WWF Scotland
Electric Vehicles: Driving the change

Final Report
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ATKINS

Plan Design Enable

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Executive summary

Introduction

The *Climate Change (Scotland) Act 2009* introduced a legally binding target of at least an 80% reduction in greenhouse gas emissions across all sectors of the Scottish economy by 2050 (compared with 1990 levels). The Act also sets an interim 42% reduction target for 2020, with the power for this to be varied based on expert advice.

In order for this target to be met, the Scottish Government has recognised the need for *'almost complete decarbonisation of road transport by 2050 with significant progress by 2030 through wholesale adoption of electric cars and vans (EVs), and significant decarbonisation of rail by 2050'*[1].

In 2010, WWF Scotland published *Watt Car: the role of electric vehicles in Scotland's low carbon future*. The report demonstrates that to ensure transport plays a full part in meeting the 42% reduction target for 2020, three changes need to be implemented. Firstly we must reverse the current growth in annual car km driven to the levels seen in 2001, secondly we must progressively decarbonise the power sector, and finally we must secure no less than **290,000 electric cars** on Scotland's roads by 2020[2].

This report identifies and ranks the barriers to greater electric vehicle use; and prioritises the measures which need to be taken forward by the Scottish Government, local authorities and the wider public sector in order to drive the uptake of electric vehicles.

The scale of the challenge is significant, however, electric vehicles offer an exciting and substantial opportunity to decarbonise road transport in Scotland, reduce dependency on oil, maintain good mobility levels, and grow the Scottish economy. Electric vehicles will be essential in delivering the level of reduction in emissions from cars that is necessary to achieve the targets required under the *Climate Change (Scotland) Act 2009*.

Barriers to EV uptake

A summary of the main barriers to EV uptake, and their relative importance, is presented in Table 1. The list reflects views from key stakeholders and experts, and evidence from other research reports.

The research has identified that many of the identified barriers are equally applicable to private, public and corporate fleets. However, there are a number of differences worth highlighting.

Local authority fleets are expected to be least affected by the identified barriers, due to a need to show leadership by demonstrating support for the technology required to meet CO_2 reduction targets. Company car users are expected to be most affected due to the high mileage they typically undertake and a general preference for larger, high performing models.

'High purchase price' could be expected to be less of a concern in the context of public and corporate fleets given the strong buying powers of the organisations concerned and a greater appreciation of whole life costs. However, public sector fleet managers have reported that they are unlikely to buy EVs for their fleets unless incentivised to do so by the Government, because the overall cost is currently seen as being uncompetitive.

The 'limited range of EVs' and 'lack of recharging infrastructure' is likely to be less of a concern for corporate utility and public sector fleets where daily mileage is predictable and less than the maximum range of a single battery charge, and where infrastructure can be provided in a depot to allow overnight charging. Scheduling tools may be required to manage charging, and the electricity supply may need to be upgraded as historically, many premises were built with limited provision of power for the building and car park.

[1] Scottish Government (2009) Meeting Scotland's Statutory Climate Change Target.
[2] WWF Scotland (2010) Watt Car: the role of electric vehicles in Scotland's low carbon future.

Table 1 – Ranking of barriers to EV uptake

Barrier	Overall ranking
High purchase cost	Very high significance
Limited range of EVs (and range anxiety issues)	Very high significance
Lack of recharging infrastructure (and issues relating to implementation and operation of infrastructure)	Very high significance
Uncertainty about future resale value	High significance
Limited supply of EVs	High significance
Lack of public awareness and knowledge about EVs	High significance
Limited performance and limited choice of vehicles	High significance
Aversion to new technology	High significance
Weak image association	High significance
Limited value placed on environmental benefits by consumers	High significance
Uncertainty about future energy costs	High significance
Limited environmental benefits associated with current models	Moderate significance
Lack of support networks (e.g. garages with appropriate skills and equipment).	Moderate significance
Lack of engineering skills	Moderate significance

Measures to address the barriers

Measures for addressing the barriers are presented in the main report.

Each measure has been assessed against a range of criteria (effectiveness, impact on wider policy areas, deliverability, public acceptability and affordability) in order to prioritise actions to be undertaken by the Scottish Government, local authorities and the wider public sector.

Those measures which have been identified as being most effective in addressing the 'very high significance' barriers relating to 'high purchase cost', 'limited range of EVs', and 'lack of recharging infrastructure' are summarised in Table 2. These measures need to be implemented as a matter of urgency if the target of 290,000 EVs on Scotland's roads by 2020 is to be met. They include infrastructure and support measures, alternative ownership models, vehicle purchase incentives, and other Government leadership measures (procurement policies, research, and lobbying to increase the EU target for the emissions intensity of new cars and vans produced by manufacturers).

Conclusion

Despite significant challenges, there are a number of ways in which both national and local government can work to increase the number of EVs in Scotland, as part of a wider sustainable transport strategy which also involves significant improvements for public transport, walk and cycle modes. Action is required now if the target of 290,000 EVs on Scotland's roads by 2020 is to be met.

However, Scotland cannot act alone in tackling the barriers to EV uptake. The car industry operators on a global scale and uptake in Scotland will be affected by what happens in the rest of Europe, North America, Japan, and rapidly emerging economies such as China and India. An important role for the Scottish Government will therefore be to influence decisions made at a UK and EU level, in order to drive growth of the EV sector and to ensure that decisions made by other legislators are consistent with and reflect the ambitions of the Scottish Government.

Table 2 – Top priority measures for addressing barriers

Measure (see Chapter 3 for full description)		Type of measure	Private	Company cars	Utility vehicles	Local authority
			Fleet sectors affected			
Top priorities – Address 'very high' significance barriers (purchase price, limited range, lack of infrastructure)						
1	F4 - Scottish Government publishes a high profile **EV Strategy and Action Plan for Scotland**, setting out a clear vision supported by targets or milestones. *Although this measure does not directly address the 'very high significance' barriers, it is seen as vital in terms of providing a clear framework for Government action and informing the implementation of other measures.*	F – Other Government leadership measure	✓	✓	✓	✓
2	A1 - Scottish Government develops an **EV Infrastructure Strategy for Scotland**, setting out a clear vision for the future, presenting a strategy for the provision and roll out of appropriate recharging infrastructure, and describing how drivers will use the infrastructure (see A3). This should be part of a broader EV Strategy and Action Plan for Scotland (see F4).	A – Infrastructure and support measures	✓	✓	✓	✓
3	A2 - Scottish Government works with relevant stakeholders in Scotland, the rest of the UK, and across Europe, to **set technical standards, specifications and regulations for implementing recharging infrastructure**.	A – Infrastructure and support measures	✓	✓	✓	✓
4	A3 - Scottish Government commissions a **review of the possible market models for recharging infrastructure** in Scotland and implements the recommendations of the review. This would involve working with relevant stakeholders to identify key roles and responsibilities for energy providers, electricity retailers, EV manufacturers, private infrastructure providers and the public sector; specify pricing and payment approaches; and agree customer interface requirements (single or multiple points of contact).	A – Infrastructure and support measures	✓	✓	✓	✓
5	A4 - Scottish Government and local authorities provide **funding for publically accessible recharging points**.	A – Infrastructure and support measures	✓	✓	✓	✓
6	A5 - Scottish Government and local authorities **incentivise businesses to install recharging points**. This would involve engaging directly with the largest businesses with employee car-parks to highlight the benefits of encouraging use of EVs rather than conventional vehicles; by providing free advice; and by providing match funding to 'innovator' and 'early adopter' businesses wishing to install recharging points in existing parking spaces. These measures would be most effective if linked to exemption from a Workplace Parking Levy (see D2).	A – Infrastructure and support measures	✓	✓	✓	✓
7	A6 - Scottish Government prepares **advice for residents on home recharging and guidance for electricians on the type of facilities needed** (including issues to be considered in communal parking areas). Local authorities to disseminate information.	A – Infrastructure and support measures	✓	✓	×	×
8	A7 - Scottish Government provides **national planning guidance** on the provision of recharging bays and infrastructure in local authority areas as part of a parking strategy which supports wider sustainable transport objectives.	A – Infrastructure and support measures	✓	✓	✓	✓
9	A8 - Scottish Government updates **building regulations** to set out minimum requirements regarding the provision of electrical infrastructure and recharging points in new buildings.	A – Infrastructure and support measures	✓	✓	✓	✓

	Measure (see Chapter 3 for full description)	Type of measure	Private	Company cars	Utility vehicles	Local authority
			Fleet sectors affected			
10	A12 - A **Working Group** of relevant stakeholders from the energy and transport sectors, chaired by a Member of the Scottish Parliament, is tasked with addressing the **electricity generation and distribution requirements for EVs**.	A – Infrastructure and support measure	✓	✓	✓	✓
11	B1 - Local authorities work with existing **car club** operators to introduce EVs into fleets and introduce EV-based car clubs in other cities. This would involve local authorities: engaging directly with existing car clubs to raise awareness of EVs and their benefits; using car clubs instead of purchasing their own fleet cars; procuring vehicles directly for car clubs using their considerable purchasing power to lever favourable purchase prices or lease contracts; and working with manufacturers to set up a publicly funded electric car share scheme.	B – Alternative ownership model	✓	×	×	✓
12	B2 - Encourage manufacturers to offer **alternative ownership models** to consumers in Scotland by promoting Scotland as an attractive market for manufacturers, and engaging with manufacturers to understand and influence their decisions about where to focus their sales strategy. Scottish Government or other public sector bodies work with manufacturers to 'trial' alternative ownership models amongst employees or as part of the vehicle procurement process, and publicise benefits.	B – Alternative ownership model	✓	✓	✓	✓
13	C1 - Scottish Government provides a **£10,000 subsidy*** for the first 25,000 EVs in Scotland (as recommended by the UK CCC), to 'kickstart' early uptake of EVs, **£5,000** for the second 25,000 EVs in Scotland, and reducing for subsequent 25,000 EV milestones. **£5,000 assumed to come from the UK Plug-In Car for the first EVs in Scotland (approximately 800, based on the current committed budget).*	C – Vehicle purchase incentive	✓	×	✓	×
14	C2 - Scottish Government introduces a **scrappage scheme** to encourage consumers to purchase EVs, with subsidies reducing as EV uptake increases.	C – Vehicle purchase incentive	✓	×	✓	×
15	C3 - Scottish Government provides **grants for purchasing second hand EVs** from specified dealers, with subsidies reducing as EV uptake increases.	C – Vehicle purchase incentive	✓	×	✓	×
16	F1 - Scottish Government, local authorities and other public sector organisations support an earlier than average switch to low carbon emissions vehicles for public sector fleet vehicles (cars and vans) through **procurement policies** (extending funding for the Low Carbon Vehicle Procurement Support Scheme; a target for 100% of public sector fleets to be electric, where appropriate; Scottish Government procuring EVs on behalf of all local authorities; commissioning specialist firms to convert existing ICE models; and ensuring sustainable procurement policies are in place). *Will not significantly increase uptake on its own, but the public sector needs to show leadership and demonstrate support for the new technology required to meet CO_2 reduction targets.*	F – Other Government leadership measure	×	×	×	✓
17	F7 - Scottish Government lobbies the EU to increase the EU target for the emissions-intensity of new cars and vans produced by manufacturers. *Greater availability of EVs will bring down price.*	F – Other Government leadership measure	✓	✓	✓	✓

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1. Introduction

1.1. Background

The *Climate Change (Scotland) Act 2009* introduced a legally binding target of at least an 80% reduction in greenhouse gas emissions across all sectors of the Scottish economy by 2050 (compared with 1990 levels). The Act also sets an interim 42% reduction target for 2020, with the power for this to be varied based on expert advice.

The Climate Change Delivery Plan, *Meeting Scotland's Statutory Climate Change Target* (Scottish Government, 2009) describes four transformational outcomes needed for the 2050 target to be met, including *'almost complete decarbonisation of road transport by 2050 with significant progress by 2030 through wholesale adoption of electric cars and vans (EVs), and significant decarbonisation of rail by 2050'*. The more recent Report on Proposals and Policies (RPP)[3], *Low Carbon Scotland: Meeting the Emissions Reduction Targets 2010-2022* (Scottish Government, 2011), describes five milestones for transport in 2020, including *'a mature market for low carbon cars, resulting in average efficiencies for new cars of less than 95 gCO_2/km'* and *'an electric vehicle charging infrastructure in place in Scottish cities'.* It also describes current Scottish policies relating to sustainable travel; and proposals for achieving a significant further reduction in transport emissions, including *'further support for low carbon vehicle infrastructure and procurement'*[4].

