service areas including sustainability, transport, parking and taxi/private hire licensing. Publicly available data was used, including UK Government vehicle registration statistics and Scottish Government vehicle usage surveys. Local taxi/private hire licensing and operational data was provided by both Council staff and taxi/private hire operators including vehicle telematic tracking data. Council licensing statistics provided information on vehicle fleet condition. Engagement was also undertaken with the Council's parking team, who provided controlled parking zone permit data, on-street parking bay maps and park and ride usage statistics. Finally, data was sourced from 'AddressBase' which provided geographical data and points of interest to identify suitable locations for charging infrastructure.

3.11 Throughout the Business Case reference is made to three scenarios for 2020 and 2023. These are intended to cover a range of growth predictions in plug in vehicles and were developed with consideration of the Scottish Government's target to phase out the new sales of petrol and diesel vehicles by 2032. The scenarios are:

3.11.1 low growth: maintaining the uptake of EV ownership based on current sales figures;

3.11.2 medium growth: similar to the low growth but a spike in EV sales in 2020;

3.11.3 high growth: more rapid uptake of EVs but only possible with larger investment in infrastructure.

3.12 The methodology employed by the EST was to use historical data on EV registrations in the city and develop a baseline. Forecasts were then applied to this under the three growth scenarios to understand how EVs will increase in numbers up to 2020 and 2023. Then, using information on current driving patterns across the city, the consultants estimated the number and location of charging points to meet this forecasted demand.

Main Findings

3.13 The Business Case uses the medium growth scenario as the recommended approach. The key headlines for this scenario by 2023 are:

3.13.1 there will be 9,874 residential EVs[2], 623 electric taxis[3] and 77 PiV drivers visiting park and ride sites per day;

3.13.2 Edinburgh will need an additional 211 charge points (111 fast charge points, 23 rapid chargers and 77 slow chargers;

3.13.3 these charge points will be able to charge over 2,000 residential EVs and 623 electric taxis per day;

3.13.4 there will be a growth in “home charging” for residents with access to garages or driveways;

3.13.5 the investment needed will be £3.3m (£1.1m by 2020 and a further £2.2m by 2023) with a payback period of seven years;

3.13.6 operating costs will be £0.8m with an excess of just under £0.5m per annum;

3.13.7 predicted carbon savings will be 7,715 tonnes of carbon per annum and 14.2 tonnes of NO_2 removed.

3.14 The consultants considered three main user types under each scenario – residential vehicles, taxis (hackney and private hire vehicles) and those who use park and ride sites (mainly commuters). A particular focus of the study was placed on residents who do not have access to dedicated off street parking for example a garage or driveway. For these residents, the provision of fast public charging infrastructure is crucial to making the use of EVs both practical and economically viable. This is particularly true as the business case for residential parking is often not attractive enough for private sector investment. Therefore, this group of users needs public intervention.

3.15 There are currently 3,118 taxis in Edinburgh. Using data provided by this sector demonstrated that the vast majority of both taxi and private hire vehicles are diesel fuelled and are rated Euro 5 or below. This would mean that they will not currently

[2] The vast majority of these users will have access to off street parking.
[3] All references in the report to “taxis” includes both hackney and private hire vehicles.

meet the UK standards for clean air zones. Moving to EVs will provide a cleaner and more cost-effective solution for these users.

Number and Type of Required Charge Points

3.16 The Business Case predicts that there will be nearly 10,000 residential and commercial EVs by 2023. An assumption has been made that many of these users will have access to driveways and garages for home charging and will not need access to public infrastructure. An additional 211 public charge points is proposed as part of the Business Case up to 2023. This would require the installation of:

3.16.1 77 “slow” chargers (7kW). ‘Slow’ is typically around a six to eight-hour charge and mainly for the park and ride sites as these drivers will usually leave the cars there for that duration;

3.16.2 23 “rapid” chargers (50kW). ‘Rapid’ being able to charge about 80% of the battery in 20 minutes. There will be a few of these dedicated to taxis, however these can also be used by the public and city car club vehicles;

3.16.3 111 “fast” DC charge points. ‘Fast’ chargers are rated at either 7-22kW and charging times vary are typically between two to four hours.

Locations of Charge Points

3.17 The Consultants were asked to determine the most suitable locations across the city. These were initially identified using geographical information and based on proximity to “points of interest”. These might include leisure centres, libraries, hospitals etc., essentially places, where people might travel to or from. Enquiries from residents was also used to assess suitable locations in terms of matching demand with the infrastructure needed.

3.18 Each location was then scored on two factors, firstly ease of installation, for example any grid constraints and secondly on the user convenience for example, distance to a charge point. Using these criteria yielded a list of locations potentially suitable for installing charge points.

3.19 Appendix 1 provides a detailed list and maps showing the proposed locations. The locations align with the three zones proposed in the EV Action Plan - city centre/residential and park and ride sites and are designed to ensure a spread across the city. In many cases locations are proposed as “hubs” with several charge points installed in close proximity to each other. A few locations may also be dedicated to one user for example at taxi ranks to ensure service accessibility.

3.20 The proposed locations are essentially a suggested “pool” for the Council to choose from and not fixed either in terms of location or in any order of priority. There is flexibility with the locations and it will be up to the Council to select a final list.

3.21 Further work will be needed with Scottish Power to determine if there are any grid constraints at these locations and if the cost is excessive then alternative locations will be looked at.

3.22 A summary of locations is seen in Figure 1 below.

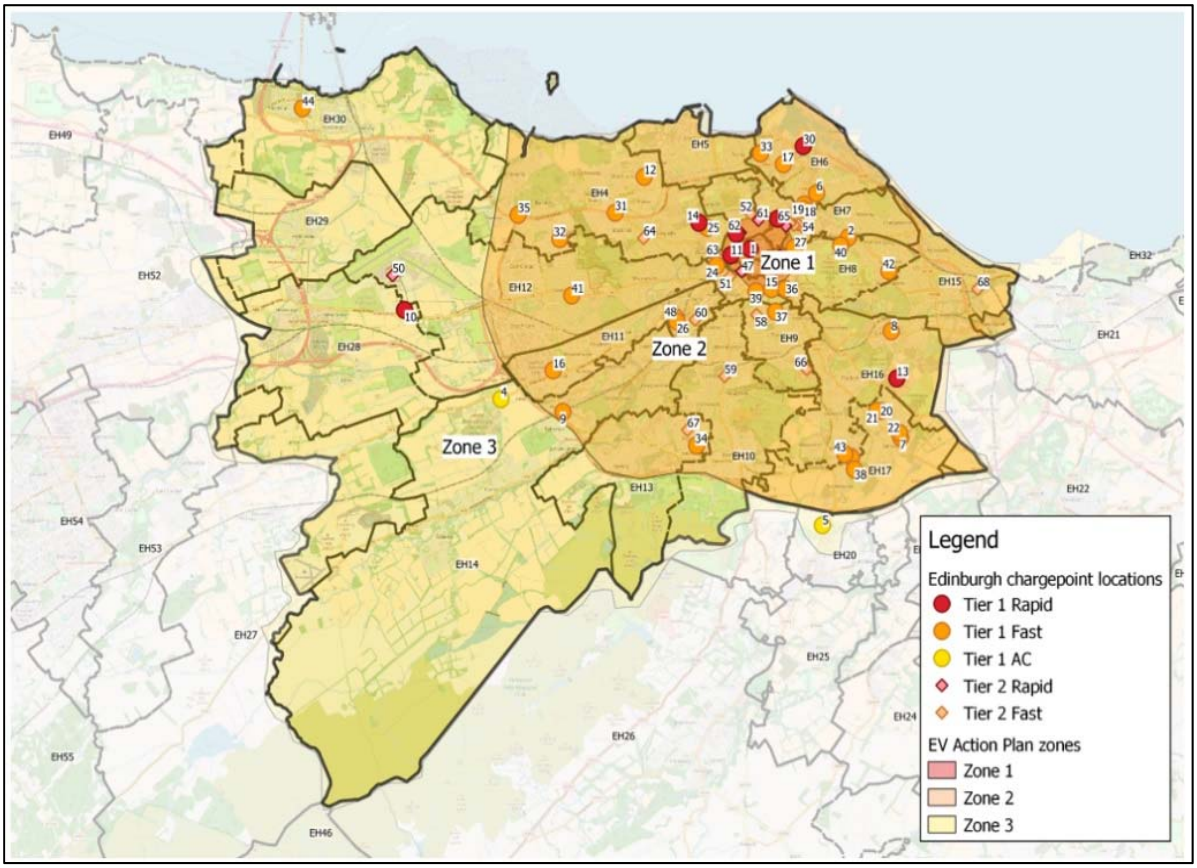

Figure 1: Proposed Location of New Charge Points Across Edinburgh

Tariffs and Charging

3.23 The introduction of charge points will incur costs for users. There are two charges – the cost for the electricity used (p/KWh[4]) and a connection charge to use the charge point itself which can vary depending on the type of vehicle. This is to support the back-office function provided by Transport Scotland including fault reporting, usage data and charging information.

Table 1 below shows the tariffs and connection charge assumptions used in the development of the Business Case.

User group	Pence per kWh	Connection fee
Residents and business	20p	30p
Taxi and private hire	20p	£1.00
Park and ride users	20p	£2.00

Table 1: Tariffs and Connection Fee used in the Business Case

3.24 Transport Scotland has proposed criteria for local authorities to introduce tariffs for publicly accessible charging infrastructure and recommended that a per kWh charge is preferable and that this should not exceed 20p/KWh. The Business Case

[4] p/KWh: pence per KiloWatt hour

assumes a tariff of 20p/KWh with the rationale for this explained in section 6.5.1 detailing that this tariff offers the quickest return on investment but is also competitive with typical market rates. Perhaps more importantly a 20p/KWh rate provides a larger revenue which could then be used to invest in more charging points across the city thus accelerating any programme.

3.25 Section 6.5.2 of the Business Case details the rationale for assuming the connection charges. The Consultants view is that the above connection charges are comparable and competitive with charging infrastructure found in other UK locations.

3.26 The Council will however, need to decide the level of charging and the individual connection charges.

Enforcement

3.27 A number of existing parking bays will need to be used as charging bays for electric vehicles and therefore it will be very important that these are seen for that purpose with vehicles not left longer in the bays than the charging time needed. A few locations may also be dedicated to specific types of vehicles e.g. taxis. A new enforcement regime will need to be developed and implemented, including applying for any regulatory powers or Traffic Regulation Orders, to ensure proper use of charging bays by vehicles.

Delivery

3.28 There are two main delivery options detailed in the Business Case. The first is a “procure and own” model whereby the Council would have full ownership of all assets installed and contract the supply and maintenance of any charging units to a supplier. The back-office function would continue to be provided by Transport Scotland as happens currently via the ChargePlaceScotland network. The Council would be responsible for maintaining and managing an asset register, managing suppliers, overseeing maintenance, assessing and evaluating usage data and for all communication with customers.

3.29 The second option is through a private sector concession whereby the installers would provide all capital costs and using locations made available by the Council, then pay a fee to the Council to operate the charge point. The concessionaire would provide all the back-office functions, maintenance, management and liaison with customers. This does substantially reduce the amount of capital needed to be found by the Council but also lowers revenue potential.

3.30 There are funding sources available to the Council which would provide capital funding (detailed in the Financial section of the report), therefore the Consultants have suggested that the Council could deliver the EV infrastructure in-house to maximise the revenue potential. However, an options appraisal of delivery options will be carried out and reported as part of developing a work programme as detailed in Paragraph.

Car Club and E-Cargo Bikes

3.31 Edinburgh has the second largest car club outside of London. All of the charging infrastructure that is proposed within the Business Case would be accessible to Enterprise Car Club (ECC) vehicles and should act as an incentive for the ECC to increase the number of EVs within their fleet. Where possible, the locations identified within the Business Case have taken account of the current locations of ECC bays which are all within a reasonable distance of the proposed charging infrastructure.

3.32 The issue of electric cargo bikes (E-cargo) was referenced in the EV Action Plan submitted to Committee in December 2017 and members were keen to know if there were issues in charging these types of vehicles and whether a pilot could be developed using these for Council deliveries.

3.33 E-cargo bikes have detachable batteries that can be charged in the home or business premises therefore there is no need for publicly accessible charging infrastructure. However, potential issues for E-cargo bikes are similar to those for e-bikes namely the need for secure on-street storage for people living in flats and tenements due to the weight of the bikes and the difficulty in getting them up stairwells. This issue of storage was out with the remit of the Business Case and therefore will need to be assessed as part of wider work on sustainable mobility. This would also include any planning issues.

3.34 A specific Council E-cargo pilot has not been progressed. However, work has been commissioned by students from the University of Edinburgh Business School into E-cargo deliveries around the Royal Mile. It is proposed to bring a report on the outcomes of this work to the next Committee.

Street Lighting

3.35 Members have expressed an interest in the use of street lighting columns as charging points especially in tenemental areas of the city. It was agreed to investigate this further. Meetings with relevant suppliers have taken place however there are some current constraints to the use of street lighting columns as possible charge points.

3.36 One key issue is the position of the column. Currently to protect the columns from vehicle damage they are set back from the pavement. If they are to be used as charging points they need to be sited directly next to the road to avoid trailing cables. This would mean moving lampposts. The other key issue is the electricity supply and the risk of the power cutting out. Currently Scottish Power's (who supply the columns) power cut outs are 20amps. It is suspected that the power rating using charging points may be around 25amps which would mean the units would cut out.

3.37 The majority of Edinburgh's street lighting columns are set back from the pavement however there are some which are next to the road which might be possible to use. The power supply issue would also need to be looked at with Scottish Power and there would need to be an assessment of suppliers of this type of technology.

3.38 However, there are some newer technologies emerging on the market, so it is proposed to investigate this issue further and report back to Committee in two cycles as part of the wider work on EV.

Wider Energy Issues

3.39 EV charging infrastructure can be coupled with battery storage, which operate by charging slowly over several hours (ideally overnight or during off-peak periods) before refuelling a vehicle, often through rapid charging. The benefit of battery storage is that it reduces the requirement for grid reinforcement work, as the batteries typically draw less power from the grid than a fast or rapid charger.

3.40 Battery storage can be installed with specific storage capacities and, with greater storage capacity, more EVs can be refuelled each day. For example, if a 60kWh battery storage device is installed to support a EV charge point, this will provide enough energy to fully recharge approximately two Nissan Leafs[5]. However, this can be expensive.

3.41 Charging infrastructure that is equipped with battery storage can also be accompanied by renewable energy generation equipment most often solar panels. By including renewable generation, the requirement to draw electricity from the grid is further reduced, the carbon emissions associated with the electricity provided by charge points is reduced and additional revenue can be generated by selling surplus renewable energy back to the grid. These options will be explored further as part of the wider SEAP programme.

Benefits

3.42 Data released by BEIS has shown that transport emissions in Edinburgh have increased year on year over the last two available data sets (2015 and 2016). The Council has set targets for the reduction of carbon emissions by 2020 and is currently considering the development of a Low Emission Zone. EVs are cleaner with far less carbon emissions or harmful pollutants from the vehicles, offering major benefits to both climate change and air quality. A good EV infrastructure may also help the implementation of a clean air zone.

[5] Nissan Leaf equipped with either 24kWh or 30kWh battery pack

3.43 Table 2 below shows the considerable reductions predicted in both carbon and nitrogen dioxide savings from EVs by 2023 across all growth scenarios.

Growth Scenario	2020		2023	
	CO_2 (tonnes per year)	NO_2 (tonnes per year)	CO_2 (tonnes per year)	NO_2 (tonnes per year)
Low	1,914	3.5	4,519	8.3
Medium	1,944	3.6	7,715	14.2
High	3,310	6.1	14,704	27.1

Table 2: Environmental Benefits from EVs

3.44 In addition, there are other benefits to users. Even although the price is reducing, currently EVs are more expensive to buy or lease than the petrol or diesel equivalents. However, they are cheaper to own on a pence per mile basis throughout the vehicle lifecycle due to lower refuelling costs and other tax incentives. The EST has stated that a fully charged all electric vehicle will typically do 100 miles at a cost of £2-4, whereas the cost for the petrol or diesel equivalent will be £13-16.

3.45 There are also currently a number of grant schemes which can help those considering the purchase of a potential EV. This includes cars and vans. An interest free loan up to £35,000 can be provided by Transport Scotland. The EST and the Office for Low Emissions Vehicles (OLEV) also provide grants for the cost of installing a domestic charge point.

Partnerships

3.46 A key issue in the development of EVs is the potential to encourage other organisations and businesses across the city to use these vehicles. While it is very likely that a private sector contractor will be needed to deliver any programme, there is the potential to develop partnership approaches with both the wider public and private sectors.

3.47 In particular, the private sector will be important, for example, in being encouraged to install charging points at workplaces, supermarkets, retail parks and leisure centres etc. The Council could potentially install these charge points with the private sector partner taking a share of the revenue, or private companies may decide to install their own infrastructure. As part of the implementation of the Business Case, the Council will look to work in partnership with the private sector which might include contact through the Business Improvement Districts, business partnerships and networks and Developers Groups.

3.48 In addition, the Council will look to promote EVs through its arms-length companies like Edinburgh Leisure, Transport for Edinburgh and Lothian Buses, encouraging them to also look to influence the private sector to install electric charging points. This work will form a key element of the work programme going forward.

Delivery and Next Steps

3.49 If approved by Committee, the first step will be a short period of consultation (six weeks) with a number of key stakeholders in particular with Scottish Power Energy Networks (SPEN) to determine if there are any grid constraints for the selected locations and the costs of any upgrades if required.

3.50 It should be noted that there may be some challenges in taking the work forward not least the issue of the grid constraints (and unknown costs) and the development of Traffic Regulation Orders. These are lengthy processes and in the case of assessing the grid issues this would need to be carried out before procurement could progress.

3.51 It is proposed therefore that the next stage will be the development of a comprehensive Work Programme for the installation of charging points across the city. This would include a risk assessment that will be needed particularly since there may be implications arising from the engagement with SPEN and the processing of TROs. This Work Programme would detail all the tasks and issues that will be involved in delivering EV across the city and include for example:

- liaison with Scottish Power for an assessment of suitable locations and any grid constraints;
- creating a final list of locations for a Phase 1;
- detailed procurement timelines;
- a charging and enforcement system;
- implications of any Powers/Transport Regulations Orders (TROs);
- a project timeline;
- detailed costs;
- delivery options;
- operational, management and governance procedures; and
- a communications strategy.

3.50 Consultation with service areas will also be important especially with colleagues involved with the new Mobility strategy, City Centre Transformation and Low Emission Zones.

3.51 The Work Programme will need input from a range of specialist service areas. Liaison with Localities officers will be important, and the existing Electric Vehicle Working Group will also be used to help develop this programme.

3.52 The intention will be to submit the Work Programme to Committee for approval within two cycles if possible.

4. Measures of success

4.1 The key measures of success for the EV Business Case will be an increase in the number of charging points across the city coupled with a growth in ownership of electric vehicles and increased usage of charging points.

5. Financial impact

Charging Tariffs

5.1 The Business Case sets out the level of investment needed to install charging points across the city and the potential revenue stream to the Council. Table 3 below details this for two scenarios – medium and high growth for two tariffs at 17.5p/kWh and 20p/kWh.