In 2010, WWF Scotland published *Watt Car: the role of electric vehicles in Scotland's low carbon future.* The report demonstrates that to ensure transport plays a full part in meeting the 42% reduction target for 2020, three changes need to be implemented. Firstly we must reverse the current growth in annual car km driven to the levels seen in 2001, secondly we must progressively decarbonise the power sector, and finally we must secure no less than **290,000 electric cars** on Scotland's roads by 2020.

This report:

- identifies and ranks the barriers to greater electric vehicle use at the level of individual car ownership, the corporate sector (company car) fleet, and the public sector fleet;
- identifies the policies and measures available to the Scottish Government, local authorities and the wider public sector to drive the uptake of electric vehicles; and,
- assesses the effectiveness of these measures in driving the uptake of electric vehicles, and highlights the priority measures to be taken forward by the Scottish Government.

It will inform WWF Scotland's ongoing work to promote solutions to reduce the emissions from the transport sector.

The majority of findings in the report are also relevant to a UK context, unless otherwise stated. This report is being published alongside another report by WWF, *Electric avenues: Driving home the case for electric vehicles in the UK*, published in March 2011.

This report primarily focuses on electric cars, but many of the barriers and measures are equally applicable to small vans. Specific issues affecting, or not affecting, small vans are highlighted where appropriate.

1.2. Meeting the target

The scale of the challenge regarding the uptake of electric vehicles is significant, requiring decisive policies to be implemented as soon as possible. To put the figures into context, data from the Society of Motor Manufacturers and Traders (SMMT) show that only 1,133 electric vehicles have been registered since 2001; and in 2009, just 55 out of the two million new cars sold in the UK were electric – 0.002% of the market[5]. In

[3] The RPP fulfils a duty placed on Scottish Ministers by section 35 of the Climate Change (Scotland) Act 2009.

[4] Measures presented are based largely on the research report, *Mitigating Transport's Climate Change Impact in Scotland: Assessment of Policy Options (Atkins, 2009).*

[5] Quoted in "Green cars: awaiting the great electrification" ENDS Report 433, February 2011 <http://www.endsreport.com/27385>, pp. 34-38. Retrieved 01 March 2011.

addition, total vehicle kilometres increased by 10% between 2001 and 2009 (Table 1.2 in Scottish Government, 2010).

Uptake of electric vehicles will need to occur across the private, corporate and public fleets. As of 31st December 2009 there were 2.256 million vehicles registered in Scotland, most of which were **privately owned** (Scottish Government, 2010, Table 1.2). The number of registered **company cars** was 174,000 (8%), of which 54,000 were located in Glasgow (Scottish Government, 2010, Table 1.3). A small proportion of registered company cars (estimated at between 2,000 and 3,000) are used by the **public sector** (local authorities and other government organisations). The size of the public sector fleet is estimated at approximately 2,000 cars and 15,000 light goods vehicles[6].

Electric vehicle uptake will need to be driven by the new vehicle market. In 2009, the number of new cars registered in Scotland was 186,000; and over the last ten years the average annual figure has been 200,000 (Scottish Government, 2010, Table 1.1). Assuming that this trend continues, the total number of new cars purchased by 2020 will total 2 million, and at least 15% of these will need to be electric vehicles in order to increase the number on Scotland's roads to 290,000. The actually proportion of new electric sales required will need to be slightly higher, as vehicles bought in the next few years may have reached the end of their life by 2020.

Although second-hand sales will be important in terms of achieving 'mass market' uptake, purchase of second-hand electric vehicles will not contribute to the target unless a significant number are bought from outside Scotland.

Faced with new technology, customers can be described as 'innovators' (2.5% of the population), 'early adopters' (13.5% of the population), 'early majority' (34% of the population), 'late majority' (34% of the population) and 'laggards' (16% of the population)[7]. Current electric vehicle owners are 'innovators'. In order to meet the 2020 target, policies and measures will need to incentivise the 'early adopters'. These individuals like owning new technology and are willing to pay a higher price to do so.

Current electric vehicle owners (the 'innovators'), tend to be multi-car families with off-street parking, living in more suburban locations, and with higher disposable incomes (Element Energy, 2009a). This is somewhat at odds with the "urban city car model" of electric vehicle adoption often promoted. In increasing the uptake of electric vehicles amongst the 'early adopters', it is likely that high profile urban centres will play an important part in achieving the overall target, however, meaningful CO_2 reductions can only be achieved through widespread adoption in suburban areas (Element Energy, 2009a).

Arup and Cenex (2009) estimate that mass production and volume availability of electric vehicles is unlikely to occur before 2014 at the earliest. The report suggests that widespread roll-out and uptake of electric vehicles will require: increased consumer confidence and education; improvements in battery performance and cost; recharging infrastructure which keeps pace with demand; and stimulation of the market through appropriate incentives which encourage the uptake of low carbon vehicles. The Society of Motor Manufacturers and Traders (SMMT, 2010) estimate that it will be 2020 before electric vehicles breakthrough into the main mass market (i.e. 'early majority' consumers), suggesting the need for strong incentives during the intervening period.

1.3. An opportunity for Scotland

While the challenge is significant, electric vehicles also offer an exciting and substantial opportunity to decarbonise road transport in Scotland, reduce dependency on oil, maintain good mobility levels, and grow the low carbon vehicle manufacturing sector of the Scottish economy. Electric vehicles will be essential in delivering the level of reduction in emissions from cars that is necessary to achieve the targets required under the *Climate Change (Scotland) Act 2009*.

[6] The Office of Government Commerce estimates that, collectively, the public sector has the UK's largest vehicle fleet, comprising well over 290,000 passenger and commercial vehicles (*Office of Government Commerce, 2006. Getting Better Value from Your Fleet).* This equates to approximately 25,000 vehicles in Scotland, if scaled on the basis of population. In addition, survey data from 23 local authorities, collected to inform the Scottish Government's *Consultation on Low Carbon Vehicles (2009),* shows that 9% of public sector vehicles are cars (i.e. 2,250) and 61% are light goods vehicles (i.e. 15,250).

[7] Technology adoption cycle, derived by Rogers E.M. (1962) *Diffusion of innovations*, Free Press of Glencoe, Macmillan Company, and Moore G.A. (1991, revised 1999), *Crossing the Chasm: Marketing and selling high-tech products to mainstream customers*, Harpers Business Essertias.

1.4. Electric vehicles

There are currently two main types of **electric vehicles** (EVs): battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

Battery electric vehicles (BEVs) – BEVs use an electric motor to propel the vehicle, rather than an internal combustion engine. The energy supplied is from batteries within the vehicle, which can be recharged through connection to the national grid or from localised sources of energy production. A BEV's range is limited by the storage capacity of the battery. BEVs to date have been limited to demonstration models, after market conversions, and quadricycles such as the G-Wiz which are mass and power limited and are subject to different regulations. However, a number of high quality BEVs are being publically launched in the UK in 2011 and 2012. Most are small family cars (e.g. the Mitsubishi-iMiev, the Nissan Leaf, the Peugeot iON/Citreon CZero[8], and the Tata Indica Vista EV) or micro cars (e.g. the Smart Fourtwo electric drive). Their maximum range on one battery change typically varies from 80 to 110 miles. The time taken to fully charge the battery varies from 6 to 8 hours, although batteries can be recharged to 80% capacity in 30 minutes.

The Mitsubishi i-Miev and the Nissan Leaf are retailing at £23,990[9] and £25,990[10] respectively (after a £5,000 Plug-in Car Grant from the Government[11]); while Peugeot iON/Citreon CZero is being offered on a four-year, 40,000 mile lease for £416 per month, which includes full maintenance and servicing, but excludes electricity costs.

Plug-in hybrid electric vehicles (PHEVs) – Hybrid electric vehicles (HEVs) use a combination of an electric motor and batteries alongside an **internal combustion engine (ICE)** which recharges the battery when the vehicle is moving. Some hybrids have the ability to recharge their batteries from the grid and are termed plug-in hybrid electric vehicles (PHEVs). PHEVs can be run using just the battery or off the internal combustion engine, which extends the range of the vehicle between periodic refuelling of the tank. Although there are currently very few real world examples of PHEVs, they are the subject of increasing attention by car manufacturers, with Toyota, Ford, General Motors, Volkswagen and Hyundai all developing models. The Toyota Prius PHEV, with a 12.5 mile electric range, has been leased to public organisations, police and businesses since 2007 and is expected to be on general sale in 2012. The Vauxhall Ampera E-REV, with a 100 mile electric range, is also expected to go on sale in the UK in 2012[12]; and is currently on sale as the Chevrolet Volt in the US.

PHEVs are initially likely to have an important role in the move towards EVs, as they can be used as a direct replacement for **internal combustion engine vehicles** (ICEVs). However, they represent a costly option due to the need for two sources of power and remain reliant on fossil fuel use.

1.5. UK context

The Department for Transport's Business Plan (2010) outlines a series of actions for supporting the early market for electric and other ultra-low carbon vehicles and mandating a national recharging network.

Specific actions include:

- Develop a nationwide strategy to promote the installation of electric vehicle infrastructure, including a decision on whether to use an energy Regulated Asset Base and/or changes to planning/building regulations (due to complete Jun 2011);
- Support Plugged-In Places pilots and programme to encourage the establishment of electric vehicle recharging infrastructure across the UK to inform the development of the electric vehicle infrastructure strategy (due to complete March 2013);
- Push for early EU adoption of electric vehicle infrastructure standards (due to complete Mar 2012);
- Consolidate existing support mechanisms for low and ultra-low emission vehicle research and development (due to complete Apr 2011); and

[8] Which are the same car under different names.
[9] www.mitsubishi-cars.co.uk
[10] www.nissan.co.uk
[11] http://www.dft.gov.uk/pgr/sustainable/olev/grant1/
[12] Descriptions and data supplied by Next Green Car (www.nextgreencar.com) – as reported in Lane (2011).

- Review strategy to support transition from early ultra-low emission vehicle market to mass market (due to complete March 2012).

These measures will support the uptake of EVs in Scotland, however it is very likely that additional action will be required by the Scottish Government if the target of 290,000 EVs on Scotland's roads is to be met by 2020.

The WWF report, *Electric avenues: Driving home the case for electric vehicles in the UK* (2011), calls for the UK government to take early action in nine key areas. It also identifies the need for the EV industry and the power sector in the UK to focus on ways to stimulate the EV market, and identifies six business recommendations.

1.6. Methodology

The information and analysis presented in this report draws on the findings of recent research and the professional expertise of individuals within Atkins. In addition, a short email questionnaire was sent to fifteen external stakeholders with an interest in electric vehicles, asking them to:

- identify any additional barriers to EV uptake that had not been identified by the Atkins' study team - an initial list of barriers was sent with the email questionnaire;
- rate each barrier to EV uptake as 'high', 'medium' and 'low' and comment on their choice of rating; and
- suggest potential measures to address the barriers identified as being most significant.

Responses were received from the Energy Savings Trust, the Institute of Advanced Motorists, Axeon (Europe's largest independent supplier of lithium-ion battery systems), Scottish and Southern Energy, Arup, One North East, ITS UK, Cenex and Dundee City Council.

1.7. Abbreviations

The following abbreviations are used within this report:

- EVs – Electric Vehicles;
- BEVs – Battery Electric Vehicles;
- PHEVs – Plug-in Hybrid Electric Vehicles; and,
- ICEVs – Internal Combustion Engine Vehicles.

1.8. Structure of report

The rest of this report is structured as follows:

- **Chapter 2 and Appendix A** present the barriers to the uptake of EVs in Scotland and also prioritises them in order of significance;
- Potential measures for increasing uptake of EVs are presented in **Chapter 3**, and an assessment of the measures is provided in **Chapter 4 and Appendix B**;
- Finally, a summary of the key findings of the study are presented in **Chapter 5**.

2. Barriers to EV uptake

2.1. Introduction

Barriers to EV uptake can be viewed as those **limiting demand from consumers** and those relating to **supply** in terms of availability of vehicles and supporting infrastructure. These barriers are of varying scale and importance, with some being more significant than others. In addition, the impact of each of these barriers will vary over time.

A number of barriers are inter-related, and addressing one barrier will help mitigate or reduce the significance of another. In particular, a number of demand-related barriers are manifestations of supply-related barriers. Equally, some supply-related barriers would become less significant if suppliers had greater certainty about future demand.

This chapter describes:

- **barriers limiting demand from consumers (Section 2.2)** – high purchase cost, uncertainty about future resale values; limited range of EVs; lack of public awareness and knowledge about EVs; weak image association; limited value placed on environmental benefits by consumers; limited environmental benefits associated with current EVs compared with the most efficient new diesel models; aversion to new technology; limited performance and limited choice of vehicles in comparison with ICEVs; and uncertainty about future energy costs;

- **barriers limiting supply (Section 2.3)** – lack of recharging infrastructure; no agreed standards, specifications and regulations for recharging infrastructure; no agreed market model to support the expansion of EVs; limited capacity of local electricity distribution networks to support large scale recharging of vehicles; carbon-intensity of electricity generation during peak periods; lack of support networks; lack of engineering skills; and limited supply of EVs;

- **wider issues which will need to be addressed as uptake increases (Section 2.4)** – management of rebound effects; loss of government revenue from Vehicle Excise Duty, company car tax, and fuel duty; new security issues; and battery disposal issues; and,

- **external factors beyond the influence of the EV sector in Scotland (section 2.5)** –state of the economy and world trends.

Finally, **Section 2.6** ranks the barriers in order of significance.

2.2. Barriers limiting demand from consumers

Barriers limiting demand from consumers cover issues associated with costs, vehicle range, knowledge, desirability, environmental credentials, technology-related risks, performance and choice of vehicles, convenience, and energy costs.

2.2.1. High purchase cost

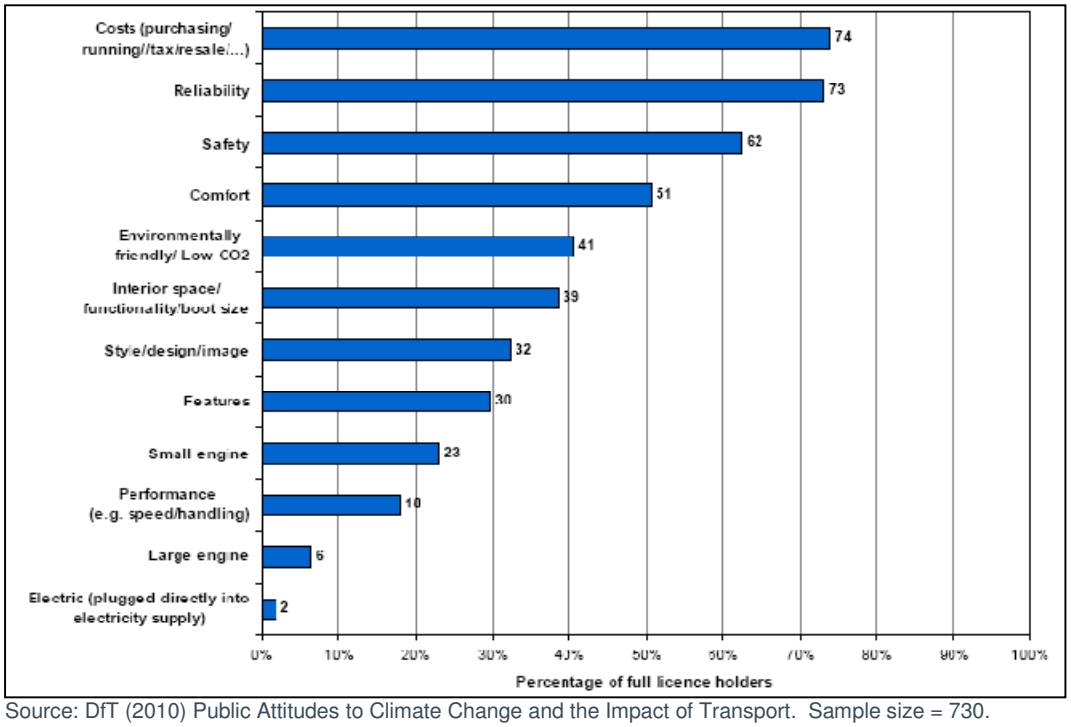
High purchase price is a barrier to EV uptake because it means that EVs are only affordable to the most affluent consumers.

For private consumers, cost is the most important factor when buying a car (Figure 2.1) and purchase cost is the most important cost (Figure 2.2). A number of studies have also identified purchase price as the most significant barrier to EV uptake, from a consumer demand perspective (e.g. Element Energy, 2009a).

The consensus is that BEVs and PHEVs will retail at significantly higher prices than comparable existing ICEV models for the foreseeable future, due to the high cost of batteries. The cost differential between EVs and comparable combustion engine models (at around £10,000) is currently too great even for early adopters. While some price differential in the early years would be acceptable, studies indicate that this would need to be less than £5,000 (Arup and Cenex, 2008) or less than 15% of the equivalent cost for an ICEV (Lane, 2011). However, in a report for the Climate Change Committee, Element Energy (2009a)

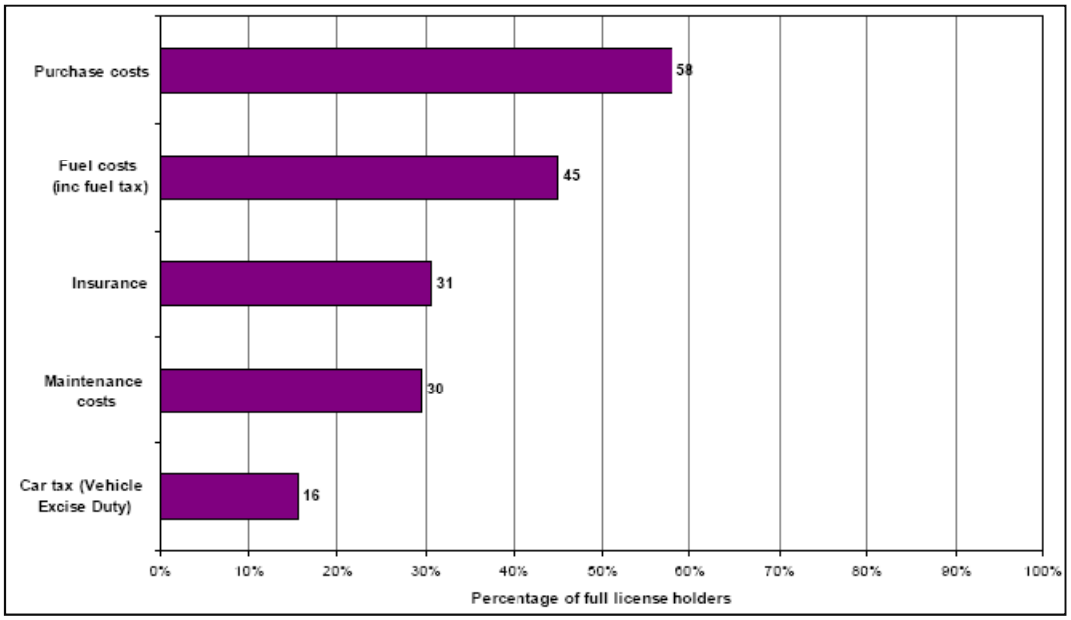
comments that for the mass market, even a substantial grant to cover the additional capital cost of a BEV would not itself be enough to ensure significant uptake, as there would remain a significant disutility associated with limited range of BEVs.

Figure 2.1 – Important factors when buying a car



Source: DfT (2010) Public Attitudes to Climate Change and the Impact of Transport. Sample size = 730.

Figure 2.2 – Costs considered important when buying a car/van



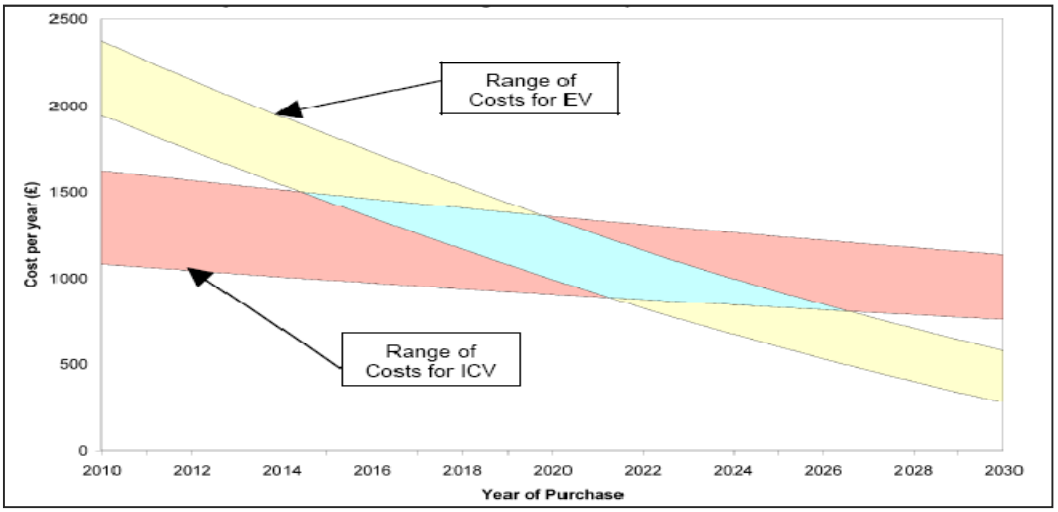
Source: DfT (2010) Public Attitudes to Climate Change and the Impact of Transport. Sample size = 730.

In the short-term, the cost of battery depreciation means that the whole-life running cost for an EV will also be significantly higher than for a comparable ICEV; but as the cost of batteries reduces whole life running costs for BEVs and PHEVs are expected to become significantly less than conventionally-fuelled alternatives, primarily due to differences in fuel prices[13]. Arup and Cenex suggested that this could happen anytime between 2015 and 2026 dependent upon the relative price to consumers of batteries, electricity and fossil

[13] Arup and Cenex (2008) estimated the energy cost of fuelling an EV using off peak electricity to be approximately one seventh the cost of fuelling a comparable ICEV in 2008. SMMT figures suggest that a typical EV will cost about £0.03 per mile to run in terms of electricity usage, while fuel for an internal combustion engine car now averages £0.14 per mile . Depending on the tariff, a flat-to-full charge could cost as little as £0.96 for an EV with a 24kWh battery and 100-mile range. (ENDS Report, 2011)

fuels (Figure 2.3); although since this analysis was undertaken, petrol and diesel fuel prices have increased significantly, suggesting that the cross over point could occur earlier.

Figure 2.3 – Comparative costs for running an EV and a petrol-based ICEV – 2010 to 2013[14]



Source: Arup and Cenex (2008) Investigation into the Scope for the Transport Sector to Switch to Electric Vehicles and Plugin Hybrid Vehicles.

In theory, running cost benefits should reduce the high purchase cost barrier over time, however, there is strong evidence that private consumers tend to buy on the basis of capital costs rather than running costs (see Figure 2.2, for example). Arup and Cenex note that private consumers tend to heavily discount future savings – possibly by as much as 60% (cf. HM Treasury, 2007); while German and Meszler (2010) suggest that consumers find future fuel cost reductions difficult to quantify for a range of reasons including variation in driving style and fluctuations in fuel price. Education will be required to raise awareness of this benefit, and encourage consumers to value whole life costs of vehicles rather than upfront costs.

Approximately three-quarters of cars bought in the UK in 2009 were 'used' vehicles'[15]. In the short term, lack of a buoyant **second-hand market** for the mass market will mean that EVs remain too expensive for the majority of drivers, and will limit the extent to which EVs make significant inroads into the Scottish fleet. An initial focus on EV uptake in the corporate and public fleets will therefore be important. These vehicles are typically replaced every three years, and will provide the basis for a second-hand market. However, many corporate and public fleet vehicles are purchased on a 'lease' basis, and uncertainty about future resale value of EVs (see below) represents a significant risk to vehicle lease operators. The cost of purchasing a lease vehicle may remain high if operators are unwilling to take on the risk.

2.2.2. Uncertainty about future resale values

Uncertainty about the life expectancy and residual value of the battery creates uncertainty about the resale value of second-hand EVs. This is a barrier to EV uptake if consumers are reluctant to buy second-hand EVs which are more than 3 or 4 years old, or if lease providers increase lease prices to account for this uncertainty.

Uncertainty about future resale values has been identified as a barrier in a number of studies, including AEA (2009) and Arup and Cenex (2008). The future resale value of EVs is uncertain because a large part of the value lies in the batteries, which may need to be replaced during the life of the vehicle. There is considerable uncertainty regarding battery reliability and concerns about obsolescence.

The business models of commercial/fleet operators are very sensitive to resale values and if these are untested, this represents an unacceptable risk which will push up the cost of lease prices. There is evidence

[14] The EV is assumed to have an efficiency of 0.16kWh/km in 2010, 0.13kWh/km in 2020, and 0.11kWh/km in 2030. The EV has a 35kWh battery which is assumed to cost £18,000 in 2010, £8,750 in 2020, and £1,800 in 2030. The battery is amortised over its assumed ten year life to give an annual cost. The curves for the EV show the difference in costs caused by charging at tariffs ranging from 5p/kWh to 20p/kWh. The 5p/kWh represents a low night-time charging rate. The 20p/kWh rate represents a peak day-time charging rate. Current electricity rates are around 15p/kWh during the day and 6p/kWh at night. The ICEV is assumed to have an efficiency of 0.060l/km in 2010, which improves by 1.8% per annum to 0.050l/km in 2020, and 0.042l/km in 2030. The curves for the ICV show the difference in costs caused by refuelling at petrol pump prices ranging from £1.00/litre to £1.50/litre. Both vehicles travel 18,000 km a year. All other aspects of the EV and ICV are similar.