Growth Scenario and Tariff	2020			2023		
	Investment	Profit Per Annum	Payback	Investment	Profit/ Per Annum	Payback
High (17.5p)	£1,401,365	**£157,660**	9 yrs	£5,864,039	**£733,425**	8 yrs
High (20p)	£1,401,365	**£205,185**	7 yrs	£5,864,039	**£957,719**	6 yrs
Medium(17.5p)	£1,104,593	**£77,041**	14 yrs	£3,358,283	**£368,399**	9 yrs
Medium (20p)	£1,104,593	**£108,383**	10 yrs	£3,358,283	**£490,031**	7 yrs

Table 3: The Level of Investment and Return from EV Charging on 2020 and 2023

5.2 The levels of investment for the installation of charging infrastructure for both medium and high growth scenarios to 2020 are in the region of £1-1.4m respectively. This investment rises to between £3-5m for the 2023 scenarios.

5.3 Table 3 shows that up to 2023 with a 20pkWh charge and a high level of growth in PiVs, the potential revenue to the Council is just under £1m/year while a medium level of growth generates just under a half a million pounds of revenue. The payback for both are in the region of six to seven years which is considered a very good payback period.

Fuel Savings

5.4 An assessment by Evo Energy[6] demonstrates the savings in fuel between a conventional internal combustion engine car versus an electric vehicle. At an annual mileage of 20,000 miles the cost to a conventional car is £2,229 per year while the cost for an electric vehicle for the same mileage is £727 per year

[6] https://www.evoenergy.co.uk/technology/ev-charging-business/ev-charging-cost-calculator-button/

representing substantial savings to the user. Similar studies show comparable savings.

5.5 The figures above for an EV are based on 0.20p/KWh. The Council is currently paying 0.12p/KWh. For Council EV fleet this represents further savings.

Resourcing and Operational Costs

5.6 The recommended delivery model is for the Council to own and manage the EV charging infrastructure. For this, there will need to a dedicated resource and while initially this could be one project officer it is likely that as the work expands, a small team would need to be set up to oversee the work. At a minimum two project officers are recommended taking on the tasks of asset management, dealing with TROs, liaising with SPEN, overseeing the procurement commission, liaising with contractors, dealing with customers and promotion and awareness raising. These costs could be in the region of £0.150 per annum but will be included in the funding application to Transport Scotland.

5.7 There will also need to be some contingency costs allowed for replacement of units that might not be covered under warranty or for promotional activities. As such a small operational budget is required for a least the first year of operation while revenue is built up through the various tariffs. An estimate of this budget is £0.04m. It is proposed to apply to Spend to Save for this budget.

Grid Costs

5.8 One of the potential challenges that the installation of multiple charge points in a single location can pose, is the potential to place significant peak demand on the local electricity grid. It may be necessary for network reinforcement to be carried out in some locations to provide sufficient power and reliability especially for rapid charge point installations. The consequence of this may be significant additional costs to the project. Some estimates can range from a few thousand pounds to several hundred thousand pounds depending on the site. There is some accounting of these costs in the overall financial model however these are yet unknown.

Funding Sources

5.9 The investment has been detailed above. Up to 2020, the costs for infrastructure are estimated at £1.1m and by 2023 at £3.4m. A number of funding sources are available to encourage the uptake of EV charging infrastructure.

5.10 Transport Scotland recently announced the launch of the ‘Switched on’ Towns and Cities Challenge Fund which will operate as a competitive capital fund with an annual call for bids. The Fund is targeted at local authorities who are well positioned to deliver the infrastructure to support EV uptake. The deadline for applications is 31 August 2018 with eligible costs per project in the range of £1.5 million to £2.5 million. Up to 100% of eligible costs may be supported by this Fund which operates on a quarterly draw down basis. However, applications that can include some match funding are looked on more favourably.

5.11 The Sustainable Development Team will be progressing an application to the Challenge Fund of just over £2m.This would provide all the funding for the Phase 1

installations plus funding to cover staff costs and potential grid costs which are as yet unknown. The grant operates on a draw down basis so funding can only be applied for retrospectively. Announcements will be made in early October with projects to be completed within two years.

5.12 The intention would be to apply to future calls for funding for subsequent installation phases.

5.13 There are also two current grant funding schemes for local authorities through OLEV. The first is the On-street Residential Charge Point Scheme which has allocated £4.5m for 18/19 and 19/20. The Scheme is primarily focused on the installation of charge points in on-street locations with funding available for 75% of the capital costs of procuring and installing the charge point and associated dedicated parking bay. Applicants need to secure 25% match funding. Transport Scotland has indicated a willingness to fill this funding gap for Scottish Local Authorities that are unable to raise the 25% match funding gap.

5.14 OLEV has also recently released the second round of the Ultra-Low Emission Taxi Infrastructure Scheme. Local authorities can now bid for grants in the second round of the Ultra-Low Emission Taxi Infrastructure Scheme. There is £6m available for taxi charge point infrastructure. OLEV will again only fund 75% of the capital cost of a changepoint with the remaining 25% to be provided via Local Authority funding. The closing date for this fund is 26 October 2018.

5.15 The intention is to apply for the Transport Scotland funding as this is 100% grant funding and officers are very familiar with the financial processes having received similar funding already. However, if the Transport Scotland bid is unsuccessful for whatever reason, the intention will be to apply to OLEV.

5.16 Finally, the Work Programme to be submitted to Committee will detail finalised costs including any financial implications of removing parking bays.

6. Risk, policy, compliance and governance impact

6.1 By implementing a Business Case the Council is mitigating any risks of non-compliance with the Climate Change (Scotland) Act 2009 by developing specific projects that reduce carbon emissions. In addition, as a key project under the SEAP, the EV Business Case will directly contribute to reducing carbon emissions thus assisting the mandatory carbon emissions reporting under the Public Bodies Duties introduced by Scottish Government. The reduction of carbon emissions is also a key Council pledge.

6.2 The EV Business Case also complements a number of other key strategies and programmes including the Local Transport Strategy and the work on Low Emission Zones (LEZ).

7. Equalities impact

7.1 There are no adverse equalities impact associated with this report.

8. Sustainability impact

8.1 The delivery of the Business Case will have a range of benefits particularly on carbon reduction and air quality. Compared to conventional cars, EV emit substantially less carbon emissions. The vehicles are also cleaner with far less exhaust emissions so delivering direct air quality improvements.

9. Consultation and engagement

9.1 In developing the Business Case, the Consultants have engaged with a number of Council service areas and external organisations. In particular the collation of data involved a number of officers across transport, parking and licensing. The Consultants also approached SPEN as the local Distributed Network Organisation and the key stakeholder for grid issues.

9.2 The Council's Electric Vehicle Working Group has been consulted on the Business Case. This group is made up of a number of service areas including parking, transport, planning, licensing and fleet. The group has welcomed the Business Case and is supportive of the aims and objectives.

9.3 There is a wider programme of work being developed across the Council which will have implications for the EV programme. This includes the City Centre Transformation programme, the new Mobility Strategy and the work on Low Emissions Zones. Meetings have been held with officers to ensure an awareness of the EV work and ensure that there is an alignment amongst all the relevant programmes of work. In addition, it will be important to engage with those officers involved in localities work where it has relevance for EV charging.

9.4 There has been considerable interest in this agenda from the wider public and businesses and consequently it is proposed that a public consultation exercise be undertaken on the Business Case. This would run for six weeks and the purpose would be to gain support, promote the agenda and the proposed work by the Council and raise awareness. The consultation exercise may also help in determining the exact locations of charging points across the city. The consultation would also involve Council staff.

9.5 The outcomes of the consultation exercise will be incorporated into the Work Programme.

10. Background reading/external references

None

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11. Appendices

Appendix 1 Electric Vehicle Infrastructure: Investment Case for Edinburgh

Electric Vehicle Infrastructure
An Investment Case for Edinburgh

August 2018

Executive Summary

City of Edinburgh Council have commissioned Energy Saving Trust to document the business case for investment in electric vehicle (EV) charging infrastructure across Edinburgh up to 2020 and 2023. Adopting the zonal approach identified within the City of Edinburgh's Electric Vehicle Action Plan[1], the study forecasts the number of electric vehicles on the road in Edinburgh by 2020 and 2023, the amount of charging infrastructure required to support them and the return on capital investment made by City of Edinburgh Council.

Background

Encouraging those living, working and visiting Edinburgh to replace their existing petrol or diesel vehicles with electric vehicles brings the environmental benefits of lowering carbon emissions and reducing urban air pollution. Users also often achieve savings in vehicle running costs, with a typical electric vehicle saving its owner roughly £100 in fuel for every 1,000 miles driven, when compared to petrol or diesel.

Affordable, modern electric vehicles are available that can drive for over 150 miles, making them suitable for the majority of uses. When electric vehicles require refuelling, they must be connected to a charging infrastructure that, depending on the type of the chargepoint, can fully refuel the vehicle in anything from half an hour to 10-12 hours. The adequate provision of this charging infrastructure is essential to allowing individuals to own and operate electric vehicles.

In many cases, local authorities have led and are leading on the deployment of electric vehicle charging infrastructure. The capital costs of installing this charging infrastructure can be considerable but, once installed, the usage of this infrastructure has significant revenue generating potential. By carefully planning its investment into electric vehicle charging infrastructure, City of Edinburgh Council can recoup any capital invested within a reasonable timescale and then benefit from a new revenue stream on an ongoing basis.

Approach

Energy Saving Trust has looked at the baseline vehicle usage in three key vehicle categories. These categories include:

- Vehicles registered in Edinburgh, including private and business vehicles
- Taxi and private hire vehicles licenced by City of Edinburgh Council
- Users of park and ride sites operated by City of Edinburgh Council

For each of these vehicle groups, a baseline was taken using existing sources of information, including data provided by the UK Department for Transport, Transport Scotland and City of Edinburgh Council. Using this baseline data, three scenarios were calculated to estimate the number of electric vehicle users by 2020 and 2023. Baseline data was also

[1] The City of Edinburgh Electric Vehicle Action Plan

used to understand the way vehicles are currently operated in Edinburgh (e.g. average daily mileages).

By combining electric vehicle adoption forecasts with information on how vehicles are typically driven in Edinburgh, a series of calculations were made to determine how much electric vehicle charging infrastructure would be required to meet demand across the three adoption scenarios, by 2020 and 2023.

With infrastructure requirements determined, the associated capital and operating costs were calculated alongside revenue generation in order to produce a business case.

Key findings

This study found that, under the medium scenario, a total of **69 chargepoints would be required to support electric vehicle use in Edinburgh by 2020**. This includes 9 rapid chargers, 35 fast chargers and 25 slow chargers. **By 2023, 211 chargepoints are forecasted to be required**. This includes 23 rapid chargers, 111 fast chargers and 77 slow chargers. Further information on the distinction between these different types of chargepoint can be found in the background section of this report.

Scenario	2020				2023			
	Residential	Park & ride users	Taxi & private hire	Total	Residential	Park & ride users	Taxi & private hire	Total
Low	34	22	9	**65**	78	57	13	**148**
Mid	35	25	9	**69**	111	77	23	**211**
High	42	36	13	**91**	192	147	40	**379**

Under the medium scenario, **£1.1m of capital funding will be required by 2020** to install charging infrastructure to support the number of electric vehicles forecasted to be on the road in Edinburgh. **A further £2.3m of capital funding will be required between 2020 and 2023**, equating to a **total required capital investment of £3.4m**.

		Capital	Annual OpEx	Annual revenue	Annual profit	RI (years)
Total	**2020**	£1,104,593	£244,439	£352,822	£108,383	10.2
	2023	£3,358,283	£876,860	£1,366,889	£490,031	6.9

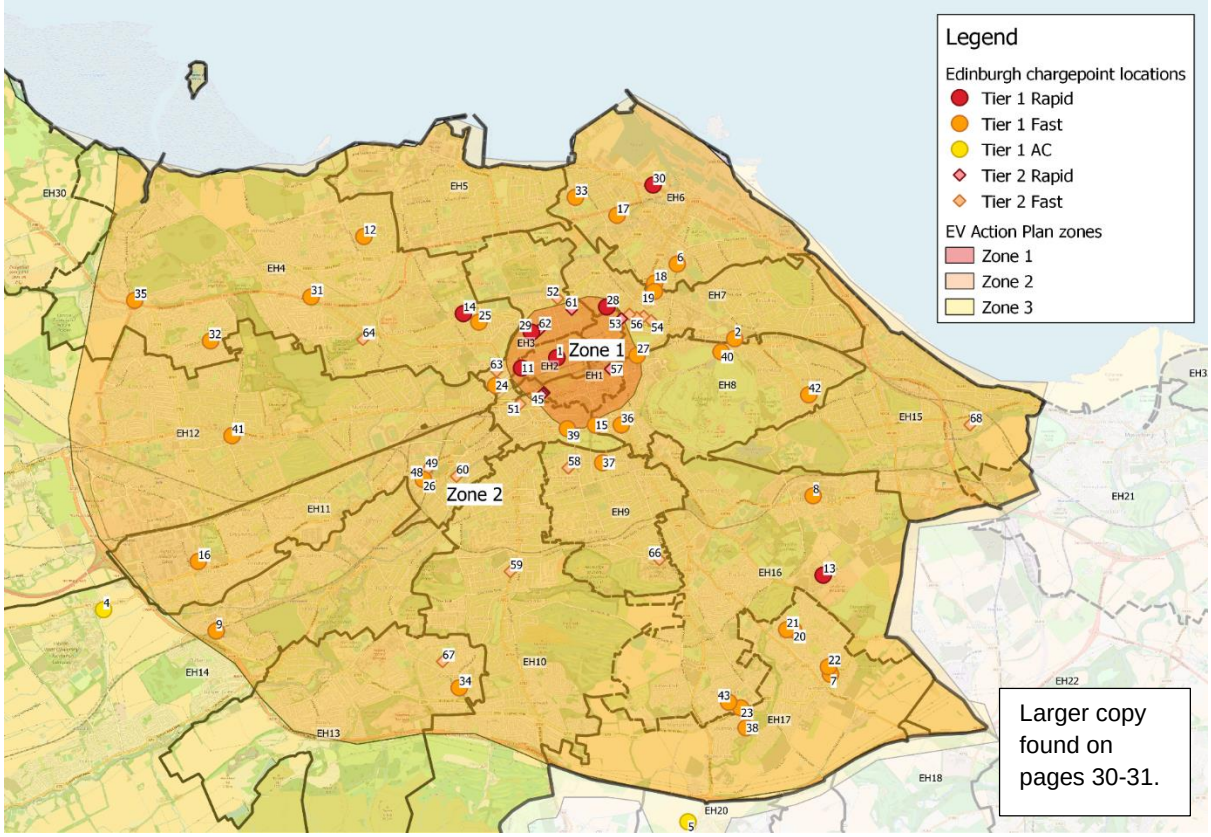
By charging electric vehicle users 20p per kilowatt hour of electricity used to refuel their vehicles using this infrastructure – as well as an additional connection fee of between 30p and £2 – the proposed electric vehicle charging infrastructure could generate **£350k of revenue and £110k of profit every year from 2020**. By 2023, the use of this infrastructure will have grown to generate **£1.4m of revenue and £490k of profit every year from 2023**.

This revenue would continue to grow as the adoption of electric vehicles increased after 2023. This level of income suggests that the **capital investment made in electric vehicle charging infrastructure will repay itself by 2030**.

Other key findings include that, by 2023:

- 9,874 electric vehicles registered in Edinburgh (6% of total)
- 77 electric vehicle drivers will visit Edinburgh's park and ride sites every day
- 623 EVs will be used taxi and private hire drivers across the City
- CO_2 emissions reduced by 7,715 tonnes per year
- Pollutant NO_2 emissions reduced by 14.2 tonnes per year

Throughout Edinburgh, 68 suitable locations for installing charging infrastructure have been identified. The merit of each location has been ranked and each scored out of ten to reflect the ease of installation and user convenience, resulting in a list of 44 sites recommended for installation up to 2020 and a further 24 sites which are feasible for installation by 2023.



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The study concludes by recommending City of Edinburgh Council further refine the identification of sites for installation of EV infrastructure, progressing to procure a charging infrastructure supplier and operator once site suitability is confirmed.

Table of Contents

1. Introduction

Energy Saving Trust (EST) were commissioned by City of Edinburgh Council (CEC) to produce a report, documenting the business case to for CEC to invest in electric vehicle (EV) charging infrastructure.

1.1 Aims of this study

The purpose of this Business Case is to:

- Produce a baseline study for Edinburgh indicating the current number of EVs and charging infrastructure type/location; assessing the merits of the current zonal approach to charging infrastructure outlined in the EV Framework;
- Forecast EV charging infrastructure demand in Edinburgh, across multiple vehicle categories required to meet the anticipated growth in EVs to 2020 and 2023 respectively;
- Produce detailed maps of charge point locations, charger types, based on the zonal approach required to 2020 and 2023;
- Produce a detailed financial assessment of the capital investment required to develop a strategic network of charging hubs across the city covering a 2020 scenario and 2023 scenario;
- Explore revenue generating opportunities, including the deployment of battery storage;
- Predict reductions in carbon dioxide (CO_2) and pollutant emissions (NO_x, PM_x);
- Create an investment grade proposal.

2. Background

With zero tailpipe emissions, electric vehicles present one way of fulfilling the transport needs of Edinburgh's businesses, residents and visitors, while tackling air pollution and reducing carbon emissions. EV uptake by private and commercial users is growing rapidly and Scotland can now boast one of the most comprehensive networks of rapid charging points in Europe[2].

The City of Edinburgh Sustainable Energy Action Plan[3] (SEAP) aims to reduce carbon emissions across the city by 42% by 2020, against 2005 baseline, which notes that transport accounts for 21.6%. By 2016 this figure had risen to 29%. As a result of investment and its compact size, Edinburgh already leads the way in sustainable transport, with the highest share of people travelling to work in Scotland by foot, cycle and bus, and the highest share travelling by bus in the UK.

To build on this success, Edinburgh has developed a strategic and coordinated approach to expand charging infrastructure across the City through its EV Action Plan. In taking the Action Plan forward, the City of Edinburgh Council, in partnership with Transport Scotland, has commissioned Energy Saving Trust (EST) to determine the investment case for EV charging infrastructure in Edinburgh. This study

[2] Switched on Scotland: A Roadmap to Widespread Adoption of Plug in Vehicles
[3] The City of Edinburgh Sustainable Energy Action Plan

The overall sustainable transport ambition for Edinburgh remains to reduce car use across the city in favour of public transport and active travel, and therefore improve congestion, parking and safety. However, cleaner cars and vans still have a highly important role as part of the wider efforts to reduce carbon emissions, air and noise pollution, and for certain activities, remain an appropriate mode of transport.

2.1 A strategic approach to encouraging EV uptake

2.1.1 National level

The Scottish Government has set out its ambitious plans for encouraging the uptake of EVs. Most notably, in their Programme for Government 2017-2018, they outline their aspiration to phase out the need for new petrol and diesel cars and vans by 2032 (eight years ahead of the rest of the UK).

The approach to EVs is also reflected in other key strategies including:

- The Scottish Climate Change Plan setting out commitments to negotiating changes to vehicles emission standards at EU and UK level, developing preferential Vehicle Exercise Duty for EVs and further supporting public procurement policies and local incentives (e.g. parking policies).
- Scotland's first Energy Strategy[4], published in December 2017,setting out a vision for the Scottish energy system up to 2050. A key target is for 50% of energy for Scotland's heat, transport and electricity to be supplied from renewable sources by 2030.Electrification of transport is necessary to meet this target. The Strategy also reaffirms support for various measures to encourage EV uptake (e.g. the A9 'electric highway') and details the importance of EVs in smarter electricity networks with more informed and flexible consumers, smoothing demand and assisting with the integration of renewables and micro-generation.
- Plans to tackle air quality include the development of low emission zones (LEZs) in the four largest Scottish cities. With zero tailpipe emissions, EVs have a vital role to play in tackling air pollution and present one way for air quality targets to be met in the proposed LEZs without compromising the mobility needs of businesses, residents and visitors.