[15] http://www.british-car-auctions.co.uk/default.aspx?page=11681&lang=en-gb. Accessed 16 February 2011.

that public sector fleet managers are currently unlikely to buy EVs for their fleets unless incentivised to do so by the government, because the overall cost is uncompetitive[16].

2.2.3. Limited range of EVs (and range anxiety issues)

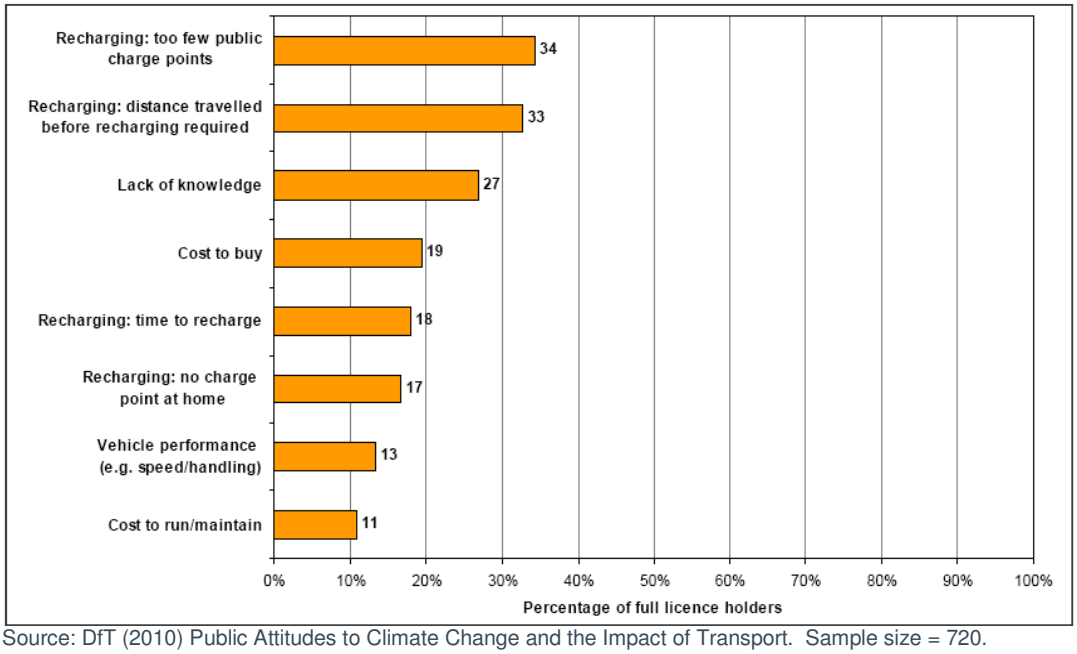
The limited range of BEVs (typically 80 to 110 miles) is a barrier to EV uptake due to the high value consumers place on their ability to drive long distances, concerns about the lack of widespread recharging infrastructure, and the time implications should an unscheduled recharge be required. This leads to 'range anxiety' and conservative use of the available battery power.

Range anxiety factors (too few public charge points and distance travelled before recharging required) are identified as the most significant barrier to EV uptake in a survey of public attitudes undertaken on behalf of the Department for Transport (2010) (Figure 2.4). However, a number of reports suggest that range concerns reduce quickly once consumers have experience of owning and driving an EV, pointing to supporting evidence from real-life trials undertaken by the Technology Strategy Board (TSB), Shell, Eon, CENEX, and BMW.

Drivers place a very high utility on the ability to drive long distances, even though they realise that such trips are rare for the majority of users (Element Energy, 2009a)[17]. For example, 64% of two-way commuter journeys in Scotland are less than 32 kms (Watt, 2010), and more than 93% of all two-way journeys made in the UK are less than 120 kilometres (75 miles) (Royal Academy of Engineering, 2010).

Element Energy (2009a) reports that BEV drivers typically use only a third to a half of the technical range of the vehicle due to concerns due to range related issues. Similarly, evidence from the Smart Move trial (Cenex 2010) of fleet-based EVs, found that users were over cautious when planning journeys. The maximum journey length undertaken was only 25% of the average vehicle range. Range anxiety effects were significant throughout the trial with 93% of journeys commencing with over 50% of battery life remaining. Data suggests that users modified their driving style when the battery state of charge reduced below 50%, and they did not use the available range of the vehicle.Energy Element (2009) estimate that to achieve an 80% reduction in CO_2 emissions on a UK basis (assuming that renewable electricity was used to charge BEVs) would require a capable range of 300-600km, resulting in a utilised range of about 200kms. Battery technology is unlikely to deliver this very high, single charge range in an affordable vehicle[18], suggesting that long distance travel will need to be undertaken using high efficiency ICEVs, PHEVs, or public transport.

Figure 2.4 – The main perceived barriers to purchasing an electric car/van



Source: DfT (2010) Public Attitudes to Climate Change and the Impact of Transport. Sample size = 720.

[16] Based on feedback provided at a seminar for vehicle fleet managers, jointly hosted by the 2020 Climate Group and Transport Scotland, to discuss the practicality of adoption of low carbon vehicles at fleet operational level.

[17] Analysis of data from the National Travel Survey Scotland for 2004 – 2006, presented by WWF Scotland (2010) shows that a high proportion of trips are in the lower distance bands, and around 64% of commuters who drive to work complete round trip commutes of less than 32km.

[18] The Tesla Roadster can already do 250 miles on a single charge but costs around £100,000.

2.2.4. Lack of public awareness and knowledge about EVs

Lack of public awareness and knowledge is a barrier to EV uptake because it limits the ability of consumers to make informed vehicle purchase decisions.

A survey undertaken on behalf of the Department for Transport in 2010 (DfT, 2011) found that the level of knowledge about EVs is low amongst most members of the public: 32% know a little, 28% hardly anything, and 27% know nothing about EVs. Lane (2011) also reports that the average consumer has little detailed knowledge about their operation, driving experience and potential benefits. These findings point to the importance of providing information to consumers as part of a wider promotion strategy, which also informs consumers of improvements in performance and efficiency.

2.2.5. Weak image association

Weak image association will limit demand if EVs are not seen as a desirable choice of vehicle.

The symbolism attached to particular makes, models and vehicle types is an important aspect of car ownership. Through ownership, car buyers communicate to others who they are: their interests, beliefs, values and social status. A survey undertaken by the Low Carbon Vehicle Partnership (Anable et al., 2008) found that most fuel-efficient models have weak symbolic associations. For example, respondents rarely make explicit linkages between good fuel economy and the desirable signifiers such as modernity, innovation, and technological development. Instead, fuel economy is generally spoken about in more mundane terms – as an important feature of car choice required to reduce the cost of motoring. Other research suggests that BEVs, with their current range limitation, may negate the sense of spontaneity currently associated with vehicle ownership – the ability to just jump in the car and go 'wherever you want' (Pollution Probe & Environsics, 2009). Understanding how EVs can be valued by consumers will provide unique insights into the most effective promotional and marketing strategies.

2.2.6. Limited value placed on environmental benefits by consumers

The limited value placed on environmental benefits by consumers is a barrier to EV uptake because it negates one of the key selling points of EV cars and means that purchase decisions are taken on traditional grounds where conventional cars may perform better.

In a survey of public attitudes, the Department for Transport (2011) found that drivers rate low CO_2 emissions as being less important than cost, reliability, safety and comfort when buying a car (Figure 2.1).

Lane (2011) also cites strong evidence from a wide variety of sources and methods that the key factors when purchasing a car are (in approximate order of importance): vehicle price, size/practicality, reliability, fuel consumption, comfort, style/appearance, cost of road tax, driving performance, cost of insurance, and brand (Dixon and Hill, 2009; Lehman et al., 2003; Whelan et al., 2000; Angle et al. 2007b; Lane, 2005; Lane and Banks, 2010; Anable et al., 2006). Lane (2011) suggests that while environmental issues are seen as important, these other factors become more important to consumers at the point of purchase. This reflects the existence of an 'attitude-action' gap, as identified in the King Review (HM Treasury, 2007; 2008) between people's attitudes towards the environment and their actions through their choice of vehicle and the way they drive. In addition, there is also evidence to suggest that most consumers do not appreciate the importance of improving fuel economy as a method of reducing carbon emissions – qualitative research conducted for the LowCVP (the Low Carbon Vehicle Partnership) finds that only around half of participants (at most) have an understanding of the link between fuel economy and CO_2 emissions (Lane & Banks, 2010).

2.2.7. Limited environmental benefits associated with current EVs compared with the most efficient new diesel models

The environmental benefits of current EVs compared with the most fuel efficient ICEVs are limited due to the carbon intensity of electricity used to charge EVs. This reduces the attractiveness of EVs, in the short-term, for those consumers who place a high value on environmental credentials when making vehicle purchase decisions. It may also undermine the credibility of government policies relating to promotion of EVs and limits marketing and promotion opportunities.

Element Energy (2009b) estimates the average CO_2 emissions from BEVs and PHEVs in electric mode at 81gCO_2/km (based on EV energy demands, recharging efficiency and grid carbon intensity), compared with a fleet average for ICEVs of 180gCO_2/km (based on total car-kms and car emission data); but a new VW

Golf BlueMotion ICEV has a tailpipe emissions rating of 99gCO_2/km, and represents an attractive 'green' consideration for potential EV purchasers.

The Scottish Government, however, has made strong policy commitments to decarbonise the power sector by 2030 and ensure that 80% of Scottish electricity demand comes from renewable sources by 2020 *(Low Carbon Scotland - Report on Proposals and Policies, March 2011).* This will significantly reduce the CO_2 emissions associated with EVs - to approximately 28gCO_2/km by 2020, according to analysis undertaken by Element Energy (2009b). There is also scope for further reductions in emissions from ICEVs, however, although it is unlikely that the major manufacturers will choose to reduce average fleet emissions below the EU target of 95 gCO_2/km by 2020[19] *(see Section 2.3.8)*.

2.2.8. Aversion to new technology

Aversion to new technology (due to uncertainty about battery obsolescence, reliability, and maintenance running/costs) is a barrier to EV uptake because it discourages the majority of consumers (the 68% described as the 'early and late majority') from entering the market until uptake has reached a critical level and risks of early market entry have been minimised.

While early adopters may pay to support new technologies, the mass market actively avoids this due to perceptions that: an innovative technology may be less reliable; that maintenance costs may be higher; or that the technology is not available in the make/model preferred by the buyer (Element Energy, 2009a). Sources suggest the 'technology aversion' barrier reduces as the technology is taken up by the market, and is no longer an issue once an uptake of 15% of the market has been achieved (Mau et al, 2008). Given that there are currently 2.256 million vehicles registered in Scotland, uptake will need to reach 338,000 EVs before the 'technology aversion' barrier is overcome. The implication is that incentives will need to be stronger during the period to 2020 and beyond, to address the mass market nervousness towards innovation.

Consumer concerns are heightened when technology is evolving rapidly, particularly if there is no single standard for that technology, leading to fears about backing the wrong technology. This can be compared with the choice between VHS and Betamax video tape recorders in the 1980s and Blueray and HD DVD high definition DVD players now; but the financial implications of backing the "wrong" car technology would be much greater. Similarly, EVs would depreciate at a much greater rate than the current market if a major technical advance emerges in 2-3 years time, leaving the owner significantly out of pocket.

There is a fundamental paradox in that rapid technological progress is required to address consumer concerns about range and performance of EVs, and consumers need to rapidly convert to EVs if emissions targets are to be achieved; but the faster technology progresses the more reluctant consumers will be to invest in that new technology (Stephens, 2010). Standardisation and forward compatible design could go some way towards addressing this barrier, but strict standards bear the risk of stifling innovation.

2.2.9. Limited performance and limited choice of vehicles in comparison with ICEVs

Limited performance and limited choice of vehicles, in comparison with ICEVs, is a barrier to EV uptake because it reduces the attractiveness of EVs for many consumers and restricts EVs to a certain sectors of the market.

This was identified as a 'moderate' barrier to EV ownership by private and fleet EV owners and those considering EV ownership (Element Energy, 2009a).

EVs will struggle to match the performance (power, acceleration, top speed, etc.), range and flexibility of comparable ICEVs (including larger family vehicles and vans) in the short term; and until more choice becomes available EVs are expected to be restricted to a limited proportion of the total vehicle fleet. A step change in battery technology is required for BEVs to offer similar specifications to those offered by current internal combustion vehicles; while the additional weight of two power units means that PHEVs will struggle to match the performance of comparable ICEVs in the short term. Arup and Cenex (2008) suggest that this will not happen until post 2020.

The range of models currently available is limited, and largely confined to small family cars. There are currently few models on the market, and no electric vans produced by the main manufacturers; although electric vans are available from smaller manufacturers such as Allied who provide adapted Peugeot vans as EVs. However, most of the main manufacturers are planning on launching EVs in 2011 and 2012, and

[19] Regulation EC/443/2009 setting emissions performance standards for new cars: http://ec.europa.eu/environment/air/transport/co2/co2_home.htm

models already exist at the high end of the market which demonstrate the performance potential of EVs. For example, the Tesla Roadster, which costs about £100,000, can do 250 miles on a single charge and is as fast as a Lotus Elise.

2.2.10. Uncertainty about future energy costs

Uncertainty about future energy costs is a barrier to EV uptake because it creates uncertainty regarding future running costs, one of the key selling points for EVs.

Energy costs to power an EV are currently relatively low. However, energy prices have risen in recent years and the use of electricity to recharge vehicles could be taxed in future, particularly if revenues from road tax and fuel duty disappear as consumers convert to tax-exempt vehicles and fuels.

2.3. Barriers relating to the supply of EVs and appropriate infrastructure

Ensuring consumers are able to appropriately maintain their batteries, easily charge their vehicles at home and/or in public locations and at their convenience, and be accurately billed will be critical to the consumer experience and the successful uptake of EVs.

2.3.1. Lack of recharging infrastructure

Lack of appropriate and sufficient recharging infrastructure is a barrier to EV uptake because it prevents EV ownership from being a practical option and causes 'range anxiety'.

Significant investment in recharging infrastructure is required to support EV uptake, and will need to keep pace with the developing market to ensure consumer confidence in the ability to recharge their vehicles with minimal inconvenience. This presents a 'chicken and egg' problem with potential consumers requiring recharging infrastructure to be in place before purchasing an EV, and funding bodies requiring certainty of future demand in order to commit to wide-scale investment in infrastructure.

Analysis by Element Energy for the UK Committee on Climate Change (2009a) and for the WWF (2009b) demonstrates that home and work-based recharging points would be technically capable of providing the majority of EV accessible passenger-kms at a much lower cost than publicly available recharging solutions. Standard off-street (e.g. home-based) recharging points cost about £50 to install and virtually nothing to maintain; while public access charge points each have capital costs ranging from £3,500 up to £50,000 (Table 2.1). However, a widespread and highly visible publicly available recharging infrastructure may need to be in place to encourage EV adoption. The minimum density of public recharging points required for consumers no longer to see this as a barrier remains an area of uncertainty, although significant investment in infrastructure is likely to be needed.

Table 2.1 – Typical cost of recharging infrastructure

Type	Approximate unit costs (excluding maintenance)	Approximate time to fully charge an EV
Home-based recharging points	£50	6-8 hours
Work-based recharging points	£100	6-8 hours
Public recharging points – standard recharging	£0 - £3,500 (Element Energy, 2009a, suggest £2,500)	6-8 hours
Public recharging points – fast recharging	£3,500-£5,000	30 minutes-3 hours
Public recharging points – rapid recharging	£25,000-£50,000	15-20 minutes

Source: Mayor of London (2009) London's Electric Vehicle Strategy.

a) Barriers to the development of a publicly accessible network of recharging points

The development of a network of publicly accessible network of recharging points is a complex process, with a number of challenges to be overcome:

- recharging posts are costly to install and require regular maintenance (see Table 2.1);

- the parking area adjacent to public recharging posts will need to be reserved for EVs, resulting in a potential lose of parking revenue for the local authority (Element Energy, 2009a);

- utilisation rates are likely to be low in comparison with home and workplace recharging – following real-world experience of EVs as part of the Mitsubishi i-MiEV trial, participants stated a stronger preference for home and workplace recharging, and were less inclined to use charge points located at supermarkets or situated on-street (Skippon, 2010). BMW Group (2010) also reports that, in the MINI E trial in Berlin, 56% of participants never used any of the 33 public access recharging points across the city, preferring to recharge at home. Analysis of data from the National Travel Survey Scotland by the WWF Scotland (2010) shows that the average length of time parked at destination is less than 2 hours for non-commuting and non-business trips, significantly less than the time required to charge a BEV; suggesting that publicly available slow recharging points away from residential area are likely to have relatively low utility;

- more cost effective infrastructure will need to be developed and utilisation rates will need to increase significantly if viable business models, attractive to the private sector, are to be developed;

- planning and rollout of EV infrastructure is a complex and time-consuming process – evidence from North East Plugged-in Places pilot suggest that all elements (site surveys, planning permission and insurance) need to be fully considered at the start of the project in order for infrastructure to be rolled out on time and budget (Accenture, 2011); and

- recharging infrastructure needs to be attractively designed to fit into the urban environment (Accenture, 2009).

b) Barriers to home-based recharging

Recharging at home can either be undertaken using the home network (on separate fused circuit), or using a stand-alone home charger unit (which uses blue commando electrical protection systems). The cost of installing a separate fused circuit will be low (less than £200) in most houses, and many homes will already have separate circuits which can be used. Fast recharging systems, needed for later vehicle types and for more frequent use require a different voltage system.

EV owners will need a driveway or garage where they can run a cable between the car and the mains. EVs are best suited to urban driving but many city dwellers do not have adequate off-street parking available. Three of Scotland's main cities have particularly high proportions of households without adequate off-street parking: Glasgow (78%), Edinburgh (68%), Aberdeen (54%), and Dundee[20]. WWF Scotland (2010) reports that lack of adequate off-street parking in Scotland means that recharging points on the public street outside the home of EV owners may be required by 2020 or 2030 to support the level of EV uptake needed to meet Scotland's CO_2 emissions reduction target, depending on future traffic growth and unless driving patterns of a proportion of EV users means that the vehicle can be charged elsewhere, such as at work. While it may be possible to achieve the target of 290,000 EVs by 2020 by focusing on just those consumers with adequate off-street parking, this implies a focus on suburban areas. In Scottish cities, many affluent individuals and likely 'early adopters' live in city centres in housing without off-street parking, and would essentially be excluded from EV ownership if on-street recharging posts are not provided in residential areas.

Lane (2011) notes that there is currently little or no home-recharging support for consumers contemplating owning an EV, and suggests that uptake could be more effectively promoted by supporting consumers wanting to recharge at home. There are specific technical issues to be addressed for those with communal parking arrangements.

c) Barriers to work-place recharging

WWF Scotland (2010) estimate that 220,000 workplace recharging points are required in Scotland by 2020. While EV uptake is in the early stages, inexpensive three-pin plug sockets will be sufficient for the majority of workplace recharging points. As the number of EV owners increases, businesses may require more sophisticated infrastructure to enable recouping of electricity costs. Manufacturers are developing suitable

[20] Scottish House Condition Survey (2004-2007).

recharging points, incorporating metering capabilities and controlled access features, which could be installed by in-house electricians (Mayor of London, 2009)[21].

2.3.2. No agreed standards, specifications and regulations for recharging infrastructure

Lack of agreed standards, specifications and regulations for recharging infrastructure is a barrier to EV uptake because it increases the risk that the recharging experiences of 'early adopters' could be frustrating and unsatisfactory, and won't provide the wider mass market with the confidence they need to invest in the new technology. The emergence of different recharging networks with different specifications will mean that the usable range of EVs is limited to the availability of compatible infrastructure, and 'range anxiety' will remain a barrier. Agreed regulations will limit cost and budget risks relating to legal requirements, planning matters and safety issues.

In an emerging industry, standards (e.g. for batteries, on-car recharging connectors and recharging units at home, in workplaces, and on-street) need to be developed to give confidence to manufacturers and consumers. Lack of clarity and leadership regarding standards could create inertia and delay essential early uptake of EVs. Initial lessons learned from the North East Plugged in Places Pilot suggest that standards will be critical to scale-up and rapid implementation of recharging infrastructure, and that lack of standards is currently severely delaying market progress due to a high risk of rollout ahead of common standards.

Consumers need to be presented with recharging infrastructure and facilities which are flexible and easy to use. They need easy and full access to all recharging points included within the publicly accessible network; and, in the same way that all petrol stations look similar and operate in a similar manner, all recharging points need to be designed to be used in a similar manner, regardless of who provides or operates them. There also needs to be a single point of contact for consumers for the purposes of payment, and a clear and consistent pricing approach.

Comparisons can be drawn with service provision for other technology-based markets. For example, in the banking sector, all automated teller machines (ATMs) can be used to withdraw cash, without the need to be a customer of a particular bank. Similarly, mobile phone customers can make calls abroad without the need to pay oversees network operators directly. Mobile operators settle the costs for customers separately through a concept known as 'roaming'. Accenture (2011) suggest that the roaming principle could be applied to recharging in the EV market, with charge point operators settling costs amongst themselves to retain a single point of customer contact.

Element Energy (2009a) report that lack of standardisation is a particular concern in London where boroughs risk developing their own recharging networks and membership schemes which are not compatible ; and Lane (2011) suggests that there is at least some anecdotal evidence of the confusion caused by the different extent and level of parking and recharging incentives used by different London boroughs to promote the use of EVs. As the network expands, it is critical that a pan-London network accessible for all EV users is developed.

Governments can either, choose to fully specify and regulate the infrastructure base, or specify minimum requirements and allow infrastructure providers some flexibility to innovate.

In June 2010, the European Commission asked European standardisation bodies to examine issues surrounding the compatibility of recharging technology. A task group is due to deliver a report with recommendations by April this year. A commission strategy document on EVs published in December 2010 recognises that "the standardisation and interoperability of recharging infrastructure is a prerequisite for consumer confidence in this technology".

2.3.3. No agreed market model to support the expansion of EVs

Lack of an agreed market model is a barrier to EV uptake because it increases the risk that infrastructure will not meet consumer requirements, and will not be delivered with sufficient speed or at a sufficient scale to address the 'range anxiety' barrier. It increases the risk that the recharging experiences of 'early adopters' are frustrating and unsatisfactory, and won't provide the wider mass market with the confidence they need to invest in the new technology. Uncertainty about the market model may also deter private sector involvement in infrastructure provision.

[21] Points designed for on-street use currently have this functionality, but may be over-specified and too expensive for a workplace context.

A large number of roles are required to support the successful expansion of the EV market including: electricity providers and retailers, charge point owners, charge point operators, recharging services providers, and IT service providers (Table 2.2).

The variety of companies and organisations that fulfil these roles implies the need for strong collaboration between them. This collaboration and the accompanying set of agreements (standards, specifications and regulations) form the basis of a market model. In some geographic locations, the market model may emerge organically; in other locations more intervention may be required to put in place an appropriate structure.

Accenture (2011) suggest that considerations and decisions need to focus on three areas:

- who the key players in the market are;
- the nature of exchanges between these players, and what sort of rules and regulations support these exchanges; and
- the variety of customer interfaces and who manages them.

A further issue to be determined is the role of the public and private sector, and the type of market agreements which need to be in place to facilitate an open market and enable market entry for new players.

Table 2.2 – Roles and responsibilities within the EV market (Accenture, 2011)

Roles	Responsibilities	Examples of market players
Electricity retailer	Provide electricity to recharging stations Identify licensee	Utility companies New market entrants; e.g., Google
Charge point owner	Pay up-front investment cost for recharging point Enable access to charge point operators	Municipalities Utility companies Automotive companies
Charge point operator	Operate and maintain recharging point Align billing system	Municipalities Utility companies Automotive companies New market entrants; e.g. end-to-end solution providers, charge point developers
Recharging services provider	Provide recharging services—recharging and billing	Utility companies New market entrants
IT services provider	Provide customer service Provide billing services	IT companies New market entrants; e.g., end-to-end solution providers, charge point developers, automotive companies, telecom operators

A key decision which needs to be made is the role of the utility companies. At present, recharging points being installed through the Plugged-in Places initiative are owned and operated by local authorities, and electricity companies charge the local authorities for the electricity used through their conventional electricity bill. This makes it difficult for the cost of electricity to be charged back to the user, because it is unclear how much electricity EV owners are using and there are no obvious methods of payment. At the moment, local authorities are generally providing electricity free of charge, but this is not a sustainable in the longer term and also limits the scope for private sector involvement. An alternative approach is for the utility companies to integrate recharging points into their asset base and charge users directly.

At present, there is no agreed market model for the Scotland, or the rest of the UK, although the Department for Transport has outlined its intentions to develop a strategy to mandate a national recharging network in 2011, within its Business Plan for 2011-2015. Clarity on the '**market model**' is necessary if the uptake of EVs is to occur rapidly and efficiently. .

2.3.4. Limited capacity of local electricity distribution networks to support large scale recharging of vehicles

The limited capacity of local electricity distribution networks to support large scale recharging of vehicles could reduce public support for EVs if widespread recharging of vehicles at peak times disrupts the local electricity supply.