[4] Scottish Energy Strategy, The Future of Energy in Scotland

2.1.2 Local Level

The Council's own policies supporting EVs include:

The Council **Sustainable Energy Action Plan (SEAP)** is the city wide energy plan aiming to reduce carbon emissions by 42% by 2020. This is the main policy driver behind the EV Action Plan linking in the issues of renewables and energy efficiency.

The **Air Quality Action Plan** in Edinburgh has identified six Air Quality Management Areas (AQMAs), five for the pollutant nitrogen dioxide (NO2) and one for fine particulates (PM10). A major source of these pollutants is diesel and petrol vehicles. EVs emit no pollutants or carbon emissions.

The **Local Transport Strategy (LTS)** 2014-2019 is the other key policy programme aiming to enable transport choices which are more environmentally sustainable. The LTS makes reference to supporting the increased use of low emission vehicles through working with partners to provide a network of electric vehicle charging points.

Edinburgh City Vision 2050, is building coalitions on how a successful Edinburgh looks in 2050. This includes innovative approaches to transport infrastructure; creating an active and green city; and ensuring we prepared for the effects of climate change.

The range of policies and strategies outlined indicates that at both national and local levels, there is a strong commitment to a cleaner energy system, with sustainable transport, including the acceleration of EV uptake, as a key component. As Scotland's capital city, investment across Edinburgh in charging infrastructure will be crucial in achieving both national ambitions, and fulfilling its vision to be an inspiring, thriving, connected and fair city for all its citizens[5] by 2050.

2.2 EV zoning approach

City of Edinburgh EV Action Plan proposes a zonal approach to providing charging infrastructure (Fig.1) to facilitate the increase in the uptake of EVs in the forthcoming years. The City's strategic vision for charging infrastructure plans for it to be integrated with other modes of transport and future infrastructure, serving range of users and supporting air quality improvement. The zonal approach takes into account various types of charge points to suit relevant groups of users within specific areas as seen in table 1.

[5] 2015 Edinburgh City Vision

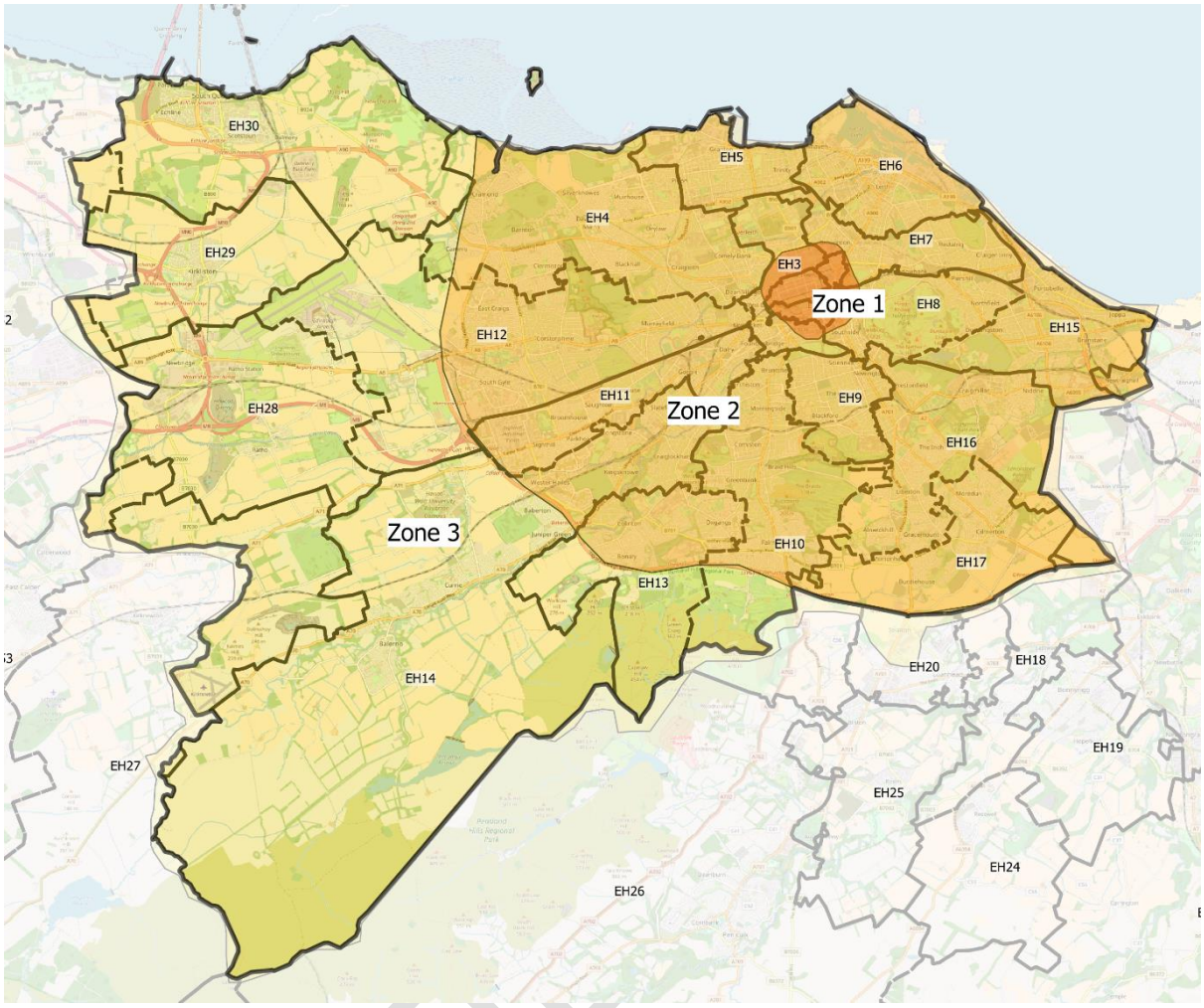


Figure 1. Proposed Zones for charging infrastructure.

Table 1; The City of Edinburgh charging infrastructure zone categories.

Zone	Area	Type of vehicles	Typical chargepoint type
1	Central	Taxis, commercial, car club	Rapid 50kW DC
2	Urban residential	Residents	Fast 22kW DC
3	Peripheral	Visitors, commuters	Fast 7kW AC

ZONAL APPROACH

To forecasting uptake of PiVs by different user groups and the required charging infrastructure

Zone 1 - City Centre

Rapid charging hubs in both on and off-street locations would be the focus, with some hubs restricted to certain groups, e.g. taxi trade, public sector fleets.

Zone 2 - Residential Area

Fast chargers are likely to be more appropriate for on-street locations and rapid chargers in off-street locations. This would be in addition to any slow chargers in private garages. Although private vehicles are likely to be the main users, these charge points would be open to taxis, car clubs and commercial vehicles.

Zone 3 - Peripheral Area

Strategic ring of charge points around Park and Ride facilities, primarily to encourage commuters to leave their vehicles and choose public transport, active travel options to come into the city. A mix of fast and rapid charging hubs would be appropriate.

Scenarios

This study considered three scenarios covering different PiV adoption pathways, forecasting for vehicle uptake in 2020 and 2023.

- Medium scenario was considered as best aligned with the ambition to phase out the need for new petrol and diesel cars and vans by 2032.
- Assumes a spike in electric vehicles sales around 2020, as a result of increased vehicle choice.

The zonal approach outlined in Edinburgh's EV Action Plan offers a structured and logical approach to planning for EV charging infrastructure network and has provided the foundation for this study and report. In addition, the boundaries specified within this approach lend themselves to the extent of a potential LEZ being implemented. In many cases, the rationale for the locations of the zones is similar to that being implemented in London.

2.3 Benefits of electric vehicles

2.3.1 Environmental and health benefits

Compared to petrol and diesel vehicles, EVs emit much lower levels of tailpipe CO_2 and other air pollutants, such as nitrogen oxides and particulates. This improves air quality which will have a positive impact on health and wellbeing. EVs are also quieter than conventional vehicles and may help to reduce noise pollution from roads.

Greater uptake of EVs may also benefit other city-wide initiatives to increase uptake of public transport and active travel. For example, if visitors driving EVs are encouraged to charge at the park and rides, it will reduce congestion. A good EV infrastructure may also help to enable the implementation of a clean air zone. In general, cleaner air and eased congestion within the centre will provide a more pleasant and safe environment, encouraging more people to walk or cycling.

2.3.2 Economic benefits

Although EVs currently cost more than their petrol or diesel equivalents to buy or lease, EVs can be cheaper to own on a pence-per-mile basis, throughout the vehicle lifecycle. This is due to lower refuelling costs and other tax incentives[6].

For commercial users, adopting EVs where appropriate within their operations can make good business sense, enhancing environmental credentials and developing competitive advantage.

More widely, the economic benefits of improved air quality will be quickly realised. For example, a reduction in respiratory illness will reduce the impact on local health services. Improved air quality may also bolster Edinburgh's reputation, and therefore its already established tourism industry[7].

2.4 Background information about EV charge points

EV charge points are primarily defined by the power (in kW) they can deliver and therefore how fast they are capable of charging an EV. The speed of charging is dependent both on the technology built into the vehicle and into the charging infrastructure. For example, when the charging capability of the vehicle is less than that of the charger then the vehicle will charge only at the maximum speed allowed by the vehicle. Charging rates as shown in table 2 vary from slow chargers - which can take more than 12 hours to completely replenish a battery in an EV - to rapid chargers which can provide 80% of charge in 20-30 minutes.

There have been significant recent advances in the speed at which EVs can be charged. Charge points as powerful as 150 kW have recently become available and rapid charge

[6] EST, 2017. A guide to ultra-low emission vehicles for Fleet Managers
[7] World Health Organization, 'Review of evidence on health aspects of air pollution – REVIHAAP Project', 2013

points delivering up to 50kW are a common sight at motorway and main road service stations throughout the UK. Chargers as powerful as 350kW will be available in the next few years which will dramatically reduce recharging times for future generation of vehicles.

For TPH users, one of the most significant considerations when operating EVs is the time required to charge. Also of great importance is daily mileage, downtime during the day and vehicle compatibility with the different types and speeds of charging equipment. The most common charge point connectors are outlined in the table 3.

Pictures: From top left clockwise: 50kW fast charge point, 50 kW fast charge point, 22kW fast charge point, rapid charger for taxi use, the Dundee taxi fleet and 7kW charge point.

Table 2. EV charging speeds

	Type of charge point		
	Slow	**Fast**	**Rapid**

Power Rating	3.5 - 7kW	7 - 22kW	43 - 50kW
Electrical Supply type	AC	Usually AC, DC available at higher rates	AC & DC
Charge time	4 to 8 hrs	2 to 4 hrs	25 - 40 minutes (80% charge)
Vehicle range added in 15 minutes	3 - 6 miles	6 - 20 miles	35 - 40 miles
Comments	Charge points are usually Type 2 sockets, however Type 1 or 2 tethered cables are available. Popular method of charging at home overnight.	Majority of chargers are untethered Type 2 sockets. DC Fast chargers 20-25kW available with tethered cables. Tend to be found on street and at destinations such as car parks, supermarkets or shopping centres.	Rapid units have tethered cables. Found at most motorway and main road service areas, increasingly found at supermarkets and on-street.

Table 3. Chargepoint connector types.

Connector Type	Typical charge speed and current	Associated manufacturers
Type 2 (Mennekes)	3.5kW, 7kW, 22kW, 43kW AC	Compatible with almost all EVs, but charge speed dependent on vehicle on-board charger
Combined Charging System (CCS)	20kW, 50kW DC (150kW coming to market)	BMW, Audi, Volkswagen, Porsche, Ford, Hyundai
CHAdeMO	20kW, 50kW DC (150kW coming to market)	Nissan, Kia, Citroën, Tesla (via adapter), Mitsubishi, Peugeot

2.5 Challenges of encouraging EV adoption

While there are many benefits, developing charging infrastructure for EVs presents several challenges. It is a new responsibility for local authorities who are not necessarily familiar with the tasks and processes involved. There have been some challenges in the uptake of EVs.

2.5.1 Vehicle driving range

The first of which is the driving range of the vehicle, effectively how far it can drive before the vehicle's battery requires recharging. A consequence of the perceived 'poor range' of pure electric vehicles, or electric only operation of EVs has been a phenomenon known as range anxiety, whereby potential EV users are put off adopting the technology because of anxiety over the practicality of making longer journeys. This is however an area where there has been significant and rapid technological development, led by vehicle and battery

manufacturers. In a matter of a few years, an affordable EV has gone from being able to drive around 50-80 miles on a single charge to being able to drive upwards of 160 miles. More expensive EV models are also available that can drive over 200 miles on a single charge. The constraint of vehicle range is therefore fast becoming less of a barrier to adoption of EV technology.

2.5.2 Lack of charging infrastructure

A second challenge is around the perceived lack of charging infrastructure. However just as with range performance, there has been considerable growth in the provision of charging infrastructure. Improvement of the infrastructure is both complimentary and necessary to facilitate the required increase in uptake of EV ownership. Greater availability and visibility of charging infrastructure will further help to reduce range anxiety and improve practicality for EV adopters.

2.5.3 Constraints on the electricity grid

One of the potential challenges that the installation of multiple charge points in a single location, or that the aggregated infrastructure in a wider area can pose, is the potential to place significant peak demand on the local electricity grid, which it may not currently be equipped to deliver. Currently, a single rapid charge point is typically rated at 50kW (equivalent to 5 electric showers running simultaneously). With such a high power demand, it may be necessary for network reinforcement to be carried out in some locations to provide sufficient power and reliability for rapid charge point installations. The consequence of this may be significant additional costs to the project. Implications for the electrical distribution network also mean that, when planning and installing EV charging infrastructure, a great deal of engagement is required with the distribution network operator (DNO) which, in the case of Edinburgh, is Scottish Power Energy Networks.

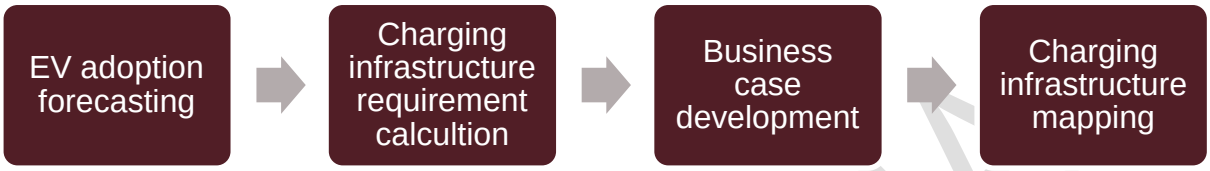
2.5.4 Infrastructure installation challenges

Further challenges include the availability of land for charging locations and careful consideration of planning guidelines which may complicate, or prohibit installation. As a local authority, the City of Edinburgh Council retains commercial property (including industrial, retail and office units) throughout Edinburgh, but this may not always be suitable for hosting charge points for public use, for example where limitations of opening hours restrict access. Another option available is to install charge points on-street, at the kerbside, but this introduces additional furniture to the pavement. In any case, adding EV charging infrastructure to traditional car parks requires enforcement to ensure that charge points are not being blocked by conventional vehicles. To do so, local authorities need to issue a traffic regulation order (TRO), involving a process which often takes considerable time. Even after this has been done, there is the potential for losses in revenue if the EV charging infrastructure is not used. The number of considerations are numerous and emphasise the importance of careful planning when investing in EV charging infrastructure.

3. Methodology

This section describes the overarching methodological process used throughout this report. Further information on the specific methodologies and assumptions used to determine findings for each vehicle group can be found in each vehicles groups relevant section of this report and also in the appendix.

Whilst the methods to collect data varied between different vehicle user groups, the overarching approach employed in this study broadly follows four key steps:



3.1.1 Stakeholder engagement and baseline data sources

At all stages, we have consulted with City of Edinburgh Council (CEC) colleagues involved in sustainability, parking and taxi & private hire (TPH) licencing. Additionally, we have informed our engagement with stakeholder groups by drawing upon publicly available sources of evidence including UK Government vehicle registration statistics and Scottish Government vehicle usage surveys.

Local TPH licencing and operational data has been provided by both CEC and TPH operators including vehicle telematics tracking data and vehicle fleet condition statistics, derived from CEC licensing statistics. Engagement has also been made with CEC's parking team, who have provided controlled parking zone permit data, on street parking bay maps and park & ride usage statistics.

Data has been provided by Enterprise Car Club to identify all car club bays within Edinburgh, including those which are already EV-enabled.

Grid capacity information has been sourced from Scottish Power Energy Networks, to provide an indication of grid capacity when suggesting EV charging infrastructure locations (although individual site surveys will be needed to confirm that capacity is available).

Data has also been sourced from AddressBase, which has provided detailed geographical data and points of interest to identify suitable locations for charging infrastructure.

3.1.2 EV uptake scenarios

Throughout this study, reference is made to three scenarios. These scenarios are intended to cover a range of potential EV adoption pathways and have been developed taking into consideration the Scottish Government's ambition to phase out the need for new petrol and diesel vehicles by 2032.

To understand the number of vehicles that will require the use of EV charging infrastructure by 2020 and 2023, EV adoption forecasts were calculated across three scenarios. All scenarios have been calculated using data specific to Edinburgh, making them unique to the area. These scenarios are described below:

Table 4. Scenarios for the adoption of EVs

Low	Based on historical trends in quarterly sales of electric vehicles in Edinburgh
Medium	As the low scenario, but assuming a spike in electric vehicles sales around 2020, as a result of increased vehicle choice.
High	Rapid uptake, possible only with investment in infrastructure and a wide-ranging package of regulatory measures to incentivise EV usage.

Forecasts have been made to 2020 and 2023, forecasting any sooner than 2020 would be of limited use – as there would not be enough time to realistically take strategic action – and forecasting any later than 2023 would be unreliable. Plans for beyond 2023 should be developed from 2020 onwards, when the trajectory of growth in EV use is more apparent.

The medium scenario has been chosen for reference for the charge points as it aligns with the Scottish Government's pledge to end the need for new petrol and diesel vehicles by 2032.

4. Forecasting Growth

This section makes use of historical data concerning new EV registrations in Edinburgh to generate forecasts which help to indicate how the use of EVs could grow throughout the period up to 2023. Building on these projections, this forecast in the increase in the number of vehicles has been used to inform and calculate the charging infrastructure requirements for EV users by 2020 and 2023.

Building on these projections, this forecast in quantity of vehicles has been used to inform and calculate the charging infrastructure requirements for EV users by 2020 and 2023.This section looks at three key vehicle groups:

Residents Vehicles

- Vehicles that are registered in Edinburgh and used by residents in Edinburgh, either for personal or business use

Taxi and Private Hire Vehicles

- Taxi (hackney carriage) and private hire cars licensed by City of Edinburgh Council

Park and Ride Users

- User of any of three of the park and ride sites that are operated by City of Edinburgh Council (Ingliston, Hermiston & Straiton)

For an overview of the methodology used to forecast EV adoption and calculations for charging infrastructure requirements, please see the appendix.

4.1 Baseline

Vehicle licensing statistics suggest that there are already 715 EVs registered by residents of Edinburgh, with around 40 public chargepoints already installed and registered on the ChargePlace Scotland network. Using baseline statistics and historical data, it is possible to forecast how these numbers will change in the future.

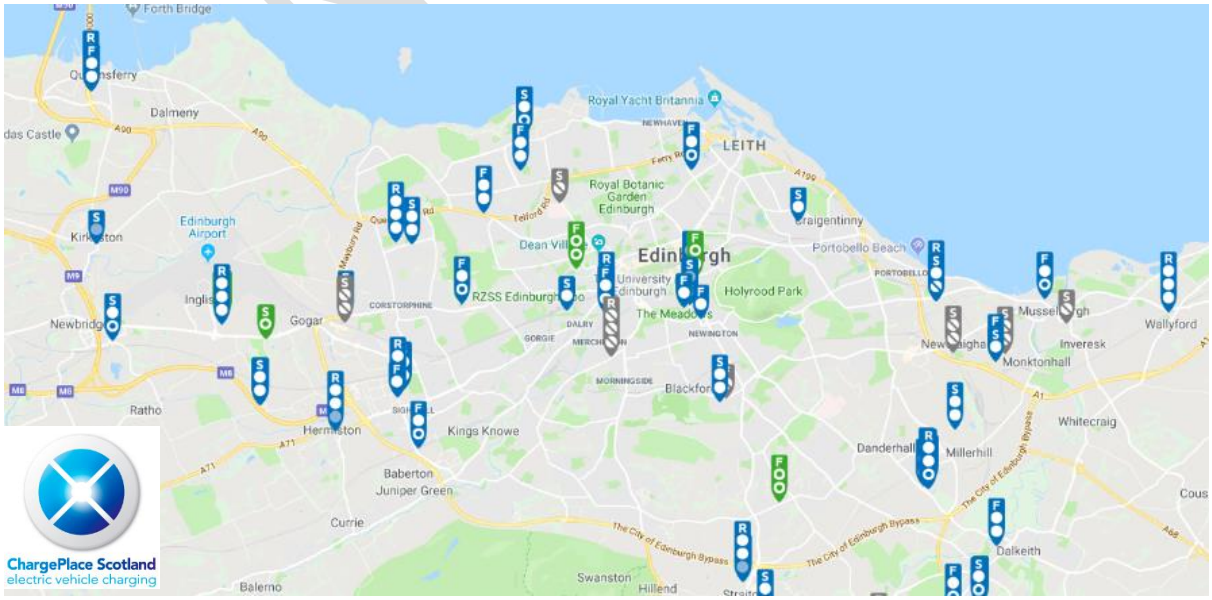


Figure 2. Map of existing public chargepoint locations in Edinburgh (source: ChargePlace Scotland)

4.2 Vehicles registered in Edinburgh

This vehicle group represents residents of Edinburgh and the vehicles that they are using, both for personal and business use, including both cars and vans. These vehicles are predominantly found in Zone 2. A particular focus is placed on residents of properties that do not have access to dedicated off-street parking (i.e. a garage or driveway). For these residents, the provision of public charging infrastructure should be considered as vital to making the use of EVs both practically and economically viable. In many instances, the business case for the provision of infrastructure to residents is not attractive enough to encourage investment from the private sector, making this group a particularly important area for public intervention.

4.2.1 Plug-in vehicle adoption forecast

The graph below illustrates the results of the EV adoption forecasts across the three scenarios described in the previous section and are supported by further detail in table 5 below. These estimates cover all vehicles registered in Edinburgh, including private use and commercial vehicles.

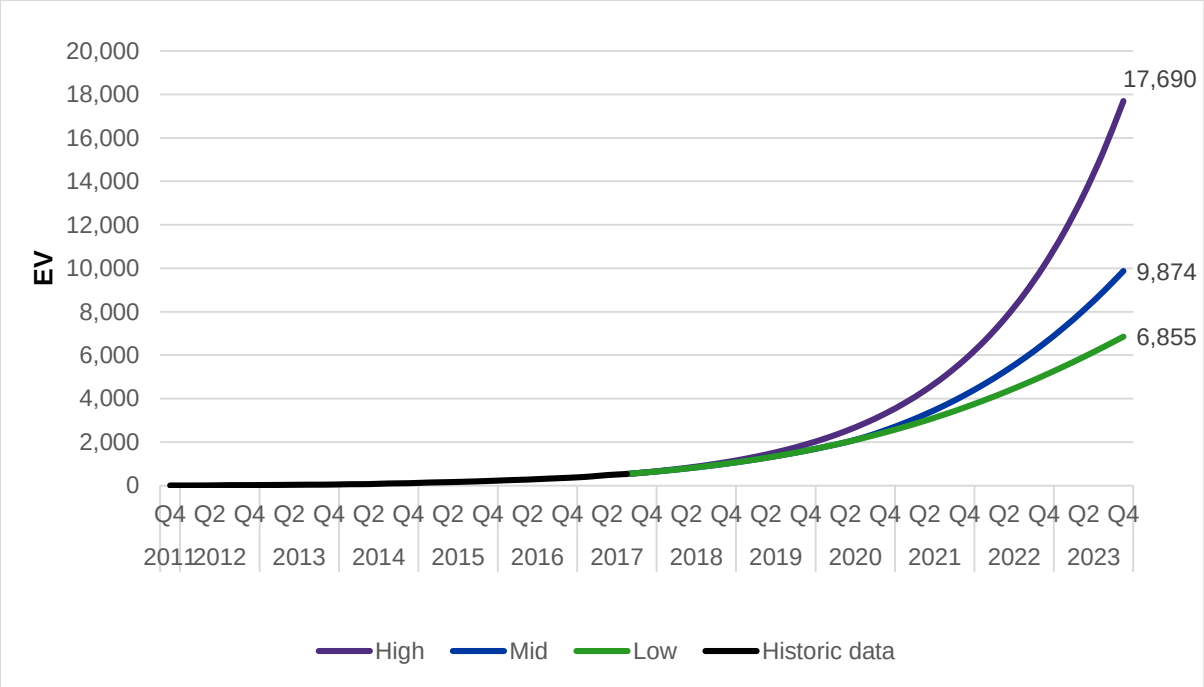


Figure 3. Forecasts for the adoption of electric vehicles in Edinburgh up to 2023 for residents.

For context, the total number of vehicles (excluding motorbikes and scooters) currently registered in Edinburgh is 163,183. Assuming this stays constant up to 2023, this can be usefully compared to the EV forecasts, as summarised in the table 5. The medium scenario forecast suggests that there will be 9,874 EVs in 2023, accounting for 6.1% of the total residential and commercial vehicles in Edinburgh.

Table 5. Forecasts for the adoption of electric vehicles by residents and commercial fleets up to 2023

Scenario	EVs 2020	% Vehicles 2020	EVs 2023	% Vehicles 2023
Low	2,453	1.5%	6,855	4.2%
Mid	2,551	1.5%	9,874	6.1%
High	3,314	2%	17,690	10.8%

4.2.2 Forecasting methodology

This business case proposes forecasts based on 3 scenarios introduced in the methodology (Table 2), allowing for a wide spectrum of future demand for EVs by residents and commercial users. These scenarios are defined in table 6.

Table 6. Scenarios for uptake of EVs across Edinburgh by residents and commercial vehicle operators.

Low	A curved growth trend, based on rate at which growth in EV registrations in Edinburgh has been slowing over the previous two years
	A realistic scenario, as far as present evidence would suggest
	4.2% of all vehicles are EV by 2023. Roughly one EV for every 23 petrol/diesel vehicles.
Medium	As medium scenario, but qualitatively predicting a second spike in EV registrations, caused by the emergence of new vehicle models in 2020
	Ambitious but realistic, taking into account anticipated growth in vehicle choice by around 2020
	6.1% of all vehicles are EV by 2023. Roughly one EV for every 16 petrol/diesel vehicles.
High	A curved growth trend, based on the rate of growth in EV registations in Edinburgh over the last two years
	An ambitious rate of adoption, requiring significant short-term investment and public intervention - e.g. EV-only charging zones, EV only parking schemes, etc.
	10.8% of all vehicles are EV by 2023. Roughly one EV for every 9 petrol/diesel vehicles.

4.2.3 Uptake of EVs across residential areas

Using publicly available data on the number of EVs licensed in each Edinburgh postcode district, a map has been produced showing how the total number of EVs would be geographically distributed across Edinburgh by 2032, under a medium scenario. Based on current evidence, this map shows that **the EH4, EH12, EH10 and EH14 postcode districts are likely to see the greatest number of EV registrations**. It has been assumed that the uptake will be distributed evenly across all districts.

It is important to note that areas which are forecasted to have the greatest amount of EV adoption are not necessarily areas where the greatest amount of charging infrastructure is required to be installed. Factors such as the availability of off-street parking would impact the amount of infrastructure required, as areas with a greater proportion of residences with off-street parking would have a larger number of residents who were able to install and use charge points on their own property.

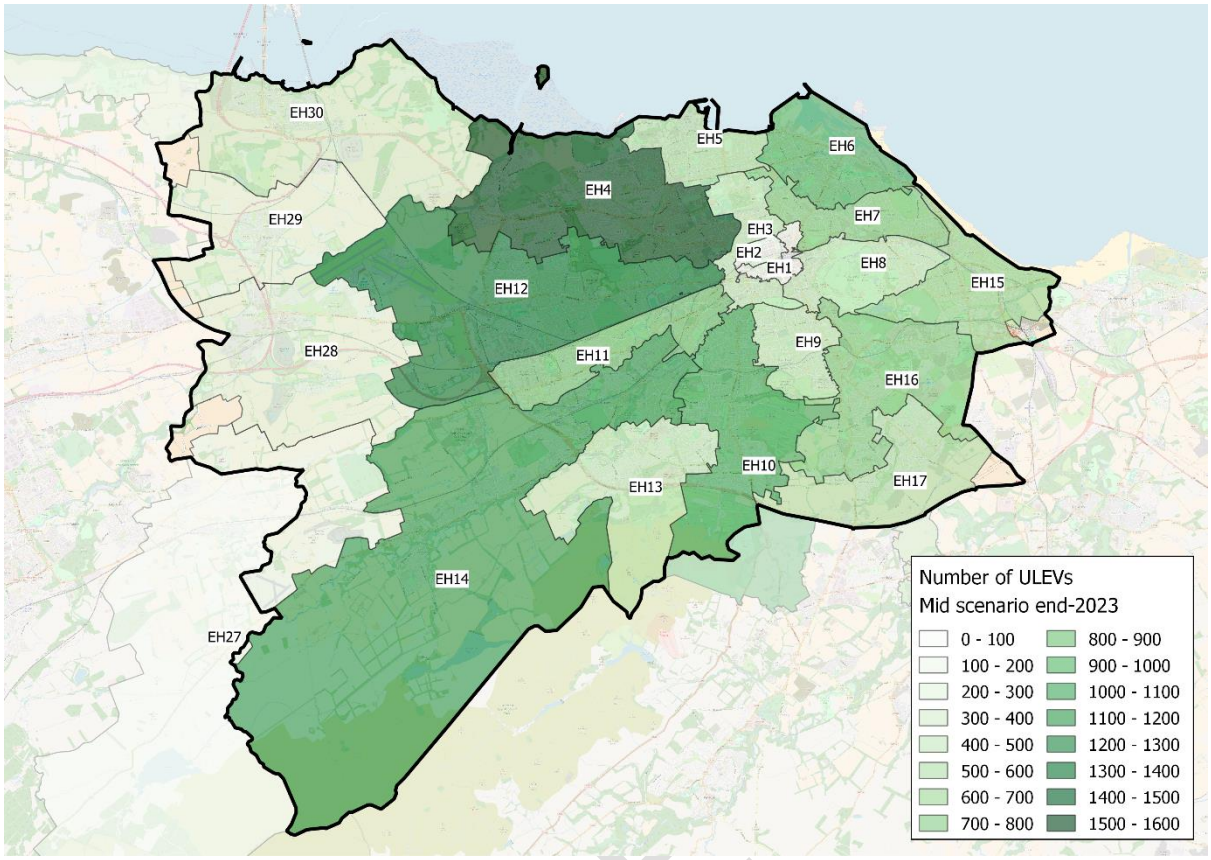


Figure 4: Forecasted registrations of EVs by postcode district in Edinburgh.

4.2.4 Number and type of chargepoints required for the residential areas

Table 7 illustrates the number of public charge points required, by 2020 and 2023, specifically for use by residents and for plug-in commercial vehicles registered in Edinburgh. This includes both cars and vans.

Please note that the number of EVs shown in table 7 is lower than the total number of EVs forecast previously in this section. This is because we have assumed that residents with off-street parking will install and use their own charge point. EV users with access to their own charge point are therefore assumed not to require public infrastructure, as it would be neither as cost effective or as convenient as a charge point installed at their property. For details of all assumptions made for these calculations, please see the appendix.

Table 7. Charge point requirements for resident and commercial EVs

Scenario	2020		2023	
	EVs	Charge Points (Fast)	EVs	Charge Points (Fast)
Low	497	34	1,393	78
Mid	507	35	2,023	111
High	673	42	3,594	192

For hubs of charge points for use by residents, DC (direct current) fast chargers are recommended, as they will be capable of providing a fast (22kW) charge to most vehicles and at least a slow (3.5-7kW) charge to virtually every electric vehicle on the market. Fast chargers that deliver an AC (alternating current) charge are available and are typically much cheaper but are only able to deliver a slow (3.5-7kW) charge to the majority of electric vehicles. This is a major disadvantage as the long charging time would be inconvenient for residents and limit the impact of the City of Edinburgh Council's investment in charging infrastructure.

Fast charge points (specifically DC variants) are typically able to recharge one vehicle at a time, meaning that the number of charge points recommended is effectively equal to the number of charging units that would need to be installed. In some cases, a single fast charge point would benefit from having two bays associated with it, as there is then space for a second vehicle to wait for the first vehicle to finish charging. However, doing so naturally doubles the requirement for parking spaces, which has implications for parking revenue.

4.2.5 Challenges of installing residential charging infrastructure

When installing charging infrastructure for use by residents, the ideal is to locate chargepoints so they are convenient for as many residents as possible. This will provide confidence to purchase an EV. This does however introduce a challenge of identifying suitable locations to install infrastructure at the ward level. This can be challenging when installing hubs of charge points, as off-street parking – or at least on-street bay parking – would generally be required. Narrowing this down further to include only public sites means that, in a typical ward, the most ideal sites will often be car parks at libraries, council-run community centres/offices, other public sector buildings and schools.

However, to ensure wider accessibility, another approach is installing charge points on-street, outside of properties without off-street parking. This approach has been pursued by numerous local authorities across the UK. The challenges associated with this approach are the introduction of additional street furniture to pavements, the need to spread infrastructure more widely across neighbourhoods and, in the short term, the tension caused by providing an EV-only parking bay where there may only be one EV owner in the area – thereby a perception that a resident has a dedicated parking space.

A key step when installing infrastructure in residential areas is to seek input from residents and ensure that they have an established line of communication to City of Edinburgh Council for matters concerning EV charging infrastructure. In addition, it will be important to emphasise that EV charging bays are not parking bays but for charging purposes only. Monitoring and enforcing a charging time limit may be required, but it may also become essentially "self-monitored" by EV users.

4.2.6 Environmental benefits

Based on the medium forecast for EV adoption for **2020**, the study estimates that **793 tonnes of CO_2** and **1.46 tonnes of NO_2** will be saved annually from vehicles registered by residents and businesses in Edinburgh, assuming that these vehicles replace their petrol and diesel vehicles. Similarly, the forecasted figures for **2023** are **3,165 tonnes of CO_2** and **5.8 tonnes of NO_2**.

4.3 Park and Ride Users

This section looks at the users of Edinburgh's three council-run park and ride sites; Ingliston, Hermiston and Straiton park and rides. These sites lie in Zone 3, just outside of the Edinburgh Bypass and are used predominantly by individuals visiting Edinburgh, including tourists and commuters. At the Ingliston park and ride, it would also be likely that TPH drivers may use the site, owing to its proximity to Edinburgh Airport. These park and ride sites are important places at which to provide EV charging infrastructure as it will not only encourage individuals visiting Edinburgh to invest in an EV, but will also encourage them not to drive into the city, thereby decreasing congestion.

4.3.1 Plug-in vehicle adoption forecast

The number of forecasted EVs using each park and ride site every day by 2020 is shown in the table 8. These numbers are based on peak usage of the sites and therefore represent the estimated maximum daily usage.

Only annual usage figures were available for Straiton park and ride and therefore estimates for this site have been based on the proportionality of peak daily to annual usage (i.e. annual usage divided by highest daily usage) of Ingliston park and ride. Figures have also been adjusted to reflect an assumption that people driving to Edinburgh in an EV will use one of these a park and ride with charge points installed, as opposed to another site.

Table 8. Estimated number of EV users visiting each park and ride site.

Scenario	EVs per day 2020			EVs per day 2023		
	Hermiston	Ingliston	Straiton	Hermiston	Ingliston	Straiton
Low	5	13	2	14	36	6
Mid	6	16	2	19	50	8
High	8	22	3	36	95	15

4.3.2 Forecasting methodology

The methodology for forecasting EV use in Edinburgh's park and ride sites, operated by the Council, is similar to that used to forecast EV adoption by Edinburgh residents. The key difference is that, where the forecast for residents was based on vehicle registration statistics for Edinburgh, **park and ride forecasts have been based on registration statistics across Scotland**. It has therefore been assumed that all users of publically-owned park and ride sites around Edinburgh will be visitors to Edinburgh (including commuters) and not residents.

Table 9. Scenarios for park and ride visitors.

Low	A curved growth trend, based on a rate of approximately 9% per quarter, which would be required to ensure all newly-sold light vehicles were electric by 2032
	In line with Scottish Government target to phase out the new sale of petrol and diesel vehicles by 2032
Medium	As medium scenario, but qualitatively predicting a second spike in EVs registrations, caused by the emergence of new vehicle models in 2020
	Would achieve Scottish Government target a year earlier, based on two years (between 2020-2022) where the rate of sale returns to the average seen between 2015-2017 - 13%
High	A curved growth trend, based on the rate of growth in EVs registations in Scotland over the last two years - 13%
	All newly registered light vehicles will be EVs by 2027

4.3.3 Number of chargepoints required

Table 10 illustrates the number of public charge points required – by 2020 and 2023 – for users of three of Edinburgh's park and ride sites. This study has focussed on publicly-owned park and ride sites as installing charge points in these locations will be significantly more straightforward.

Table 10. Charge point requirements for park and ride visitors with EVs.

Scenario	2020		2023	
	EVs/day	7kW AC Charge points	EVs/day	7kW AC Charge points
Low	20	22	56	57
Mid	24	25	77	77
High	33	36	146	147

For park and ride sites, 7kW AC charge points are recommended as users are typically likely to leave their vehicle at these sites for several hours and will not attend to their vehicle until they leave, meaning that faster charge points are likely be highly underutilised.

7kW AC charge points are typically capable of charging two vehicles at once, meaning that the number of charge points recommended in table 10 is effectively twice the number of charging units that would need to be installed.

4.3.4 Environmental benefit

Based on the EV adoption medium forecast for **2020**, the study estimates that on an annual basis, **90 tonnes of CO_2** and **0.17 tonnes of NO_2** will be saved from park and ride vehicles used by visitors based on the assumption that EVs adopted by visitors replace petrol and diesel vehicles. Similarly, the forecasted figures for 2023 are **286 tonnes of CO_2** and **0.53 tonnes of NO_2**.