The Royal Academy of Engineers (2010) report that widespread adoption of EVs would be manageable in terms of the effect on the national electricity grid, but the same is not true for the local distribution network. WWF's *Electric Avenues* Report (2011) also reaches a similar conclusion.

Large numbers of drivers 'plugging-in' at similar times will place significant pressure on the local distribution network; particularly if vehicles are predominantly charged at home during the evening peak in electricity consumption or if recharging loads at locations such as out-of-town shopping centres, sports stadia, exhibition venues or multi-storey car-parks dominate the local electricity network. This could result in a need for wholesale replacement of cables in the streets, charge delay devices, or a 'smart grid' to manage loading on a street-by-street basis so that load and generation can be scheduled as efficiently as possible.

2.3.5. Carbon-intensity of electricity generation during peak periods

Decarbonisation of the grid is a prerequisite if EVs are to achieve their maximum carbon savings potential. The current high carbon intensity of electricity generation during peak periods reduces the attractiveness of EVs for those consumers who place a high value on environmental credentials when making vehicle purchase decisions, and limits the potential to promote the benefits of EVs more widely.

For EVs to achieve their maximum potential in reducing CO_2 emissions, they will need to be charged at times when the carbon intensity of electricity generation on the grid is low. However, during periods of high demand, supply to the national grid is boosted using additional rapid start-up generators, powered by carbon intensive fuels.

'Smart pricing' would encourage EV users to charge their vehicles outside of the peak demand period, however, merely arranging for EV chargers to switch on when a particular price signal is transmitted from a central facility risks overloading local electrical connections. WWF's *Electric Avenues* Report (2011) suggests that widespread use of charge delay devices would reduce potential strain on local distribution networks and transformers, which are less able to cope with peaks in demand than the national grid, given their low voltage and thermal rating. Others, including WWF (2011) identify the need for a disaggregated smart grid with intelligence at substation level to balance local loads and carbon intensity together for an optimal solution. The Royal Academy of Engineers (2010) report that this bears little resemblance to what is currently being discussed and there is a narrow window of opportunity to ensure that the architecture of the smart grid takes proper account of the future needs of EVs.

2.3.6. Lack of support networks

Lack of appropriate support networks is a barrier to EV uptake because it exacerbates concerns about investing in new technology, as it increases the risk that maintenance of EVs will be expensive and problematic.

A comprehensive support network similar to that which exists for ICEVs is required including dealerships, garages for services and repairs, and producers and distributors of spare parts.

This will be less of a barrier in the short term as, new vehicles will be serviced at the original manufacturer's outlet while under guarantee; however, it is likely to become more of an issue once a second-hand market for EVs develops. Need for maintenance is expected to be more extensive in the first few years of market development.

2.3.7. Lack of engineering skills

Lack of engineering skills is a barrier to EV uptake because it limits scope for research and development and increases the likely timescales for reducing the cost of batteries, increasing the range of EVs, reducing the time taken to charge, decarbonising the electricity supply, managing local electricity demands, increasing the performance and choice of EVs, etc.

Without engineering skills the required introduction of EV infrastructure and upgrades to the power / electrical supplies cannot be delivered. Given the demands from other UK developments such as rail electrification, high speed rail, renewable energy production and the nuclear programme, the supply of engineering professionals is unlikely to keep up with demand unless there is a new urgency to the education and training of engineers and technicians.

2.3.8. Limited supply of EVs

Limited supply of EVs will constrain the growth of the market, and contribute to high purchase prices. Scotland must therefore sell itself as a location in which manufacturers are prepared to market and maintain their EVs.

A number of stakeholders responding to our questionnaire survey identified the limited supply of EVs as a potential barrier to uptake. There are very few EVs available in the world at present, and demand currently outstrips supply. There is already a long waiting list for the Nissan Leaf, for example.

Planned volumes of EV production over the next few years are low. Mitsubishi is aiming for full-scale production of the i-MiEV in 2012/13 with at least 30,000 units to be built every year[22]; while Nissan expects the maximum global Leaf capacity in 2011 to be 50,000 cars[23]; and Peugeot/Citreon are looking at producing around 15,000 EVs a year initially[24], increasing to a projected total of 50,000 by 2015[25].

The low levels of production are partly related to the fact that most of the major car manufacturers are already well on their way to meeting the EU target for the emissions-intensity of new cars and vans. This requires all vehicle manufacturers to reduce their new car fleet average emissions to 130 gCO_2/km by 2015, and 95 gCO_2/km by 2020[26]. Progress against this target is being monitored by the European Federation for Transport and Environment (T&E). Data for 2009 (T&E, 2010) shows that carmakers in Europe are heading for very significant 'over-compliance' with the CO_2 regulation and are hence likely to hit the target for 2015 years in advance. Rapid progress is being achieved by focusing on efficiency improvements for conventional internal combustion engine vehicles, reducing the need for large scale sales of EVs.

While some manufacturers such as Nissan are ready to be at the forefront of a transition to EVs if the EU target becomes more ambitious, it is unlikely that the volume of EVs produced will increase significantly if the target remains as is, unless there is very strong demand from consumers.

2.4. Wider issues

There are a range of other issues which while not barriers to uptake will need to be addressed as the market grows.

2.4.1. Management of rebound effects

The provision of cheap 'guilt-free' motoring could increase traffic levels, and related congestion, journey times and parking demand, unless supported by appropriate sustainable travel and demand management interventions that reduce the amount people drive. (WWF, 2011).

2.4.2. Loss of government revenue from road tax, company car tax and fuel duty

EVs are currently exempt from vehicle excise duty ('road tax') and company car tax, and EV owners do not pay any fuel duty. While these are valuable subsidies to accelerate the introduction of EVs, by the time significant penetration of EVs has occurred, the government will need to find alternative revenue sources. The Royal Academy of Engineers (2010) suggests that large-scale adoption of EVs is likely to accelerate the need for a comprehensive system of road pricing or another mechanism for pay-as-you-drive taxation.

The potential loss of revenue could be considerable. Fuel duty and VAT accounts for about 60% of total diesel prices (according to WebTAG), while the only tax receipt from electricity is VAT which is charged at 5%

[22] http://www.dlegs.com/mitsubishi-to-increase-production-of-imievs/.
[23] http://nissan-leaf.net/2010/07/08/nissan-plans-to-sell-25000-leafs-in-us-in-2011/.
[24] http://www.timesonline.co.uk/tol/news/environment/article7066850.ece.
[25] http://www.mynewsdesk.com/uk/view/pressrelease/peugeot-peugeots-electric-i0n-wins-another-award-525202
[26] Regulation EC/443/2009 setting emissions performance standards for new cars: http://ec.europa.eu/environment/air/transport/co2/co2_home.htm

for domestic use (20% for business); and the per mile cost of electricity is much less than the per mile cost of petrol or diesel[27].

2.4.3. New security issues

The availability of lithium for the more powerful lithium-ion batteries has been identified as a potential barrier to the development/uptake of battery-powered vehicles in the long term and could create new security issues in the same way as the current reliance on the oil states. The largest lithium reserves are in Chile, Bolivia and Argentina, followed by the US (North Carolina and Nevada), Zimbabwe and China (Tibet). The high exposure to South America may present a geopolitical risk in the future (HSBC, 2009).

2.4.4. Battery disposal

Batteries at the end of their lives may be liabilities because of their recycling costs. Ninety-seven percent of the lead in lead-acid batteries can be recycled, but lithium is more difficult to handle and currently less valuable than lead (Hensley et al, 2009, p94). One possible idea is the use of EV batteries as local energy stores after they are no longer suitable for use in vehicles[28].

2.5. External factors

In addition, to the above barriers, there are also a number of external factors, beyond the influence of the EV sector, which will influence the scale and rate of EV uptake, including the state of the UK economy and activities across the rest of the world within the car sector.

2.5.1. State of the economy

Sales of new cars are closely tied to the state of the economy. Rates of replacement slow down significantly during periods of low growth or recession and there are differences in the rate of sales across public, corporate and private fleets. Slow economic growth over the period to 2020 could be expected to have a significant impact on the volume of new EVs purchased, and in turn, would hinder the generation of a buoyant second-hand market.

However, consumer response to economic conditions is complex, and slow growth could have two positive benefits for EV uptake. Firstly, slower replacement rates will delay decisions about whether or not to purchase an EV. During this period a wider choice of EVs should become available, increasing the likelihood of consumers choosing an EV rather than an ICEV in the medium term.

Secondly, in response to the fuel price peaks in 2008, followed by the global economic downturn, the UK car market saw a marked shift to smaller, more fuel-efficient cars, with the 'biggest drop in new car CO_2 on record' – falling 3.6% in the second quarter of 2008 and then 5.5% in 2009 (SMMT, 2008; Next Green Car, 2009). During this period, some surveys have also observed that fuel economy has increased in importance during the car purchasing process (e.g. Lane & Banks, 2010).

2.5.2. World trends

Scotland cannot act alone in tackling the barriers to EV uptake. The car industry operators on a global scale and uptake in Scotland will be affected by what happens in the rest of Europe, North America, Japan, and rapidly emerging economies such as China and India.

[27] The fuel cost per mile for a diesel VW Golf BlueMotion is 8.8p (Which, 2011), which implies that the tax revenue per mile is 5.28p (8.8p * 60%). The electricity cost per mile for a Nissan Leaf is 2.9p (Which, 2011), suggesting that the tax revenue per mile is 0.14p (2.9p*5%) or 0.58p (2.9p*20%) for business trips. This implies a tax revenue difference per mile of 5.14p (assuming domestic charging) - a reduction of over 95% in the current tax income per mile. This is a conservative estimate as most ICEVs will use more fuel per mile than a Blue Motion, and therefore incur more tax.

[28] http://www.batterylaptops.co.uk/news/2011/02/06/before-recycling-electric-vehicles-lithium-ion-batteries-enjoy-a-second-life/

2.6. Ranking of barriers

2.6.1. Overview

Table 2.3 (below) ranks the above barriers in order of significance, based on:

- views from key stakeholders about the importance of an identified list of barriers, provided in responses to an email questionnaire;
- evidence from other research reports; and
- expertise within the Atkins' study team regarding the complexity of the barrier and scale of resultant benefits.

A more detailed presentation of evidence used to rank the barriers is provided in **Appendix A**.

Table 2.3 also indicates how the barriers apply to different fleet sectors, including:

- privately owned vehicles;
- company cars – cars made available to employees for both private and business use as a 'benefit in kind', often as a 'perk', or for employees required to travel extensively as part of their job;
- corporate vehicles – cars and light vans used by trades people and large organisations such as BT, Royal Mail, electricity and gas companies, etc. where daily mileage is predictable and often within the maximum range of an EV; and
- public sector fleets – cars and light vans used by local authorities.

In general, local authority fleets are expected to be least affected by the identified barriers, due to a need to show leadership by demonstrating support for the technology required to meet CO_2 reduction targets. Company car owners are expected to be particularly affected by the barriers, due to the high mileage often associated with these vehicles, and a preference for larger, high performing models.

High purchase price could be expected to be less of a concern in the context of public and corporate fleets, given the strong buying powers of the organisations concerned and greater appreciation of whole life costs; however, public sector fleet managers have reported that they are unlikely to buy EVs for their fleets unless incentivised to do so by the government, because the overall cost is seen as being uncompetitive (see Section 2.2.2).

The **limited range of EVs** and **lack of charging infrastructure** may be less of a concern for corporate utility and public sector fleets where daily mileage is predictable and less than the maximum range of a single battery charge, and where infrastructure can be provided in a depot to allow overnight recharging. Scheduling tools may be required to manage recharging, and the electricity supply may need to be upgraded as historically, many premises were built with limited provision of power for the building and car park.