4.4 Taxi & Private Hire Vehicles

There are currently 3,118 TPH cars licensed in Edinburgh; 1,316 of which are taxis (hackney carriages) and the remaining 1,802 are private hire cars. Through engagement with Edinburgh's TPH licensing colleagues, as well as TPH operators, it was possible to understand the number of vehicles presently licensed by CEC, as well as the condition of those vehicles and the manner in which they are operated.

An analysis was conducted on the condition of TPH vehicles licensed by CEC. The results of this analysis showed that the majority of both TPH cars are diesel fuelled and rated Euro 5 or worse, which means that they do not meet the UK framework for clean air zones[8] and are likely to make a significant contribution to urban air pollution in Edinburgh.

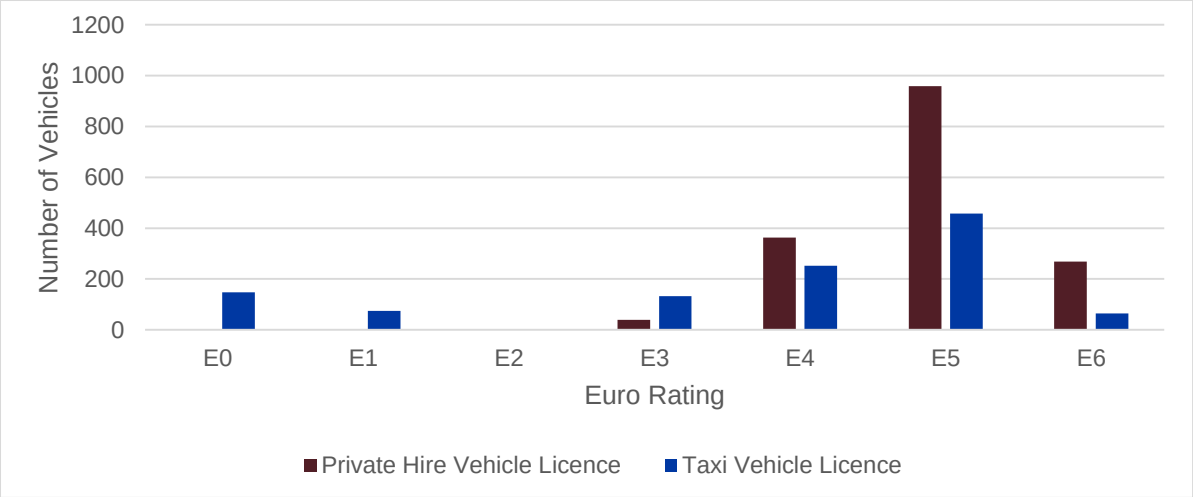


Figure 4. Breakdown of CEC taxi and private hire cars by Euro rating.

4.4.1 Electric vehicle adoption forecast

Forecasts for the use of EVs for TPH purposes are shown in table 11.

Table 11. Forecasts for taxi and private hire EVs up to 2023

	2020		2023	
Scenario	EVs	EV fares/day	EVs	EV fares/day
Low	155	979	311	1,957
Mid	155	979	623	3,914
High	311	1,957	1,247	7,828

4.4.2 Forecasting methodology

Forecasts for EV adoption within Edinburgh's TPH sector are shown in table 12. These forecasts were agreed with City of Edinburgh Council and are based on varying levels of intervention by the council. These forecasts cover both TPH cars and range from a low scenario assuming that 10% of TPH vehicles will be EV by 2023, through to 40% in the high scenario.

[8] For taxi and private hire vehicles, UK Government guidance for clean air zones stipulates that petrol vehicles should be Euro 4 or better and diesel vehicles should be Euro 6 or better. [pg. 30/31]

Table 12. Scenarios for taxi and private hire users.

Low	5% of licensed TPH vehicles are PiV by 2020
	10% of licensed TPH vehicles are PiV by 2023
Medium	5% of licensed TPH vehicles are PiV by 2020
	20% of licensed TPH vehicles are PiV by 2023
High	10% of licensed TPH vehicles are PiV by 2020
	40% of licensed TPH vehicles are PiV by 2023

For the medium and especially the high scenario to be achieved, significant regulatory action would be required from City of Edinburgh Council, including changes to licensing conditions. Regulatory action which City of Edinburgh Council may consider include:

- Removing licensing fees for EVs
- Only issuing new taxi and/or private hire vehicle licenses to EVs
- Only renewing existing taxi and/or private hire vehicle licenses for EVs
- Only issuing or renewing operator licenses for companies operating a certain proportion of EVs within their fleet.
- Introducing EV-only ranks, potentially in desirable locations (e.g. railway stations, airport)
- Relaxing conditions of fitness for EVs, for example allowing rear-access wheelchair accessible vehicles
- Introducing saloon hackney carriage licenses for EVs
- Implementing a lower age limit for taxi and/or private hire cars (which would encourage EV adoption if combined with a change to conditions for licensing new vehicles)

4.4.3 Number of chargepoints required

Table 13 illustrates the number of public charge points required, by 2020 and 2023, for use by taxi and private hire cars licensed by City of Edinburgh Council.

Table 13. Charge point requirements for taxi and private hire EVs.

Scenario	2020		2023	
	EVs	Charge Points (Rapid)	EVs	Charge Points (Rapid)
Low	155	9	311	13
Mid	155	9	623	23
High	311	13	1,247	40

For providing hubs of charge points for use by taxi and private hire cars, rapid chargers have been recommended. The use of slower charge points would have a significant negative impact on the taxi and private hire business model as it would increase vehicle 'downtime'.

Rapid charge points are typically equipped to supply one vehicle at a time, meaning that the number of charge points recommended is effectively equal to the number of charging units that would need to be installed. However, particularly for use by taxi and

private hire cars, a single rapid charge point would benefit from having two EV-only bays associated with it, as there is then space for a second vehicle to wait for the first vehicle to finish charging. Although likely to be used predominately by taxi and private hire cars, **car club vehicles and residents in the city centre would also be able to use these charge points (except where the sole use by TPH is considered necessary, for instance in the Edinburgh Airport or at Edinburgh Waverley Station).**

4.4.4 Environmental benefits

With reference to the medium scenario, and based on the EV adoption forecasted for **2020**, the study estimates that on an annual basis, **1,061 tonnes of CO_2** and **1.2 tonnes of NO_2** will be saved from taxi and private hire cars based on the assumption that EVs adopted by the trade will replace ICE vehicles. Similarly, the forecasted figures for 2023 are **4,265 tonnes of CO_2** and **7.9 tonnes of NO_2**.

4.4.5 Car club vehicles

Charging infrastructure installed for taxi and private hire purposes will also be made available for use by electric car club vehicles. According to data provided by Enterprise Rent-A-Car – the car club operator in Edinburgh – there are currently 145 car club bays in Edinburgh, of which 17 are for electric vehicles. Figure 5 shows the locations of all car club bays across Edinburgh, based on a data provided by Enterprise Rent-A-Car.

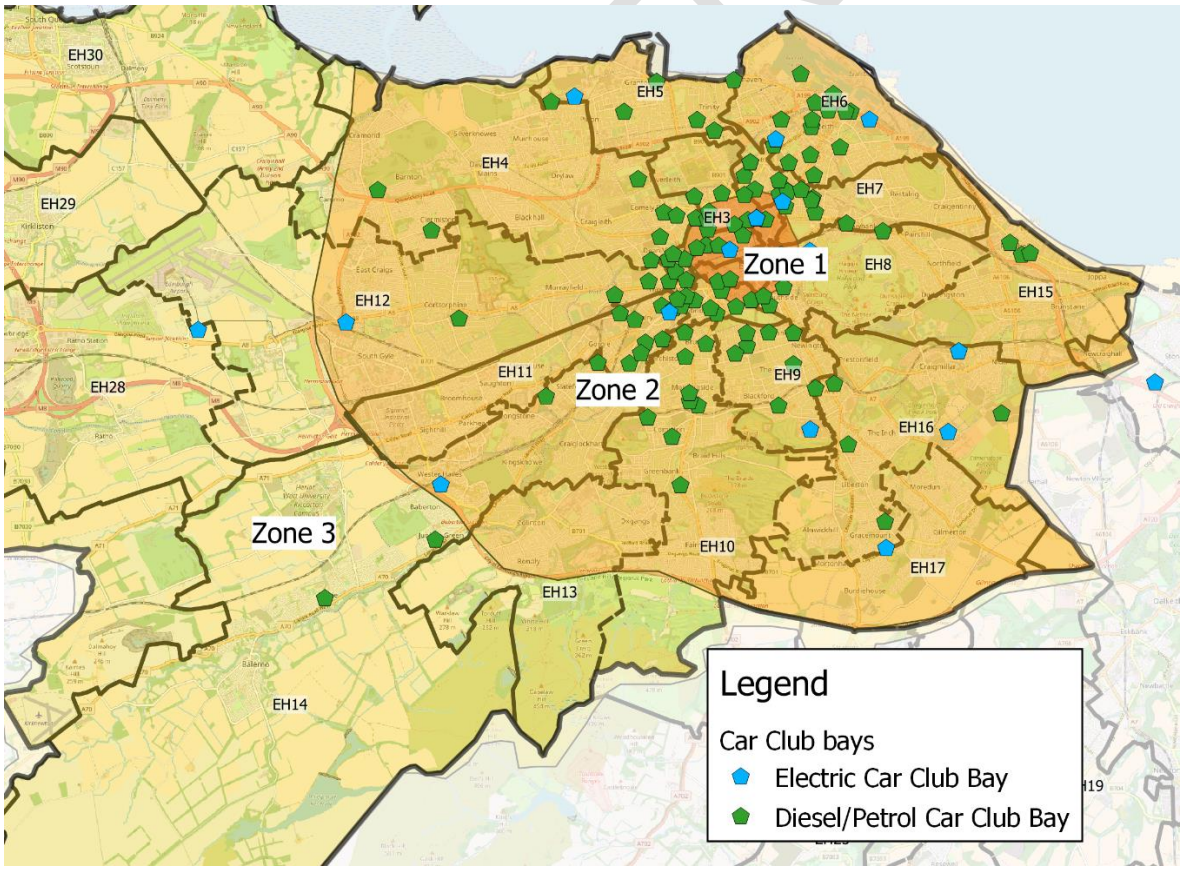


Figure 5: Map showing location of car club bays in Edinburgh and whether they are petrol/diesel car club bays or electric car club bays.

5. Charging Infrastructure Locations

This section considers the locations where charging infrastructure could be installed, subject to the satisfactory completion of an in-depth technical site survey and consultation with Scottish Power as the DNO.

5.1 Mapping Methodology

Locations were initially identified based on proximity to points of interest (PoI's) throughout Edinburgh. Points of interest include locations where vehicle users are likely to require charging infrastructure, especially those where vehicles are typically likely to be parked for significant periods of time. These locations include bus and railway stations, CEC and Scottish Government buildings, shopping centres, leisure centres and parks. Once mapped, these locations formed a longlist of 114 potential sites which were then reviewed by a peer review panel consisting of three expert EST consultants, specialising in EV infrastructure. Each location was rated on a scale of one to five for ease of installation and user convenience. Examples of the criteria considered in deciding these scores is detailed in table 14.

Table 14. Scoring Rationale for Installation of charging points

Score	Installation
1	No evident electricity supply. No access to site. Privately owned with little chance of installation being permitted.
2	Electricity available, but significant works likely required. Restrictive access to site. Land privately owned.
3	A considerable distance from the sub-station, on site conditions dictate that considerable civil engineering works and road/pedestrian areas may require closure.
4	Substation in close proximity. Pavement closure possible. Publicly-owned.
5	Substation in immediate vicinity. No disruption likely to be caused. Publicly-owned.

Table 15. Scoring rationale and methodology of location practicality for use.

Score	Usability
1	If charge infrastructure was installed it would not be accessible to a viable number of users
2	Location would require a specific journey for the majority of user groups
3	Convenient for regular use by select user groups, but inconvenient for majority of EVs
4	Would be convenient for the majority of vehicle users to use on a regular basis
5	Would likely be in frequent use by most EV users from most user groups

Following the weighting of scores, sites were allocated to one of two tiers. These categories are largely based on the simplicity of installation, with consideration also given to ensure that the locations are also convenient for users for the periods up to 2020 and 2023. The definitions of tier one and tier two are as follows:

- **Tier 1**: Locations where installation of charging infrastructure is viable and could realistically be installed to meet projected demand by 2020. These are the sites where installation would likely be relatively straight forward and where it is likely the charge points would be convenient to use for most EV user groups.
- **Tier 2**: Locations where the installation of charging infrastructure would be difficult or imprudent to pursue in the short term but would be realistic to meet demand by 2023. Typically, these sites would still be ideal, from a user perspective, but the installation process would be more complicated, potentially requiring discussions with land owners. These discussions would slow the process of infrastructure installation and therefore these sites are not recommended to be included in plans for 2020.

5.2 Charge Point Map

Figures 5 & 6 provide maps of different scales, showing of charging infrastructure locations, indicating all Tier 1 and Tier 2 sites along with the recommended type of charge point. Table 16 provides a list of sites, and further details about the size of the hubs and whether the location is on or off-street.

Figure 5. Location of sites for installing charge points

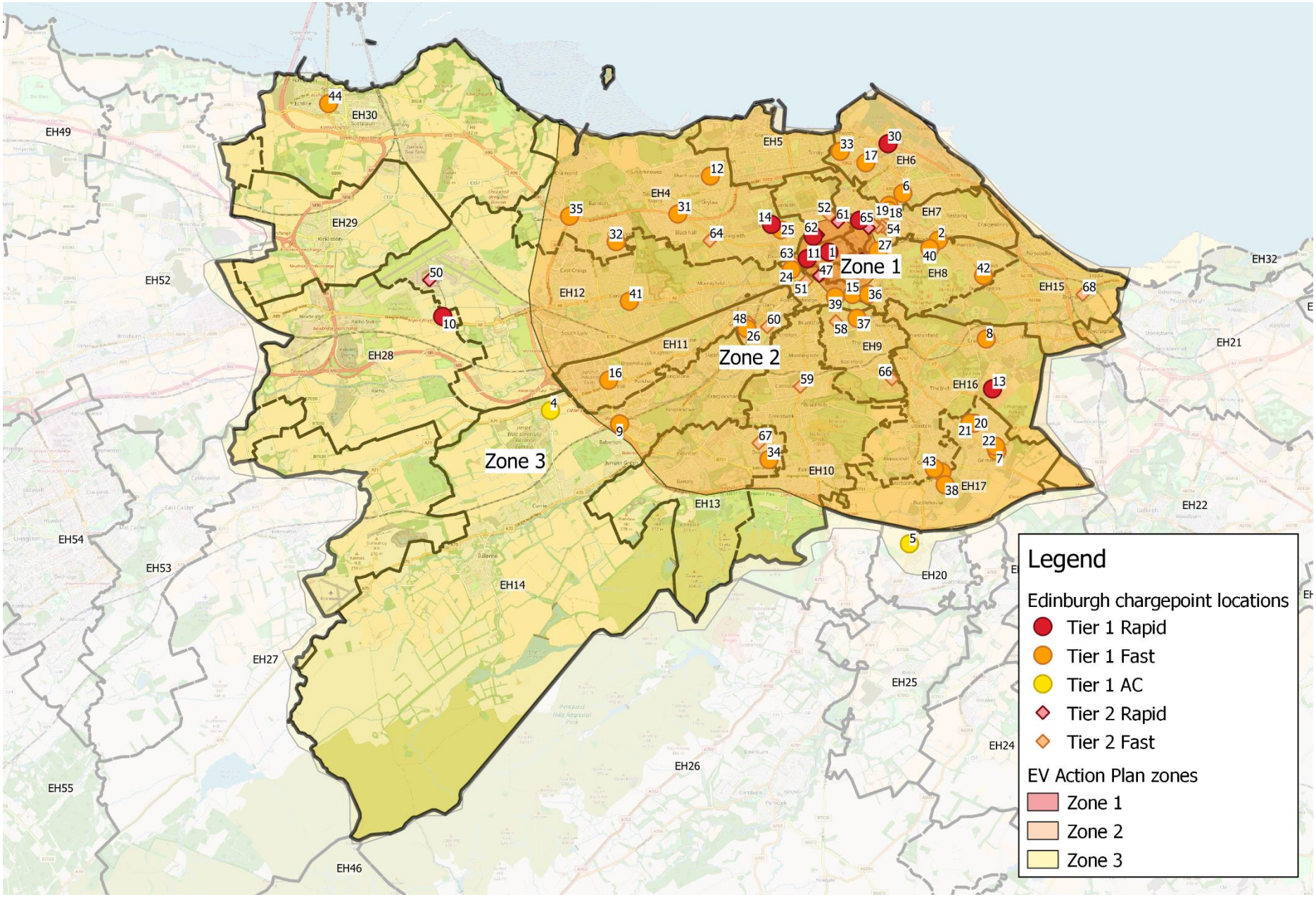
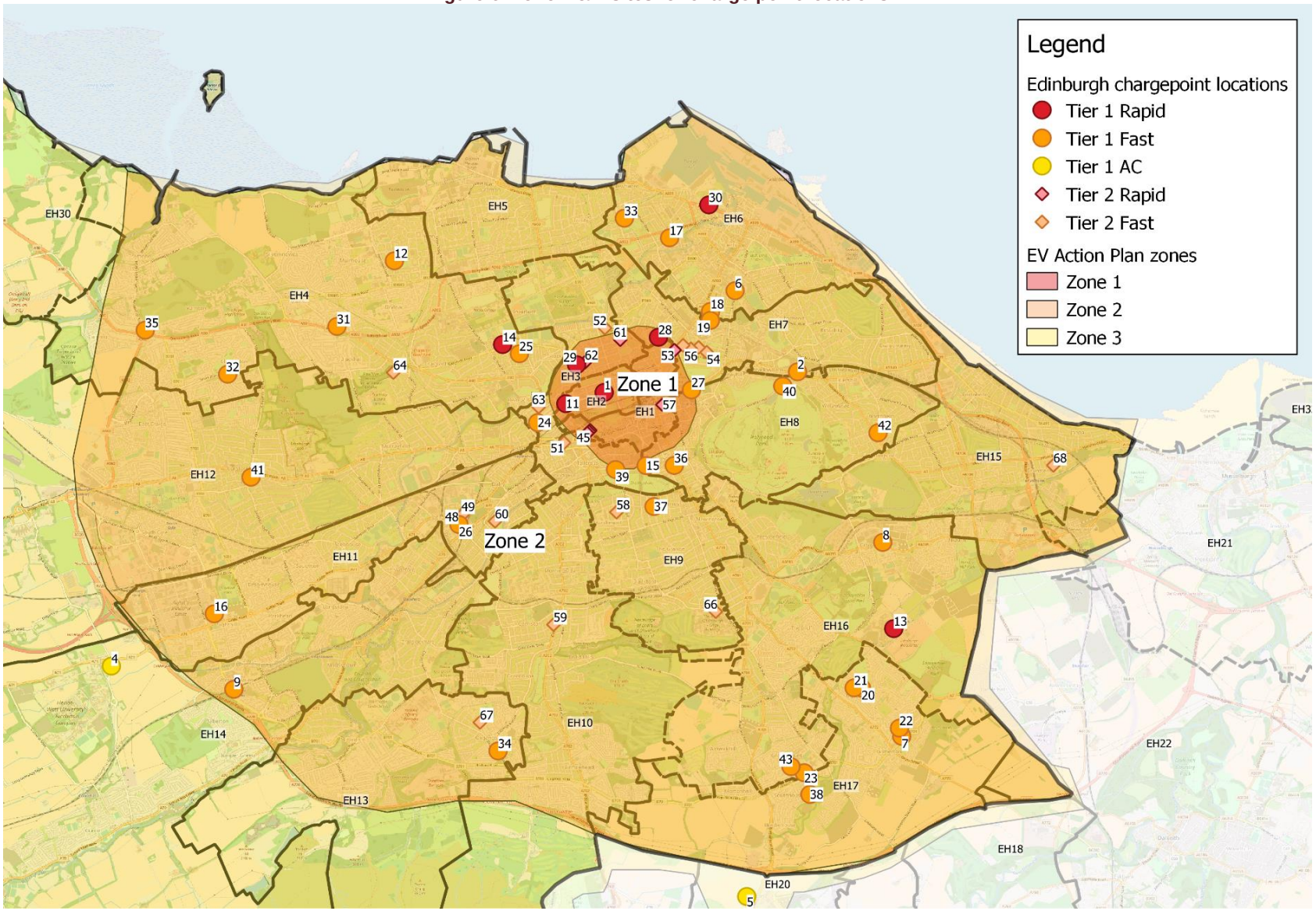


Figure 6. Zone 1 & 2 sites for charge point locations



5.2.1 List of locations from map

Table 16 shows each location, along with its respective primary purposes. These purposes include *Taxi* for taxi and private hire cars, *Park and Ride* users for visitors and commuters using park and ride, *Residents* for use by personal and commercial business users of vehicles registered in Edinburgh and *General use* where charge points would likely serve multiple user groups.

Locations are listed broadly in order of idealness, in terms of installation and usage, based on scoring criteria described previously in this section. Further information on these sites can be found in the appendix.

Table 16. List of Tier 1 and Tier 2 sites for installing charge points.

Tier 1 locations

Ref	Location description	Primary purpose	Charge Type
1	George Street	Taxi	Rapid
2	Meadowbank Sports Centre	General use	Fast
3	Ingliston Park and Ride (park and ride users)	Visitors	AC
4	Hermiston Park and Ride	Visitors	AC
5	Straiton Park and Ride	Visitors	AC
6	Easter Road	Residents	Fast
7	Ferniehill Square	Residents	Fast
8	North East Neighbourhood Office – CEC	Residents	Fast
9	Wester Hailes Healthy Living Centre (Harvesters Way)	Residents	Fast
10	Ingliston Park and Ride (taxis)	Taxi	Rapid
11	Charlotte Square	Taxi	Rapid
12	Edinburgh North Neighbourhood Services	Residents	Fast
13	Edinburgh Royal Infirmary	General use	Rapid
14	Fettes Avenue	General use	Rapid
15	George Square	Residents	Fast
16	Edinburgh College	General use	Fast
17	Pitt Street	Residents	Fast
18	Iona Street	Residents	Fast
19	Albert Street	Residents	Fast
20	Moredunvale Bank	Residents	Fast
21	Moredunvale View	Residents	Fast
22	Ferniehill Terrace	Residents	Fast
23	South East Locality Office - CEC	Residents	Fast
24	Melville Street	Residents	Fast
25	Comely Bank Street	Residents	Fast

Ref	Location description	Primary purpose	Charge Type
26	Stewart Terrace	Residents	Fast
27	New Parliament House (Regent Road)	General use	Fast
28	East London Street (outside bus garage)	General use	Rapid
29	Gloucester Place/India Street	General use	Rapid
30	Commercial Street	General use	Rapid
31	Blackhall Library	Residents	Fast
32	Drumbrae Library	Residents	Fast
33	Victoria Park/Craighall Avenue Car Park	Residents	Fast
34	Oxgangs Street (South side, at Oxgangs Rd North)	Residents	Fast
35	Barnton Grove	Residents	Fast
36	St Patricks Square (on-street)	General use	Fast
37	Sciennes Road	General use	Fast
38	Southhouse Brae	Residents	Fast
39	The Quartermile (Nightingale Way/Chalmers St)	Residents	Fast
40	Duke's Walk Car Park	General use	Fast
41	Westfield House Social Work Centre	Residents	Fast
42	Northfield Broadway (Near Northfield Farm Avenue)	Residents	Fast

Ref	Location description	Primary purpose	Charge Type
43	Gracemount Drive (opposite Balmwell Avenue)	Residents	Fast
44	South Queensferry, Forth Road Transport Authority	Residents	Fast

Tier 2 locations

Ref	Location description	Primary purpose	Charge Type
45	King's Stables Road	General use	Rapid
46	Castle Terrace Car Park	General use	Rapid
47	Castle Terrace (on-street)	General use	Rapid
48	Wardlaw Place	Residents	Fast
49	Wardlaw Street	Residents	Fast
50	Edinburgh Airport	Taxi	Rapid
51	Edinburgh Intl Conference Centre (near Western Approach Rd)	General use	Fast
52	Eyre Place	Residents	Fast
53	Elm Row (street side parking)	General use	Rapid
54	Wellington Street	Residents	Fast
55	Hillside Street	Residents	Fast

Ref	Location description	Primary purpose	Charge Type
56	Brunswick Street	Residents	Fast
57	East Market Street (mid-point)	Taxi	Rapid
58	Arden Street	Residents	Fast
59	Craiglea Drive	General use	Fast
60	Harrison Park East - W Bryson Road	Residents	Fast
61	Royal Crescent, park side	Residents	Rapid
62	Circus Place	Residents	Rapid
63	Drumsheugh Gardens	Residents	Fast
64	West Court - Parking east side	Residents	Fast
65	Montgommery Street	Residents	Fast
66	James Hutton Road - University of Edinburgh	Residents	Fast
67	Colinton Mains Park Pavilion - car park off Oxgangs Rd North	Residents	Fast
68	Edinburgh College Milton Road	General use	Fast

The locations listed in this section have been identified to provide the levels of infrastructure required to meet the high scenario at 2020 and 2023. For other scenarios, there is therefore flexibility to choose the most relevant locations to meet the charging infrastructure figures.

The total number of chargepoint locations proposed is shown in table 17. Note that chargepoints recommended for visitors are double-headed, meaning the total number sites is effectively half the number of total charging bays.

Table 17. Total number of EV chargepoint sites identified through mapping.

	General use	Residents	Taxi	Visitors	Total
Tier 1 (2020)	48	146	14	79	285
Tier 2 (2023)	40	70	10	-	120
Grand Total	**88**	**216**	**24**	**79**	**405**

6. Financial Case

A business case has been developed based on the charge point requirements of each vehicle group, estimated capital and annual operating costs, leading to estimate of annual revenue and profit (revenue less operating costs). Based on the balance between capital funding requirement and profit potential, repayment intervals have also been calculated (capital costs divided by annual profit). These repayment intervals are based on levels of demand forecast at 2020 and 2023 respectively. This section details the assumptions and concludes with the financial business model itself.

6.1 Itemised Costs

The costs underpinning the business model have been calculated using quotes previously provided to the City of Edinburgh Council by a leading chargepoint provider. As these costs are taken from a previously issued quote, they provide reassurance that the overall business case proposed in this report is reliable and, at the very least, an indication of the highest capital cost that CEC should realistically incur in delivering the recommended levels of charging infrastructure. Through a procurement process, more competitive quotes may be sourced and this will naturally have a positive effect on the overall business case. For the purposes of the business case proposed in this report, the value of each item costed is shown in table 18. All prices are exclusive of VAT.

Table 18. Costs associated with each charge point unit.

Item	Equipment (per unit)	Installation (per unit)	Operation, maintenance & warranty (per unit per year)	Electricity cost (per kWh)[9]
50kW DC rapid charger	£19,647	£5,000	£1,650	£0.126
22kW DC fast charger	£17,647	£5,000	£1,650	£0.126
7kW AC double-headed fast charger	£1,705	£1,900	£555	£0.126

6.2 Procurement Options

Costs are based on a purchase-and-own procurement model, whereby CEC would have full ownership of all assets installed and would contract the maintenance of the units to a supplier. Other procurement models for installing and operating electric vehicle charging infrastructure have been developed, but the case for a purchase-and-own procurement model is strong in this instance. This is because present estimates suggest that capital investment made in the short-term will be repaid in the medium-term.

An alternative procurement model would be to run a concession system, whereby charge point providers pay a fee to operate their charge point from a location made available by CEC over a given period of time. During the period of this concession, a revenue or profit share would be agreed. Typically, a concession framework lowers the capital exposure of installing charging infrastructure and elements of contractual risk but lowers revenue and profit potential.

[9] The average cost of electricity purchased by CEC

6.3 Grid Constraints

Installation costs shown in table 18 include expenses related to a standard grid connection or building connection, but **do not include any costs related to further electricity grid distribution infrastructure upgrades** (e.g. uprated or new substations). Later in this report, we have identified and recommended charge point locations that, amongst other important criteria, are located near to substations. This somewhat reduces the risk of substantial costs being incurred to upgrade electrical distribution infrastructure.

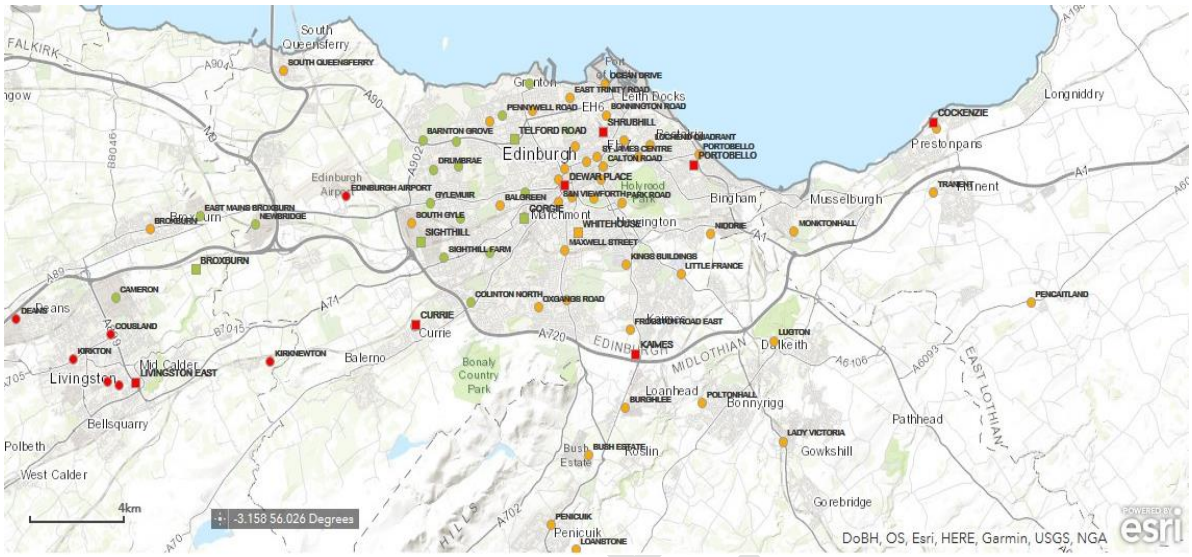


Figure 7. Scottish Power Energy Networks Heat Map - Electrical Distribution Network in Edinburgh.

According to information provided by Scottish Power Energy Networks (SPEN)[10] (valid April 2018), all recommended charge point locations fall within areas where both the high voltage network and the nearest primary substation are rated at least amber by SPEN. This suggests that some grid constraints may exist, but also that capacity may likely be available for certain applications. A number of sites fall into areas where both primary substations and the high voltage network are rated green, suggesting that grid reinforcement is less likely to be required. None of the sites recommended for charging infrastructure installation would draw upon either primary substations or high voltage networks that are categorised as red by SPEN, meaning that extensive grid reinforcement is unlikely to be required on the high voltage network or at primary substations prior to the installation of charging infrastructure.

A constraint that is likely to exist in the case of many of the sites recommended is at the grid supply points (GSPs) of Edinburgh's distribution network. GSPs are infrastructure facilities where electricity is transferred from the transmission network to the distribution network. The following GSPs have a fault level constraint and would likely need to be reinforced prior to the mass installation of charging infrastructure in the area:

- Dewar Place GSP, covering central Edinburgh, which will supply the majority of charging infrastructure in Zone 1
- Shrubhill GSP, covering north Edinburgh, which will supply charging infrastructure in Leith and Trinity
- Portobello GSP, covering north-east Edinburgh, which will supply charging infrastructure in Portobello, Bingham and Middrie

[10] Scottish Power Energy Networks, Distribution Network Heatmap

The Whitehouse GSP, covering south Edinburgh, may also potentially require reinforcement in the future, but currently has headroom to accommodate new connections for charging infrastructure.

To determine whether or not grid reinforcement would be required and the associated capital costs of such works, site surveys will need to be conducted by SPEN.

6.4 Battery storage and renewable generation

EV charging infrastructure can be coupled with battery storage, which operate by charging slowly over several hours (ideally overnight or during off-peak periods for electric demand) before refuelling a vehicle, often through rapid charging (full charge in under an hour). The benefit of battery storage is that it reduces the requirement for grid reinforcement work, as the batteries typically draw less power from the grid than a fast or rapid chargepoint.

Battery storage can be installed with specific storage capacities and, with greater storage capacity, more EVs can be refuelled each day. For example, if a 60kWh battery storage device is installed to support an EV chargepoint, this will provide enough energy to fully recharge approximately two Nissan Leafs[11].

In terms of cost, indicative estimates provided by a supplier of battery storage for EV charging infrastructure suggest that **a 90kWh battery storage device would add approximately £90,000 to the capital cost of EV chargepoint installation**. For a site where four rapid chargers were being installed, the cost of battery storage would roughly double the overall installation cost. For this reason, the business case for battery storage technology is typically only sound in locations where grid reinforcement works are required to the extent where the cost of battery storage is less than the cost of grid reinforcement.

Charging infrastructure that is equipped with battery storage can also be accompanied by renewable energy generation equipment – most often solar panels. By including renewable generation, the requirement to draw electricity from the grid is further reduced, the carbon emissions associated with the electricity provided by chargepoints is reduced and additional revenue can be generated by selling surplus renewable energy back to the grid.

6.5 Tariffs

When the first generation of EV charging infrastructure was installed, it was common that these chargers would be free for the public to use. This was seen as a method to encourage faster uptake of EVs and was achieved on the basis of subsidies from either national or local government. In the present day, the market for EVs has developed and the practice of providing free charging infrastructure is uncommon. In this business case, we have set tariffs on the basis that capital investment can be repaid by revenue generated by the infrastructure. A summary of the tariffs that this business case is based on are shown in table 19. How this tariff was decided upon is described later in this subsection.

Table 19. Tariffs used in the business model.

User group	Pence per kWh	Connection fee
Residents and business	20p	30p
Taxi and private hire	20p	£1.00
Park and ride users	20p	£2.00

[11] Nissan Leaf equipped with either 24kWh or 30kWh battery pack.

6.5.1 Pence per kWh

The viability of the business model is heavily dependent on the tariffs set. The tariffs assumed for each of the user groups are shown in table 19. Rates have been set at 20p per kWh of electricity provided (in line with Transport Scotland guidance), with connection fees charged at varying rates to different user groups.

Whilst 20p per kWh is the highest tariff recommended by Transport Scotland, it still represents a competitive and attractive tariff when compared to existing EV charging infrastructure across the UK. For example, Shell announced in 2017 that rapid chargers at Shell petrol stations would charge 25p per kWh until June 2018, at which point they were due to raise the tariff to 49p per kWh[12]. Another comparator is that. at time of writing, new users of Tesla's supercharger network are billed at 20p per kWh[13]. 20p per kWh tariff is therefore not significantly out of step with wider market trends.

The business case proposed in this report is based on a 20p per kWh tariff, as that tariff is associated with the shortest investment repayment interval and the greatest revenue generating potential, whilst being comparable and even competitive with typical market rates. There are reasons that CEC may wish to consider lower tariffs (e.g. as a further incentive for residents to purchase an EV) but, as these reasons are largely for social benefit and are therefore valued subjectively, they should be subject to political discourse. Alternative financial models were calculated for 15p and 17.5p per kWh tariff, which can be found in the appendix. For comparative purposes, the repayment intervals associated with each tariff (as of 2023) are shown in table 20.

Table 20. Comparison of repayment periods of 15p/kWh, 17.5p/kWh and 20p/kWh tariffs, as of 2023.

	Repayment period (years)		
Scenario	**15p/kWh**	**17.5p/kWh**	**20p/kWh**
Low	18.5	11.4	8.2
Medium	13.6	9.1	6.9
High	11.5	8.0	6.1

6.5.2 Connection fees

Connection fees are charged when the user begins charging and are often an effective deterrent to prevent users from plugging into a charge point when they do not require a significant charge. This ensures that charge points are more likely to be available when they are *needed* by users. In this context, there is a greater requirement for connection fees in the case of charge points for taxi and private hire vehicles and for park and ride users. For TPH vehicles, connection fees will help avoid situations where a driver who requires a small charge prevents a driver whose battery is nearly empty from using the charge point. Similarly, for park and ride users, connection fees can prevent users from plugging their vehicle in for several hours when a small charge is all that is required.

In this business model a **£2.00 connection fee has been suggested for park and ride users**, as the misuse of these chargepoints could have the greatest detrimental effect. Without a significant connection fee, a park and ride user whose EV only requires a quick charge could block out a chargepoint for many hours before they return from Edinburgh City

[12] https://www.shell.co.uk/motorist/welcome-to-shell-recharge.html
[13] https://www.tesla.com/en_GB/supercharger

Centre. This could have the consequence of not allowing another user, whose EV is without charge, from recharging their vehicle, potentially preventing them from returning home. Another consideration to make, albeit of a political nature, is that this group of EV users are visitors to Edinburgh and therefore do not make the same local economic contributions as residents, arguably justifying a higher fee than other user groups.

This business case has suggested a **£1.00 connection fee for taxi and private hire drivers**. This is for two reasons. Firstly, TPH drivers require the use of rapid chargers which come at a higher capital cost and it is therefore sensible to assume that they will be moderately more expensive to use. Secondly, the misuse of rapid chargers that are intended for TPH use would have considerable negative consequences if, for example, a driver whose EV *needs* recharging is forced to wait for a driver who elected to charge their EV without it being entirely necessary.

Lastly, a **30p connection fee has been suggested for users of charging infrastructure in residential locations**. This fee is not necessarily intended to dissuade residents from misusing public charging infrastructure, but is instead proposed to contribute to the business case for investment in public charging infrastructure for residents. Without a 30p connection fee, it was forecasted that many of the chargepoints installed for use by residents would potentially make an ongoing loss.

For comparison, Dundee City Council charges a £2.00 connection fee at all of the rapid chargers it hosts. The connection fees proposed in this business case are therefore comparable and competitive with charging infrastructure found in other locations.

6.6 Financial Model

The financial model for investing in charging infrastructure up to 2023 can be found in table 21. This table shows estimates for capital expenditure, annual operating expenditure, annual revenue and annual profit if the medium scenario was realised. These figures are based on the tariffs proposed in table 19.

These figures are based on a series of agreed assumptions (which can each be found in the appendix) as well as the costs and approach described previously in this section of the report. It shows the estimated costs and potential revenue generation for providing the charging infrastructure which the forecasts suggest will be required by each user group.

Alternative financial models have been calculated to compare different tariffs and illustrate the impact of tariffs on the business case. **The results of the financial models using 15p/kWh and 17.5p/kWh tariffs are shown in the appendix.**

Table 21. Business model for investment in charging infrastructure for each zone and scenario. Note - capital spend values for 2023 are *cumulative* and therefore inclusive of capital spend by 2020. All values are exclusive of VAT and based on 20p per kWh tariff.