Table 2.3 – Ranking of barriers

Category and barrier	Type	Relevance to fleet types (see key below)				Comment
		Private	Company cars	Utility vehicles	Local authority	
Very high significance						
• **High purchase cost**	Demand	✓	✓	✓	✓	**Widely identified as one of the two most significant barriers.** Could be expected to be less of a concern in the context of public and corporate fleets, given the strong buying powers of the organisations concerned and greater appreciation of whole life costs; however, public sector fleet managers have reported that they are unlikely to buy EVs for their fleets unless incentivised to do so by the government, because the overall cost is seen as being uncompetitive (see Section 2.2.2).
• **Limited range of EVs (and range anxiety issues)**	Demand	✓✓	✓✓	(✓)	(✓)	**Widely identified as one of the two most significant barriers. Experience reduces anxiety but longer journeys not practical. In the longer term (post-2020) the range of EVs is likely to increase significantly.** Particular concern for the private fleet vehicles due to the high value consumers place on the ability to drive long distances, and company car owners undertaking high mileage. Less of a concern for corporate utility fleets and public sector fleets where daily mileage is predictable and less than the maximum range of a single battery charge, and where infrastructure can be provided in a depot to allow overnight recharging. (Note – many buildings were built with limited provision of power for the building and car park. Scheduling tools may be required to manage recharging).
• **Lack of recharging infrastructure, including….**	Supply	✓	✓✓	(✓)	(✓)	**Closely linked with limited range and range anxiety issues. Identified as significant barrier in its own right, by wider stakeholders and in other reports.** Particular concern for company car owners undertaking high mileage. Range anxiety is a significant concern for private owners, but in practice, most are expected to favour home-based recharging in practice. Less of a concern for corporate utility fleets and public sector fleets (see above).
• …no agreed standards, specifications and regulations for recharging infrastructure • …no agreed market model to support expansion of EVs • …limited capacity of local electricity distribution networks to support large scale recharging of vehicles • …carbon-intensity of electricity generation during peak periods						**Closely linked to provision of recharging infrastructure. Unlikely to be mentioned by consumers, but will be crucial in ensuring consumer experiences of EV ownership are positive. Complex issues to be overcome.**

Category and barrier	Type	Relevance to fleet types (see key below)				Comment
		Private	Company cars	Utility vehicles	Local authority	
High significance						
• **Uncertainty about future resale value**	Demand	✓	✓✓	✓✓	✓✓	**Will limit uptake in the short to medium term.** Specific issue for company car, utility and local authority fleets, as limits the scope for competitive lease contracts.
• **Limited supply of EVs**	Supply	✓	✓✓	✓	✓	**Will limit uptake in the short to medium term.** Expected to be particular issue regarding the supply of larger, high performance models favoured by company car users. The availability of electric vans from the main manufacturers is expected to be limited, but smaller manufacturers may be able to cater for demand by refurbishing existing models.
• **Lack of public awareness and knowledge about EVs**	Demand	✓✓	✓✓	✓	✓	**Will limit uptake in the short to medium term.** Expected to be more of an issue for private consumers and company car users, than for fleet owners who may have procurement staff to fully consider the options and purchase on the basis of value for money.
• **Limited performance and limited choice of vehicles in comparison with ICEVs**	Demand	✓	✓✓	✓✓	(✓)	**Will limit uptake in the short to medium term.** Specific issue for company car users, who favour larger, high performance models (most current EVs are small family cars); and for utility fleets (there are no electric vans produced by the main manufacturers, although some smaller manufacturers convert existing models). Local authority fleet managers are expected to attach less importance to choice and performance.
• **Aversion to new technology**	Demand	✓	✓	✓	(✓)	**Will limit uptake in the short to medium term. Uptake of new technology needs to achieve 15% penetration levels across the market before the risk of investing in new technology is no longer seen as a barrier by the mass market.** Expected to less of an issue for local authority fleets, because local authorities will need to show leadership and demonstrate support for the technology required to met CO_2 reduction targets.
• **Weak image association**	**Demand**	✓	✓✓	✓	(✓)	**Will limit uptake in the short to medium term.** Expected to be most relevant to company car users (for whom the car may be status symbol); and less relevant to local authority fleet managers, who will need to show leadership and promote EV use.
• **Limited value placed on environmental benefits by consumers**	Demand	✓✓	✓✓	✓	(✓)	**Will limit uptake in the short to medium term.** Expected to be least relevant for local authority fleet managers who will need to show leadership and promote EV use.
• **Uncertainty about future energy costs**	Demand	✓	✓	✓✓	(✓)	**Significant issue in current climate,** but there is evidence that private consumers buy on the basis of purchase cost rather than whole life costs. In addition, there is currently a lack of public awareness and understanding regarding the cost of running an EV.

Category and barrier	Type	Relevance to fleet types (see key below)				Comment
		Private	Company cars	Utility vehicles	Local authority	
Moderate significance						
• **Limited environmental benefits associated with current models**	Demand	✓	✓	✓	(✓)	**Unlikely to be a concern for most consumers. Expected to be addressed in time.** Local authority fleet managers who will need to show leadership and promote EV use.
• **Lack of support networks (e.g. garages with appropriate skills and equipment).**	Supply	✓	✓	✓	✓	**Market expected to respond to demand.**
• **Lack of engineering skills**	Supply	✓	✓	✓	✓	**Unlikely to be a concern to consumers. Sector expected to respond to demand.**

Key:

✓ = Barrier relevant to this fleet sector

✓✓ = Barrier particularly relevant to this fleet sector

(✓) = Barrier less relevant to this fleet sector

3. Potential measures for increasing uptake of EVs

3.1. Introduction

The normal market penetration rate for a new technology is slow and direct intervention is required if uptake of EVs is to be accelerated to meet the necessary emissions reduction trajectory.

This chapter explores the powers available to the Scottish Government and local authorities to intervene, considers the broad types of measures available, and then discusses each of the individual measures available.

3.2. Scottish Government and local authority powers

Scottish Government powers

Since 1999, the majority of transport functions and transport spending powers have been devolved to the Scottish Parliament. In addition, the Transport (Scotland) Act 2001 made Scottish road pricing schemes possible, providing revenue generated was spent on transport projects. Scottish powers relating to the promotion of EVs are summarised in *Low Carbon Scotland: Meeting the Emissions Reduction Targets 2010-2022*, a *Report on Proposals and Policies* which Scottish Ministers are required to lay before the Scottish Parliament under Section 35 of the Climate Change (Scotland) Act 2009. This outlines powers relating to the promotion of sustainable travel, planning policy, and parking regulations. From January 2011, local authorities and other public bodies also have a duty, under the Climate Change (Scotland) Act to "act in the way best calculated to contribute to the delivery of the Act's emission reduction targets" and "in a way that it considers most sustainable".

Some matters, particularly those relating to tax, remain reserved to the UK Parliament. Apart from local taxation (including powers to set business rates), the Scottish Parliament currently only has the power to vary the basic rate of income tax by up to 3 pence in the pound, up or down (the "Scottish Variable Rate" or SVR). This power has not been used so far. It does not have fiscal autonomy to tailor fuel and vehicle excise duties to better take account of Scottish circumstances.

Scottish powers have recently been reviewed by the Scottish Commission on Devolution, chaired by Sir Kenneth Calman. Findings and recommendations were published in June 2009, in *Serving Scotland Better: Scotland and the United Kingdom in the 21st Century*. The report states that in an economic Union devolving taxation could introduce serious economic inefficiencies and recommends against wide-scale devolution of tax raising powers, including the devolution of vehicle excise duty ('road tax') and fuel duty. The recommendations of the Final Report of the Commission on Scottish Devolution are due to be implemented in a new act. The Scotland Bill is currently being debated by Parliament. It includes powers for the Scottish Parliament to add new devolved taxes (Section 80B). A number of MSPs are pushing for more powers than currently proposed in the Bill.

Where the Scottish Government has evidence and support for changes relating to issues not covered by devolved powers, it can press the UK Government for changes to be made to UK legislation or ask for additional devolved powers in order to make changes in Scotland alone.

In 2009 the Scottish Parliament unanimously passed the Climate Change Scotland Act; part 4 of the act places duties on public bodies that include the requirement to contribute towards the Act's emissions reduction targets.

Local authority powers

At a local level Scottish local authorities currently have a wide range of statutory powers that could be employed in a manner that would allow them to influence the update of EVs. In particular local authorities have existing statutory powers in relation to finance, roads, traffic, parking, planning, and building control that could be used to incentivise the take up and use of electric vehicles.

Capital investment by local authorities is largely funded through capital grants and borrowing supported by the Scottish Government. Local authorities can also borrow additional funding under the 'prudential borrowing regime' and finance payments from their own resources. In determining the levels of unsupported 'prudential' borrowing, local authorities must ensure that their plans are affordable, prudent and sustainable based on prudential indicators as set in the Prudential Code published by the Chartered Institute of Public Finance and Accountancy (CIPFA). Prudential borrowing can only be used to fund capital investment (e.g. funding recharging points) and cannot be used to support revenue expenditure.

In addition to the statutory instruments available to Scottish local authorities there is also scope for them to influence the uptake of EVs through their own procurement processes – through the purchase of vehicles for their own fleets, and through their tender specification's when acquiring external services.

3.3. Types of measures available

A range of possible interventions are available, which are all being deployed to varying extents by different countries to accelerate the uptake of EVs. These can be categorised as follows:

- A – Infrastructure provision;
- B – Alternative ownership models;
- C – Fiscal measures and subsidies to reduce vehicle purchase cost;
- D – Fiscal measures and pricing policies to reduce running costs;
- E – Awareness, information and training measures; and
- F – Other Government leadership measures.

The range of measures available under each of these categories is described below. At this stage each measure is presented as a 'stand-alone' intervention.

Measures combine 'sticks' to discourage purchase of ICEVs, and 'carrots' to encourage EV uptake. It is assumed that strong incentives will be needed throughout the period to 2020. As discussed in Section 2.2.7, 'technology aversion' is generally a barrier to uptake of new technologies until market penetration has reached at least 15%. The target of 290,000 EVs on Scotland's roads by 2020 equates to less than 15% of the current car market, suggesting the need for strong incentives until 2020 and beyond.

Table 3.1 summarises the specific measures considered within the above categories. Further information about each of the measures is presented in the rest of this chapter. All measures have been presented in a Scottish context, but the key themes are equally applicable to other parts of the UK.

All measures are considered to be realistic proposals for encouraging EV uptake. However, some relate to matters which are currently reserved to the reserved to the UK Parliament, and require the Scottish Government to lobby for change at a UK level or request additional devolved powers in order to make changes in Scotland alone.

Table 3.1 – Summary of measures considered

A - Infrastructure and support services measures	Action for Scottish Gov	Action for local authorities
A1 - EV Infrastructure Strategy for Scotland (as part of a broader EV Strategy and Action Plan for Scotland, see F4).	✓	
A2 - Government action to agree technical standards, specifications and regulations for recharging infrastructure	✓	
A3 - Government action to agree market model for recharging infrastructure	✓	
A4 - Funding for publicly accessible recharging points	✓	✓
A5 – Incentives for workplace recharging infrastructure	✓	✓
A6 - Support for home recharging infrastructure	✓	✓
A7 - Planning guidance on the provision of recharging bays and infrastructure	✓	✓
A8 - Building regulations relating to the provision of recharging infrastructure in new buildings	✓	
A9 - Battery swap feasibility study	✓	✓
A10 - Induction recharging research	✓	
A11 - Qualifications for garage mechanics and quality insurance scheme for garages servicing, undertaking MOTs, and repairing EVs	✓	
A12 - Working Group to address the electricity generation and distribution requirements for EVs	✓	
B - Alternative ownership models		
B1 - Car club schemes	✓	✓
B2 - Other ownership models	✓	✓
C - Fiscal measures and subsidies – vehicle purchase incentives		
C1 - Grants for purchasing new EVs	✓	
C2 - Scrappage scheme designed to increase sales of EVs	✓	
C3 - Grants for purchasing second hand EVs	✓	
C4 - Registration tax (increase ‘first year rates’)	✓	
C5 - Registration tax feebate scheme	✓	
C6 - Tax credits	✓	
C7 - Enhanced capital allowances	✓	
D - Fiscal measures and pricing policies to reduce running costs		
D1 - Road pricing (congestion charging schemes, low emissions zones, road tolling)	✓	✓
D2 - Workplace Parking Levy	✓	✓
D3 - On-street parking charge policies	✓	✓
D4 - Vehicle Excise Duty	✓	
D5 - Fuel tax	✓	
D6 - Company car tax	✓	

E - Awareness, information and training measures	Action for Scottish Gov	Action for local authorities
E1 - Demonstration projects	✓	✓
E2 – Provide opportunities for consumers to test drive EVs	✓	✓
E3 - Customer information about EVs and where to charge them	✓	✓
E4 - Public promotion campaigns	✓	✓
E5 - Eco-driving training	✓	✓
F - Other Government leadership measures		
F1 - Public sector procurement of low carbon vehicles for own fleet	✓	✓
F2 - Government research	✓	✓
F3 - Funding to convert specific vehicles to electric platforms	✓	
F4 - A high profile EV Strategy and Action Plan for Scotland, setting out a clear vision supported by targets or milestones	✓	
F5 - Mandate specifying proportion of EV sales by major manufacturers	✓	
F6 - Government action to encourage private sector to convert to EVs	✓	✓
F7 - Lobbying to increase the EU target for the emissions-intensity of new cars and vans	✓	

3.4. A – Infrastructure and support services measures

Lack of recharging infrastructure has been identified as a barrier of 'very high' significance, alongside the high purchase cost of EVs and range anxiety issues. Infrastructure for recharging EVs is therefore vital. In providing infrastructure it as also essential that technical specifications and standards are first agreed, market models clarifying the roles and responsibilities of those involved are clearly defined, and that demands placed on local electricity distribution networks are fully addressed. Development of a comprehensive recharging network will require considerable investment and it is essential that the right decisions are made about where to focus investment. Measures will also need to be put in place to ensure that consumers are confident that appropriate support networks are available (e.g. garages able to service EVs, breakdown companies with appropriate expertise).