Scenario		2020					2023 (cumulative)				
		Capital	Annual OpEx	Annual revenue	Annual profit	RI (years)	Capital	Annual OpEx	Annual revenue	Annual profit	RI (years)
Residents (zone 2)	High	£951,174	£207,678	£256,502	£48,824	19.5	£4,348,224	£1,055,727	£1,369,694	£313,968	13.8
	Mid	£792,645	£162,045	£193,324	£31,279	25.3	£2,513,817	£598,967	£770,769	£171,802	14.6
	Low	£769,998	£158,350	£189,533	£31,183	24.7	£1,766,466	£415,000	£530,693	£115,693	15.3
Taxi & private hire (zone 1)	High	£320,411	£107,682	£250,684	£143,002	2.2	£985,880	£393,140	£974,499	£581,359	1.7
	Mid	£221,823	£57,966	£125,342	£67,376	3.3	£566,881	£201,520	£487,249	£285,730	2.0
	Low	£221,823	£57,966	£125,342	£67,376	3.3	£320,411	£103,235	£243,625	£140,390	2.3
Park and ride (zone 3)	High	£129,780	£34,886	£48,245	£13,359	9.7	£529,935	£145,958	£208,350	£62,392	8.5
	Mid	£90,125	£24,428	£34,156	£9,728	9.3	£277,585	£76,373	£108,871	£32,499	8.5
	Low	£79,310	£21,180	£29,032	£7,852	10.1	£205,485	£56,303	£79,839	£23,536	8.7
Total	**High**	**£1,401,365**	**£350,246**	**£555,431**	**£205,185**	**6.8**	**£5,864,039**	**£1,594,825**	**£2,552,543**	**£957,719**	**6.1**
	Mid	**£1,104,593**	**£244,439**	**£352,822**	**£108,383**	**10.2**	**£3,358,283**	**£876,860**	**£1,366,889**	**£490,031**	**6.9**
	Low	**£1,071,131**	**£237,496**	**£343,907**	**£106,411**	**10.1**	**£2,292,362**	**£574,538**	**£854,157**	**£279,619**	**8.2**

7. Conclusion and recommendations

The commissioning of this study by Edinburgh City Council has clearly demonstrated the council's commitment to exploring the practical solutions necessary to meet climate change and air quality targets within the wider context of the Scottish and UK Governments current policy agenda.

In addition to the technical challenges that transition towards an EV enabled city poses, this report aims to demonstrate how the installation of supporting infrastructure can benefit both the council administration and wider public by applying solutions in a technically and economically sound method which offers sustainable returns on capital expenditure.

The problems associated with the carbon-based economy are not merely constrained to a single socio-economic group and by the studies consideration of the infrastructure requirements within the wider context of the city and across a range of demographics, the delivery of the benefits can be realised across a more diverse proportion of society. This equality is complimentary to the application of low emission zoning as despite defined regions being geographically separate by definition; the benefits are evenly distributed across different user groups and are non-discriminatory.

This study highlights the mechanisms, that if adopted, will provide the appropriate infrastructure and technology to support a significant step change in EV uptake for the periods up to 2020 and 2023. This will provide Edinburgh with a competitive edge, equipping the Council with proven and scalable delivery mechanisms for the period beyond 2023 and towards 2032.

A key strategy of Edinburgh City Council is to realise it's ambitions to be an "Inspired, Thriving, Connected and Fair City" and through development of the recommendations contained within this report, Edinburgh has an opportunity to be a world leader in the proactive, economically viable enablement of EV infrastructure.

7.1 Technical Recommendations

7.1.1 Quantity of Charge Points Required

Drawing together the forecasts for each user group and zone, it is estimated that 69 Tier 1 charge points of different types (7kW, 22kW and 50kW) will be required in total across the city by 2020, increasing to 211 by 2023, under a medium scenario. Around 379 charge points will be required by 2023 under the high scenario, as described in the table 22.

Table 22. Summary of charge point requirements across all user groups.

Scenario	2020				2023			
	Residents & Commercial (Fast - 22kW DC)	Park & Ride visitors (7kW AC)	Taxi & Private hire (Rapid – 50kW DC)	Total	Residents & Commercial (Fast - 22kW DC)	Park & Ride visitors (7kW AC)	Taxi & Private hire (Rapid – 50kW DC)	Total (cumulative)
Low	34	22	9	**65**	78	57	13	**148**
Mid	35	25	9	**69**	111	77	23	**211**
High	42	36	13	**91**	192	147	40	**379**

7.1.2 Environmental benefits of electric vehicle adoption

With vehicle users moving from petrol and diesel vehicles to EVs, there will be environmental benefits both in terms of reducing carbon emissions, that are linked to climate change, and pollutant emissions, that are the cause of over 40,000 premature deaths a year across the UK. The environmental benefit of EV adoption in each category is calculated as the product of the number of EVs forecasted, the average annual mileage and emission factors developed by the UK Department for Environment, Food and Rural Affairs.

Based on the assumptions made to predict the charge point requirements of EVs in Edinburgh, it was possible to estimate the total reduction in both carbon and pollutant emissions. This is shown in table 23:

Table 23. Summary of the environmental and health benefits from investment in charge points.

Scenario	2020		2023	
	CO_2 (tonnes per year)	NO_2 (tonnes per year)	CO_2 (tonnes per year)	NO_2 (tonnes per year)
Low	1,914	3.5	4,519	8.3
Mid	1,944	3.6	7,715	14.2
High	3,310	6.1	14,704	27.1

7.1.3 Zonal approach

Through the sites identified in this study, the zonal approach proposed in City of Edinburgh Council's EV Action Plan is a viable framework within which EV charging infrastructure investment can be planned. In the vast majority of cases, the profile of likely users for sites identified in each of the EV Action Plan's three proposed zones matches the description of the intended target user groups.

Based on this study, it is apparent that there are several locations which do not necessarily conform to the EV Action Plan. One example of this is South Queensferry, which resides within Zone 3, but has more in common with Zone 2 and charging infrastructure provision should therefore be made on that basis. Similarly, Edinburgh Airport resides in Zone 3, but is a key site around which TPH drivers would likely wish to charge, meaning it may have more in common with Zone 1. Another notable deviation from the zonal approach is in the case of hospitals, many of which are located in Zone 2 but, with the amount of use from TPH drivers, has more in common with Zone 1. Lastly, locations within Zone 1 are likely to be required for use by residents living in Edinburgh City Centre, meaning that they have elements of the definition of Zone 2.

As a result of these occasional deviations from the Zonal approach, it is recommended that flexibility is retained within the plan to ensure that locations that do not necessarily conform to the typical use profile of the zone in which they reside can be provided with EV charging infrastructure that meets the specific requirements of that location.

7.2 Next Steps

7.2.1 Pre-2020 (short term)

Following this delivery of this report to committee, its key findings should be scrutinised, with particular attention given to proposed locations of charging infrastructure. Agreement should

be made on the extent of CEC's ambition, including which of the scenarios proposed in this report are to be pursued.

Once approved by committee, connection estimates should be requested from SPEN for the sites identified. Should any of the proposed locations be unfeasible due to a lack of electric grid supply, alternative nearby sites should be considered. It is important however to ensure that the location of the charge point and its use is the primary consideration. Charge points will only be regularly used in locations where they are needed.

Incorporating the cost estimates received from SPEN, the final business model should be developed and agreed. At this point, engagement with the EV charging infrastructure industry and the procurement of an infrastructure supplier should commence, with the initial procurement focussing on Tier 1 sites.

With an infrastructure provider procured, stakeholder engagement across CEC should begin, particularly with site managers in locations where infrastructure is being installed. Wider public awareness of the plan could be raised through public announcements and events.

At this point, the installation phase of the charging infrastructure network will commence and project progress should be monitored.

Whilst monitoring project progress regarding the installation of infrastructure in Tier 1 sites, engagement should begin with private land owners where Tier 2 sites have been identified – such as shopping centres, fuel stations, hospitals and Edinburgh airport. This will lay the groundwork for medium term installation of charging infrastructure across Tier 2 locations.

7.2.2 2020-2023 (medium term)

The number of EVs on the road will keep increasing for many years and therefore the provision of charging infrastructure must grow with it. As such, it is important that, in the medium term, the use of the existing network of charging infrastructure is monitored to ensure that the network is expanded in locations where demand is growing.

Ongoing engagement with the private stakeholders above should include monitoring, where possible, the privately-funded installation of public charging infrastructure on private land. This will ensure that the provision of charging infrastructure is meeting and not exceeding demand and that CEC can plan its level of investment accordingly.

Having raised awareness with the public through the increased visibility of EV charging infrastructure, necessity for new sites may emerge. It is therefore important to remain open to suggestions and requests from the public and other stakeholder groups.

7.2.3 Post-2023 (long term)

All sites (Tier 1 and 2) should be installed and in operation. CEC should consider a full review and forecasting exercise in order to determine the success of the scheme to date including the uptake of EVs across commercial and private users and investigate new sites for development up to 2030.

Technologies that are presently not market ready are likely to have come to market within this timescale. These technologies include wireless (inductive) charging, ultra-rapid charging (thought to be up to seven times faster than the rapid chargers proposed in this report) and energy storage at scale. As such, a review of EV infrastructure provision should take these

new technologies into consideration alongside the rate of growth of the EV use in the City and the commercial success of the investment made in infrastructure to date.

7.3 Non-Technical Recommendations

Aside from the technical recommendations made in this study, there are a number of non-technical considerations that are important to consider. We would recommend that the following non-technical considerations are made:

Offer residents a point of contact within City of Edinburgh Council whereby they may express their interest in having EV charging infrastructure installed in their area.

Whilst every effort has been taken in this study to rationally determine where EV adoption is likely to take place, there is no method by which the exact locations can be identified. From the perspective of the City of Edinburgh Council, the greatest method by which specific areas of demand for EV infrastructure can be identified is to encourage, monitor and report on enquiries made by residents. For a resident who is considering the purchase of an EV who does not have access to off-street parking, having the ability to notify City of Edinburgh Council of their intent to purchase is both important to the resident – as they will be reliant on public charging infrastructure – and important to City of Edinburgh Council, who can use these enquiries to target infrastructure investment.

Liaise with ChargePlace Scotland network operator on a regular basis to identify specific areas where EV adoption is occurring or where charging infrastructure is being especially well utilised, in order to better respond to demand.

Another method by which demand for EV charging infrastructure can be identified is through liaison with the network operator. In the case of Scotland, public infrastructure is operated by Charge Your Car as part of the ChargePlace Scotland network. By liaising with the network operator, insight on the location of EV owners who have registered on the network can be shared, highlighting locations where users may require a greater provision of charging infrastructure. The network operator can also provide insight on existing infrastructure that can distinguish the locations where charging infrastructure is approaching peak utilisation, indicating that a case may exist for further investment. By reviewing this insight regularly, the development of the charging infrastructure network in Edinburgh can be demand-led – an approach that lends itself to a robust business case for investment.

Work with local businesses to encourage the installation of workplace charging infrastructure

Residents without access to off-street parking will most likely need provision of public infrastructure to provide them with the confidence required to purchase an EV. Despite the greatest efforts of City of Edinburgh Council, it is almost inevitable that certain residential areas will neither have off-street parking, nor will there be a feasible site for public infrastructure to be installed nearby. In these instances, the provision of charging infrastructure at a respective user's workplace is the next most convenient location that infrastructure could be installed. Whilst the local authority generally has no direct influence over the provision of charging infrastructure in a private workplace, City of Edinburgh Council still has a role to help encourage businesses to install charging infrastructure for use by their employees. Making sure that local businesses are aware of the importance of the transition to EVs, as well as the wider measures being taken across Edinburgh, would help provide businesses with the confidence to invest in charging infrastructure on their property.

Provide private landowners with a point of contact to discuss provision of charging infrastructure at retail parks, leisure centres and other attractions.

This study had focussed almost exclusively on public-owned sites for charging infrastructure installation, as these sites are within the control of City of Edinburgh Council. This makes the installation of charging infrastructure considerably more straightforward. However, a safe rationale to follow when choosing sites for charging infrastructure is to identify areas where motorists are already parking. These sites can often include privately owned multi-story car parks, retail parks, leisure centres and venues. Whilst City of Edinburgh Council cannot force private land owners to install charging infrastructure, it potentially has a role to play in ensuring that these land owners have the confidence to install charging infrastructure and are aware of the costs and benefits.

Ensure that planning guidance is enforcing the installation of charging infrastructure on newly developed sites.

Local authorities have limited powers to enforce the provision of charging infrastructure on existing privately-owned sites but, through planning, local authorities can ensure that new developments are being planned and built with the future in mind. Ensuring that planning guidance is being set in a way which requires new developments to provide parking spaces with charging infrastructure already installed (or at least with the necessary cabling in place to simplify the installation at a later date) is an effective measure that would improve the level of charging infrastructure provision across Edinburgh. Most importantly, the residents of new multi-tenement developments, that typically have private off-street car parks, would not require the use of public infrastructure to operate an EV.

8. Appendix

8.1 Methodology EV Adoption and Charge Points

For all vehicle groups, forecasts for EV adoption were combined with information on vehicle use to estimate the amount of charging infrastructure that will be required to support the use of EVs. The methodology followed is summarised in figure 8.

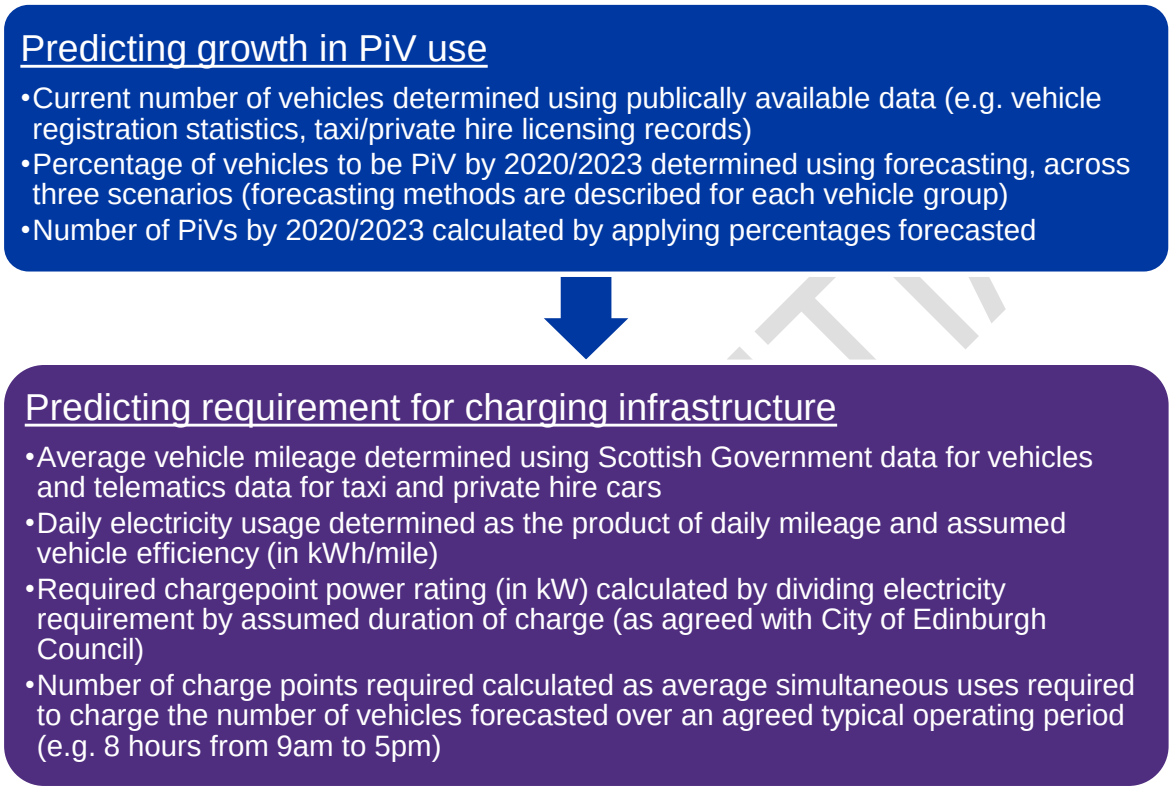


Figure 8. Methodology for EV adoption and charge points.

While anticipated charging habits for each vehicle user group takes account of similar variables, such as average distance driven, and length of charge, the assumptions within the methodology will be different, due in part to the differences in the data source for each group. For each vehicle group, assumptions made and the sources of information on which they are based can be found listed for each vehicle group in tables below.

It has been assumed that the proposed charge point sites may be utilised by electric car club users. In 2016/17 35%, or 101 of the Scottish car club fleet were EVs and 70 of those were EV or hydrogen fuel cell vehicles[14].

8.2 EV Trends

The graph below forecasts the number of EVs that will be registered up to 2023 across Scotland, based on the same methodology and scenarios for the forecasts for EV adoption within Edinburgh, such as figure 4 (residential and commercial users).

[14] Carplus; Annual Survey of Car Clubs, 2016/17, Scotland

For context, there are approximately 2.7 million cars and lights vans in Scotland. Under the medium scenario by 2023, 2.5% will be EVs and under the high scenario, 5%.

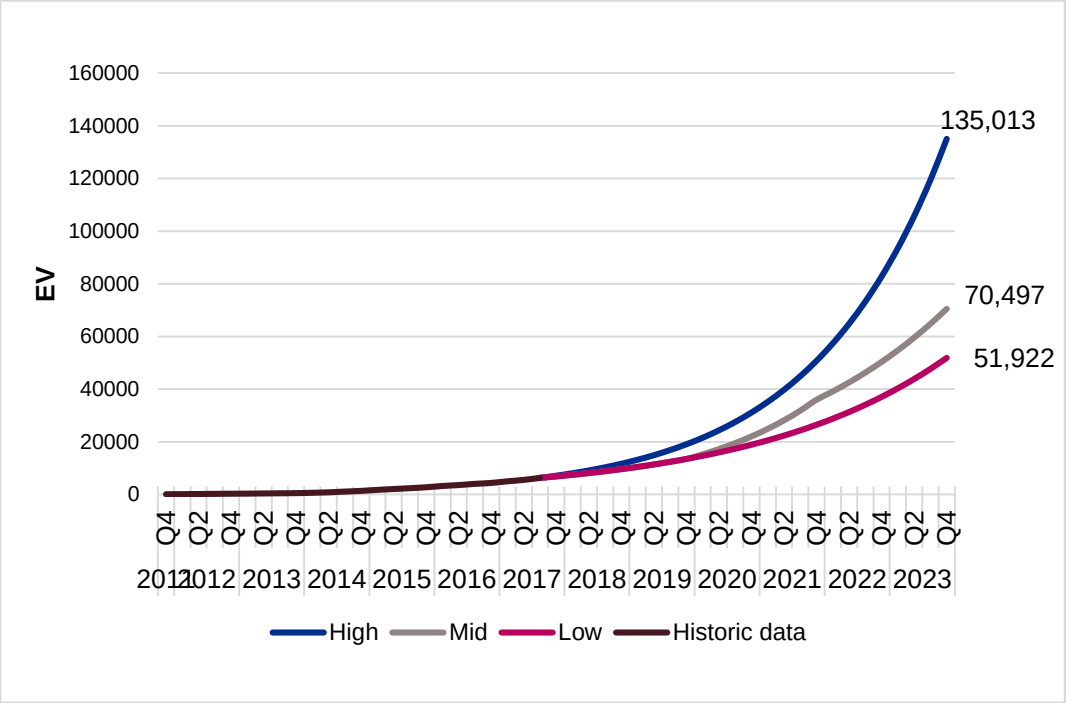


Figure 9. Forecasted adoption of EVs across Scotland.

8.3 Chargepoint Calculation Assumptions

Assumptions have been made, for modelling and forecasting purposes. These assumptions are based on the typical behaviour of vehicle operators in each user group. Where precise, numerical indicators were required (e.g. daily vehicle mileage), data has been taken from reliable sources. In other instances, assumptions are based on common practical considerations for each vehicle group (e.g. peak hours of chargepoint usage).

8.3.1 Resident & Commercial Vehicle

Assumptions concerning how vehicles registered in Edinburgh are used were informed by consulting a variety of sources and are described in table 24. In some cases, assumptions have been made based on sound judgement, where it was sensible to do so, and in agreement with City of Edinburgh Council.

Table 24. Assumptions behind the residential and commercial EV forecasts

Assumption	Data source (where applicable)
Average daily mileage of 14.9 miles a day	Scottish Government Household Survey 2016
Average journey frequency of once every two days	Scottish Government Household Survey 2016
40-70% of residents have access to off-street parking, varying by postcode district	Data from controlled parking zones, where possible. Agreed with CEC outside of CPZs.

Assumption	Data source (where applicable)
Residents without off-street parking are 20% less likely to purchase an EV	Taken from findings of EST survey undertaken in West of England
Residents with off-street parking will have their own charge point installed and will use that over a public charge point	This is likely to be most convenient and grants are currently available to assist with installation costs.
Average efficiency of electric vehicle is 0.3kWh per mile.	Based roughly on the combined real-world efficiency of a Nissan Leaf and a Renault Zoe
Vehicles will be charged once a day	Agreed assumption, based on practical considerations of vehicle group
Vehicle charging will take place within a four hour window (assumed to be 5-9pm)	Agreed assumption, based on practical considerations of vehicle group
Charge points will be roughly 75% utilised during the four hour period between 5-9pm.	Agreed assumption, based on practical considerations of vehicle group
Average charging sessions will be 15 minutes	The time required to provide an amount of charge equal to the average daily mileage of vehicles registered in Edinburgh
Residents will fully charge their vehicle upon each use	Agreed assumption, based on practical considerations of vehicle group
Charge point use spread evenly across usage period	Agreed assumption, based on practical considerations of vehicle group
A 53.5% petrol and 46.5% diesel split was assumed when calculating emission savings from EV adoption.	Scottish Transport Statistics 2017

8.3.2 Taxi & private hire vehicles

Assumptions on the operation of taxi and private hire cars were formed largely from gathered data and previous experience of the taxi and private hire industry, and detailed in table 25. In some cases, assumptions have been made based on sound judgement, where it was sensible to do so and in agreement with City of Edinburgh Council.

Table 25. Assumptions behind the taxi and private hire forecasts

Assumption	Data source
Average taxi and private hire daily working mileage of 39.3 miles, per vehicle, per shift	Telematics data
Average taxi private hire daily non-working mileage of 25.9 miles, per vehicle, per shift	Calculated to be two thirds of working mileage, reflecting commute and journeys back to rank/base
75% of taxi and private hire drivers fully charge their vehicle at home when off-shift	Agreed assumption, based on practical considerations of vehicle group
Taxi and private hire drivers who can charge at home overnight will do so	Agreed assumption, based on practical considerations of vehicle group

Assumption	Data source
Each taxi and private hire vehicle will use public charge points on average three times every two days.	Agreed assumption, based on practical considerations of vehicle group
Average efficiency of electric vehicle is 0.35kWh per mile.	Based on an average real world consumption of between the LEVC TX (eCity technology) black cab and a Nissan Leaf, reflecting mix of taxi and private hire
Vehicle charging will take place across 18 hours of the day (8am-following 2am)	Agreed assumption, based on practical considerations of vehicle group
Charge point use spread evenly across usage period	Agreed assumption, based on practical considerations of vehicle group
Charging sessions will be 10 minutes, on average	Agreed assumption, based on practical considerations of vehicle group

8.3.3 Park and Ride User Vehicles

Assumptions on the operation of vehicles visiting Edinburgh are outlined below. In some cases, assumptions have been made based on sound judgement, where it was sensible to do so and in agreement with the City of Edinburgh Council.

Table 26. Assumptions behind the park and ride EV user forecasts

Assumption	Data source
Average mileage of visitors to Edinburgh of 32.08 miles	Scottish Government Household Survey
Vehicle will be fully charged before setting out on journey to Edinburgh	Agreed assumption, based on practical considerations of vehicle group
Those travelling to Edinburgh from distances beyond the typical range of an electric vehicle will use alternative modes of transport	(this has been taken into account when using Household Survey data)
Usage of park and rides will not drastically increase up to 2023	Agreed assumption, based on practical considerations of vehicle group
Average efficiency of electric vehicle is 0.3kWh per mile.	Based roughly on the combined real-world efficiency of a Nissan Leaf and a Renault Zoe
Vehicle charging will take place across 12 hours of the day (7am-7pm), with vehicles remaining parked throughout this period	Agreed assumption, based on practical considerations of vehicle group
Charge point use spread evenly across usage period	Agreed assumption, based on practical considerations of vehicle group
Vehicles will be plugged into charger for the duration of their parking (i.e. owners will not unplug their vehicle until they leave)	Agreed assumption, based on practical considerations of vehicle group
A 53.5% petrol and 46.5% diesel split was assumed when calculating emission savings from EV adoption.	Scottish Transport Statistics 2017

8.4 Example Cost Calculation

The following is an example calculation which follows the same method employed to generate the financial model shown in this report. In this example, an area or 'hub' of five fast charge points for residential and commercial users, where charging is undertaken for 75% of the key 4 hour window for residential charging, 5pm-9pm, will be used 39 times every day, consuming 353kWh a day. This leads to the realistic cost calculation as follows:

Capital cost

- Five fast charge points x (equipment cost + installation cost)
- 5 x (£17,647 + £5,000)
- £113,235

Annual operating cost

- (Five fast charge points x operating, maintenance, warranty cost) + (daily electricity use x electricity rate) x 365
- (5 x £1,650) + (353kWh x £0.126) x 365
- £24,484 per year

Annual revenue

- (Daily electricity use x tariff price per kWh) + (daily number of uses x tariff connection fee) x 365
- ((353kWh x £0.20) + (39 x £0.30)) x 365
- £30,040

Annual profit

- Annual revenue - annual operating cost
- £30,040 - £24,484
- £5,556

Repayment interval

- Capital cost / annual profit
- £113,235 / (£5,556/yr)
- 20.38 years

8.5 Further information on chargepoint locations

Tier 1 locations

Map Ref	Zone	Postcode district	Location description	On-street *	Private land	Primary purpose	Charge Type	No of parking bays	Max no of charge-points	Installation (score/5)	Usage (score/5)	Tier
1	1	EH2	George Street	Y	N	Taxi	Rapid	6	6	5	5	Tier 1
2	2	EH7	Meadowbank Sports Centre	N	Y	General use	Fast	6	6	5	5	Tier 1
3	3	EH28	Ingliston Park and Ride (park and ride users)	N	N	Visitors	AC	50	25	5	5	Tier 1
4	3	EH14	Hermiston Park and Ride	N	N	Visitors	AC	19	10	5	5	Tier 1
5	3	EH20	Straiton Park and Ride	N	N	Visitors	AC	8	4	5	5	Tier 1
6	2	EH6	Easter Road	Y	N	Residents	Fast	8	8	5	5	Tier 1
7	2	EH17	Ferniehill Square	Y	N	Residents	Fast	8	8	5	5	Tier 1
8	2	EH16	North East Neighbourhood Office - CEC	N	N	Residents	Fast	4	4	5	5	Tier 1
9	2	EH14	Wester Hailes Healthy Living Centre (Harvesters Way)	N	N	Residents	Fast	6	6	5	5	Tier 1
10	3	EH28	Ingliston Park and Ride (taxis)	N	N	Taxi	Rapid	6	6	4	5	Tier 1
11	1	EH2	Charlotte Square	Y	N	Taxi	Rapid	2	2	4	5	Tier 1
12	2	EH4	Edinburgh North Neighbourhood Services	N	N	Residents	Fast	4	4	5	4	Tier 1
13	2	EH16	Edinburgh Royal Infirmary	N	Y	General use	Rapid	4	4	4	5	Tier 1
14	2	EH4	Fettes Avenue	Y	N	General use	Rapid	4	4	4	5	Tier 1

Map Ref	Zone	Postcode district	Location description	On-street *	Private land	Primary purpose	Charge Type	No of parking bays	Max no of charge-points	Installation (score/5)	Usage (score/5)	Tier
15	2	EH8	George Square	Y	N	Residents	Fast	6	6	4	5	Tier 1
16	2	EH11	Edinburgh College	N	Y	General use	Fast	8	8	4	5	Tier 1
17	2	EH6	Pitt Street	Y	N	Residents	Fast	8	8	4	5	Tier 1
18	2	EH6	Iona Street	Y	N	Residents	Fast	6	6	4	5	Tier 1
19	2	EH7	Albert Street	Y	N	Residents	Fast	6	6	4	5	Tier 1
20	2	EH17	Moredunvale Bank	Y	N	Residents	Fast	8	8	4	5	Tier 1
21	2	EH17	Moredunvale View	Y	N	Residents	Fast	6	6	4	5	Tier 1
22	2	EH17	Ferniehill Terrace	N	N	Residents	Fast	8	8	4	5	Tier 1
23	2	EH16	South East Locality Office - CEC	N	N	Residents	Fast	2	2	5	4	Tier 1
24	2	EH3	Melville Street	Y	N	Residents	Fast	6	6	4	5	Tier 1
25	2	EH4	Comely Bank Street	Y	N	Residents	Fast	4	4	4	5	Tier 1
26	2	EH11	Stewart Terrace	Y	N	Residents	Fast	8	8	4	5	Tier 1
27	1	EH7	New Parliament House (Regent Road)	Y	N	General use	Fast	6	6	5	4	Tier 1
28	1	EH7	East London Street (outside bus garage)	N	N	General use	Rapid	2	2	4	4	Tier 1
29	1	EH3	Gloucester Place/India Street	Y	N	General use	Rapid	2	2	4	4	Tier 1

Map Ref	Zone	Postcode district	Location description	On-street *	Private land	Primary purpose	Charge Type	No of parking bays	Max no of charge-points	Installation (score/5)	Usage (score/5)	Tier
30	2	EH6	Commercial Street	N	N	General use	Rapid	4	4	4	4	Tier 1
31	2	EH4	Blackhall Library	N	N	Residents	Fast	2	2	5	3	Tier 1
32	2	EH4	Drumbrae Library	N	N	Residents	Fast	4	4	5	3	Tier 1
33	2	EH6	Victoria Park/Craighall Avenue Car Park	N	N	Residents	Fast	6	6	4	4	Tier 1
34	2	EH13	Oxgangs Street (South side, at Oxgangs Rd North)	Y	N	Residents	Fast	4	4	4	4	Tier 1
35	2	EH4	Barnton Grove	Y	N	Residents	Fast	2	2	4	4	Tier 1
36	2	EH8	St Patricks Square (on-street)	Y	N	General use	Fast	4	4	4	4	Tier 1
37	2	EH9	Sciennes Road	Y	N	General use	Fast	4	4	4	4	Tier 1
38	2	EH17	Southhouse Brae	Y	N	Residents	Fast	4	4	4	4	Tier 1
39	2	EH3	The Quartermile (Nightingale Way/Chalmers St)	Y	N	Residents	Fast	4	4	4	4	Tier 1
40	2	EH8	Duke's Walk Car Park	N	Y	General use	Fast	4	4	4	3	Tier 1
41	2	EH12	Westfield House Social Work Centre	N	N	Residents	Fast	4	4	4	3	Tier 1
42	2	EH8	Northfield Broadway (Near Northfield Farm Avenue)	Y	N	Residents	Fast	4	4	4	3	Tier 1
43	2	EH16	Gracemount Drive (opposite Balmwell Avenue)	N	N	Residents	Fast	6	6	4	3	Tier 1
44	3	EH30	South Queensferry, Forth Road Transport Authority	N	N	Residents	Fast	8	8	4	3	Tier 1

Tier 2 locations

Map Ref	Zone	Postcode district	Location description	On-street *	Private land	Primary purpose	Charge Type	No of parking bays	Max no of charge-points **	Installation (score/5)	Usage (score/5)	Tier
45	1	EH1	King's Stables Road	Y	N	General use	Rapid	4	4	3	5	Tier 2
46	1	EH1	Castle Terrace Car Park	N	Y	General use	Rapid	10	10	3	5	Tier 2
47	1	EH1	Castle Terrace (on-street)	Y	N	General use	Rapid	4	4	3	5	Tier 2
48	2	EH11	Wardlaw Place	Y	N	Residents	Fast	6	6	3	5	Tier 2
49	2	EH11	Wardlaw Street	Y	N	Residents	Fast	6	6	3	5	Tier 2
50	2	EH12	Edinburgh Airport	N	Y	Taxi	Rapid	6	6	3	5	Tier 2
51	1	EH1	Edinburgh Intl Conference Centre (near Western Approach Rd)	N	Y	General use	Fast	8	8	3	5	Tier 2
52	2	EH3	Eyre Place	Y	N	Residents	Fast	6	6	3	5	Tier 2
53	1	EH7	Elm Row (street side parking)	Y	N	General use	Rapid	4	4	3	5	Tier 2
54	2	EH7	Wellington Street	Y	N	Residents	Fast	4	4	3	5	Tier 2
55	2	EH7	Hillside Street	Y	N	Residents	Fast	4	4	3	5	Tier 2
56	2	EH7	Brunswick Street	Y	N	Residents	Fast	4	4	3	5	Tier 2
57	1	EH8	East Market Street (mid-point)	Y	N	Taxi	Rapid	4	4	3	5	Tier 2
58	2	EH9	Arden Street	Y	N	Residents	Fast	8	8	3	5	Tier 2
59	2	EH10	Craiglea Drive	Y	N	General use	Fast	2	2	3	4	Tier 2

Map Ref	Zone	Postcode district	Location description	On-street *	Private land	Primary purpose	Charge Type	No of parking bays	Max no of charge-points **	Installation (score/5)	Usage (score/5)	Tier
60	2	EH11	Harrison Park East - W Bryson Road	Y	N	Residents	Fast	4	4	3	4	Tier 2
61	1	EH3	Royal Crescent, park side	Y	N	Residents	Rapid	6	6	3	4	Tier 2
62	2	EH3	Circus Place	Y	N	Residents	Rapid	2	2	3	4	Tier 2
63	2	EH3	Drumsheugh Gardens	Y	N	Residents	Fast	4	4	3	4	Tier 2
64	2	EH4	West Court - Parking east side	Y	N	Residents	Fast	6	6	3	4	Tier 2
65	2	EH7	Montgommery Street	Y	N	Residents	Fast	4	4	3	4	Tier 2
66	2	EH9	James Hutton Road - University of Edinburgh	Y	Y	Residents	Fast	4	4	3	4	Tier 2
67	2	EH13	Colinton Mains Park Pavilion - car park off Oxgangs Rd North	N	N	Residents	Fast	2	2	3	3	Tier 2
68	2	EH15	Edinburgh College Milton Road	N	Y	General use	Fast	8	8	3	3	Tier 2

8.6 Alternative Tariff Options

8.6.1 Results of financial model – 17.5p/kWh tariff

Scenario		2020					2023 (cumulative)				
		Capital	Annual OpEx	Annual revenue	Annual profit	RI (years)	Capital	Annual OpEx	Annual revenue	Annual profit	RI (years)
Residents (zone 2)	High	£951,174	£207,678	£229,046	£21,367	44.5	£4,348,224	£1,055,727	£1,223,082	£167,356	26.0
	Mid	£792,645	£162,045	£172,631	£10,586	74.9	£2,513,817	£598,967	£688,266	£89,299	28.2
	Low	£769,998	£158,350	£169,246	£10,896	70.7	£1,766,466	£415,000	£473,888	£58,888	30.0
Taxi & private hire (zone 1)	High	£320,411	£107,682	£233,574	£125,892	2.5	£985,880	£393,140	£909,590	£516,450	1.9
	Mid	£221,823	£57,966	£116,787	£58,821	3.8	£566,881	£201,520	£454,795	£253,275	2.2
	Low	£221,823	£57,966	£116,787	£58,821	3.8	£320,411	£103,235	£227,398	£124,163	2.6
Park and ride (zone 3)	High	£129,780	£34,886	£45,287	£10,401	12.5	£529,935	£145,958	£195,578	£49,619	10.7
	Mid	£90,125	£24,428	£32,062	£7,634	11.8	£277,585	£76,373	£102,197	£25,825	10.7
	Low	£79,310	£21,180	£27,253	£6,073	13.1	£205,485	£56,303	£74,945	£18,642	11.0
Total	**High**	**£1,401,365**	**£350,246**	**£507,907**	**£157,660**	**8.9**	**£5,864,039**	**£1,594,825**	**£2,328,250**	**£733,425**	**8.0**
	Mid	**£1,104,593**	**£244,439**	**£321,480**	**£77,041**	**14.3**	**£3,358,283**	**£876,860**	**£1,245,258**	**£368,399**	**9.1**
	Low	**£1,071,131**	**£237,496**	**£313,286**	**£75,790**	**14.1**	**£2,292,362**	**£574,538**	**£776,231**	**£201,693**	**11.4**

8.6.2 Results of financial model – 15p/kWh tariff

Scenario		2020					2023 (cumulative)				
		Capital	Annual OpEx	Annual revenue	Annual profit	RI (years)	Capital	Annual OpEx	Annual revenue	Annual profit	RI (years)
Residents (zone 2)	High	£951,174	£207,678	£201,590	-£6,089	N/A	£4,348,224	£1,055,727	£1,076,470	£20,743	209.6
	Mid	£792,645	£162,045	£151,937	-£10,108	N/A	£2,513,817	£598,967	£605,762	£6,796	369.9
	Low	£769,998	£158,350	£148,958	-£9,392	N/A	£1,766,466	£415,000	£417,082	£2,082	848.4
Taxi & private hire (zone 1)	High	£320,411	£107,682	£216,465	£108,783	2.9	£985,880	£393,140	£844,681	£451,542	2.2
	Mid	£221,823	£57,966	£108,232	£50,266	4.4	£566,881	£201,520	£422,341	£220,821	2.6
	Low	£221,823	£57,966	£108,232	£50,266	4.4	£320,411	£103,235	£211,170	£107,935	3.0
Park and ride (zone 3)	High	£129,780	£34,886	£42,330	£7,444	17.4	£529,935	£145,958	£182,805	£36,847	14.4
	Mid	£90,125	£24,428	£29,968	£5,540	16.3	£277,585	£76,373	£95,523	£19,151	14.5
	Low	£79,310	£21,180	£25,473	£4,293	18.5	£205,485	£56,303	£70,050	£13,748	14.9
Total	**High**	**£1,401,365**	**£350,246**	**£460,385**	**£110,138**	**12.7**	**£5,864,039**	**£1,594,825**	**£2,103,956**	**£509,132**	**11.5**
	Mid	**£1,104,593**	**£244,439**	**£290,137**	**£45,698**	**24.2**	**£3,358,283**	**£876,860**	**£1,123,626**	**£246,768**	**13.6**
	Low	**£1,071,131**	**£237,496**	**£282,663**	**£45,167**	**23.7**	**£2,292,362**	**£574,538**	**£698,302**	**£123,765**	**18.5**