3.4.1. A1 – EV Infrastructure Strategy for Scotland

Potential measure: Scottish Government develops an EV Infrastructure Strategy for Scotland, setting out a clear vision for the future, presenting a strategy for the provision and roll out of appropriate recharging infrastructure, and describing how drivers will use the infrastructure (see A3). This should be part of a broader EV Strategy and Action Plan for Scotland (see F4).

Barrier(s) addressed: lack of recharging infrastructure.

An infrastructure strategy would ensure a coherent and efficient approach to the development of recharging infrastructure; and would inform actions by local authorities to provide recharging infrastructure. It would need to be developed in conjunction with relevant stakeholders, and would be informed by a review of existing Infrastructure Strategies such as *London's Electric Vehicle Infrastructure Strategy: Turning London Electric*, published for consultation by the Mayor of London in December 2009.

The strategy should set out a vision for Scotland; timescales, milestones and targets for the number and type of recharging points required; key locations and priority areas for investment (based on analysis to determine the location of 'early adopter' clusters); requirements for on-street recharging points in residential areas; and integration with wider sustainable transport policies. It should also describe how drivers interact with the infrastructure, in terms of access, pricing and payment approaches (see A3).

3.4.2. A2 – Government action to agree technical standards, specifications and regulations for recharging infrastructure

Potential measure: Scottish Government works with relevant stakeholders in Scotland, the rest of the UK, and across Europe, to set technical standards, specifications and regulations for implementing recharging infrastructure.

Barrier(s) addressed: no agreed standards, specifications and regulations for recharging infrastructure; aversion to new technology *(will ensure that the experiences of early adopters are positive and provide the wider mass market with confidence to invest in EVs).*

Clarity on technical standards, specifications and regulations for recharging infrastructure will ensure that the experiences of 'early adopters' are positive, and provide the wider mass market with the confidence they need to invest in EVs. Regulations need to be put in place specifying technical standards and specifications for home-based, work-based and public recharging infrastructure; and specifying the process for implementing new infrastructure in terms of legal requirements, planning matters and safety issues. Governments can either choose to fully specify and regulate the infrastructure base, or specify minimum requirements and allow infrastructure providers some flexibility to innovate.

Pan-London scheme for recharging infrastructure
Proposals for a pan-London scheme are set out in London's EV Infrastructure Strategy (Mayor of London, 2009). This envisages an approach involving: interoperable tags or cards accepted by all scheme recharging points; common branding for all scheme recharging points (with their location and availability viewable from one website); standard recharging point connectors, and; a call centre for help and advice.

This work would need to consider lessons learned in the Plugged in Places pilot areas, the work undertaken by Transport for London to specify a common pan-London approach (see below), and work being undertaken by the European standardisation bodies to examine issues surrounding the compatibility of

recharging technology (commissioned by the European Commission in June 2010 and due to report in April 2011).

3.4.3. A3 – Government action to agree a market model for recharging infrastructure

Potential measure: Scottish Government commissions a review of the possible market models for recharging infrastructure in Scotland and implements the recommendations of the review. This would involve working with relevant stakeholders to identify key roles and responsibilities for energy providers, electricity retailers, EV manufacturers, private infrastructure providers and the public sector; specify pricing and payment approaches; and agree customer interface requirements (single or multiple points of contact).

Barrier(s) addressed: no agreed market model to support expansion of EVs; aversion to new technology *(will ensure that the experiences of early adopters are positive and provide the wider mass market with confidence to invest in EVs).*

Eurelectric (2010) identify four possible market models for consideration:

- an integrated infrastructure model – This involves integrating the recharging infrastructure into the national asset base with current electricity providers offering tariff systems common to the whole system, with different rates for slow and fast recharging. Under this model the deployment of recharging infrastructure could be financed collectively by electricity users;
- a separated infrastructure model – A new role of recharging infrastructure operator is created to own and operate recharging infrastructure, purchasing electricity from suppliers before selling it onto the customer;
- independent e-mobility provider – A new role of e-mobility provider is created to install a proprietary network of EV recharging sockets, conforming to agreed standards, and providing electricity bundled with other services, including recharging; and
- spot operators – Recharging points and the selling of electricity are conducted by the parking spot owner or operator.

A number of countries (including the Netherlands - see below), have recently or are currently considering these alternative models and specifying an approach which reflects their circumstances and best meets their requirements.

Preferred market model in the Netherlands (Accenture, 2011)
In the Netherlands, EnergieNed, the Dutch organization for energy producers, traders and suppliers, and Netbeheer Nederland, the Dutch organization of grid operators, recently commissioned a study to design the market model for EV recharging infrastructure in the public domain, based on consultation with the key stakeholders. Within the preferred market model, the charge spot operator is responsible for operating the recharging point, for settlement, and for granting access to the recharging station. The provider, in turn is (as in the telecommunications industry), responsible for the customer. The provider has a contract with the customer offering full access to recharging spots, and is responsible for cost settlement with both the customer and the operator. This model seeks to offer optimal service and freedom of choice for the customer. It is expected to stimulate new market entrants to participate in the electrification of transport as it supports access to all, therefore supporting competition and innovation. Underpinning this free market structure, local governments will lay down certain conditions for recharging infrastructure including location, safety and accessibility.

3.4.4. A4 – Funding for publicly accessible recharging points

Potential measure: Scottish Government and local authorities provide funding for publicly accessible recharging points.

Barrier(s) addressed: lack of recharging infrastructure; range anxiety issues associated with limited range of EVs.

A number of government organisations, in the UK and elsewhere, are either directly funding the installation of public recharging points or are providing subsidies for others to install points. The UK Government's '**Plugged-In Places**' programme offers match-funding to local consortia of businesses and public sector partners to support the installation of a critical mass of EV recharging infrastructure. The UK Office of Low Emission Vehicles initially awarded £14.5 million to London, Milton Keynes and the North East for the installation of over 11,000 recharging points by 2013/14. In London, this is contributing towards the Mayor's target of 25,000 charge points in London by 2015 (including 500 on-street and 2000 in off-street car-parks), with no Londoner more than a mile from a recharging point. In December 2010, a further £20 million was announced to help install 4,000 recharging points in Northern Ireland, Scotland, Greater Manchester, the Midlands and the East of England. A consortia led by Transport Scotland will receive a grant of £1.45million for installing 375 recharging points across Edinburgh, Glasgow and the Central Belt; in homes, in on-street locations and at public, workplace and retail car parks; as part of a £3 million programme of investment.

While the Plugged-In Places programme will make an initial start there is clearly a need for a **much greater level of investment across the whole of Scotland**. This could take the form of match funding provided by the Scottish Government to local consortia of businesses and public sector partners; and direct funding from local authorities from their own resources.

The Committee for Climate Change (2009) estimates that an extensive network of recharging points (comprising dedicated slow recharging posts for the 25% of drivers who do not have off-street parking, recharging posts in workplaces for 5% of drivers, fast recharging points in public places - two for every 1,000 electric cars, and four fast recharging points every 35-50 kilometres in each direction on motorways and trunk roads), might cost around £1.4bn at a UK level, or (very approximately) £112 million in Scotland. This represents a considerable level of investment, which could be reduced if a market model for EV infrastructure (Proposal A3) is developed which encourages private sector investment.

Potential locations for recharging points include local authority car-parks, public transport car-parks (including ferry terminals and on-board ferries)[29], retail and leisure centres, and motorway services (fast recharging). Public car-parks could also be opened up over night to allow residents to use recharging facilities.

Funding could come from the Scottish Government, in the form of match funding which local consortia of businesses and public sector partners could apply for (similar to the 'Plugged-in Places programme); or directly from local authority sources. Local authorities could use 'unsupported prudential borrowing' powers to fund recharging infrastructure, and use parking charges or other revenue generating activities to support this borrowing.

3.4.5. A5 – Incentives for workplace recharging infrastructure

Potential measure: Scottish Government and local authorities incentivise businesses to install recharging points. This would involve engaging directly with the largest businesses with employee car-parks to highlight the benefits of encouraging use of EVs rather than conventional vehicles; by providing free advice; and by providing match funding to 'innovator' and 'early adopter' businesses wishing to install recharging points in existing parking spaces. These measures would be most effective if linked to exemption from a Workplace Parking Levy.

Barrier(s) addressed: lack of recharging infrastructure; range anxiety issues associated with limited range of EVs.

WWF Scotland (2010) estimate that 220,000 workplace recharging points will be required in Scotland by 2020 to meet demand. The above measures would seek to incentivise businesses to make sufficient investment in infrastructure to meet this target.

Provision of workplace recharging infrastructure should be seen as part of an overall shift towards more sustainable travel, and incentives would need to encourage recharging points to be installed in existing parking spaces and should lead to new spaces being provided.

[29] Stena Line now offer charging points onboard their ships on the Stranraer-Belfast route. Free charging points are available onboard for passengers travelling with electric and hybrid vehicles. (http://www.electriccarsite.co.uk/electric-car-charging-points).

3.4.6. A6 – Support for home recharging infrastructure

Potential measure: Scottish Government prepares advice for residents on home recharging and guidance for electricians on the type of facilities needed (including issues to be considered in communal parking areas). Local authorities to disseminate information.

Barrier(s) addressed: lack of recharging infrastructure; range anxiety issues associated with limited range of EVs.

Home-based recharging points will provide an important opportunity to recharge EVs, at a much lower cost than publicly available recharging solutions. While advice and guidance could most efficiently be prepared by the Scottish Governments, local authorities would have an important role in disseminating the information.

The information should emphasis the role of EVs in achieving an overall shift towards more sustainable travel.

There may also be a role for the Scottish Government to provide grants towards the cost of installing recharging points, similar to the grants which are currently available for other energy efficiency improvements to householders (e.g. loft insulation grants and cavity wall insulation grants. Some EV manufacturers, however, are currently installing recharging points for EV consumers.

3.4.7. A7 – Planning guidance on the provision of recharging bays and infrastructure

Potential measure: Scottish Government provides national planning guidance on the provision of recharging bays and infrastructure in local authority areas as part of a parking strategy which supports wider sustainable transport objectives.

Barrier(s) addressed: lack of recharging infrastructure; range anxiety issues associated with limited range of EVs.

Planning guidance is set out in a hierarchy of documents. At a national level, the second *National Planning Framework – NPF2 (July 2009)* sets out a strategy for long-term development in Scotland; policy statements on nationally important land use planning matters are set out in *Scottish Planning Policy - SPP (February 2010)*; and detailed guidance on policy implementation is set out in various Circulars.

At a local authority level, *strategic or local development plans* set out policies that will guide decision-making on planning applications at a local level. Development plans must reflect statements of Scottish Government policy in the NPF, the SPP, Designing Places and Circulars.

This measure would require updates to be made to paragraphs 171 to 173 of *Scottish Planning Policy*, covering 'parking policies'. Minimum standards for the proportion of recharging bays to be provided in specific types and scales of development should be set out. For example, Policy 6.13 in the consultation draft of the London Plan (October 2009) proposes that 20% of parking bays in new developments be equipped with recharging infrastructure. Over time this is expected to deliver several thousand recharging points each year, at a minimal cost (Mayor of London, 2009).

This measure would be part of a sustainable travel approach to reduce the total number of parking spaces, and reduce reliance on car travel.

3.4.8. A8 – Building regulations relating to the provision of recharging infrastructure in new buildings

Potential measure: Scottish Government updates building regulations to set out minimum requirements regarding the provision of electrical infrastructure and recharging points in new buildings.

Barrier(s) addressed: lack of recharging infrastructure, range anxiety issues associated with limited range of EVs.

Scottish Ministers are responsible for Building Standards in Scotland with the key purpose of protecting the public interest, creating building regulations and preparing technical guidance to ensure buildings are safe, efficient and sustainable for all. Local authorities are responsible for ensuring building regulations are adhered to.

This measure would apply to residential, workplace and other public buildings.

3.4.9. A9 – Battery swap feasibility study

Potential measure: The Scottish Government conducts a feasibility study into the potential to trial a network of battery swap stations.

Barrier(s) addressed: lack of recharging infrastructure; range anxiety issues associated with limited range of EVs; high purchase price.Battery swap takes a matter of minutes and potentially offers a quick, attractive means for users to recharge their EVs. In addition, operators of the battery swap stations retain ownership of the battery, removing the high purchase cost barrier. The batteries can also be used to store electricity while not in use, increasing the opportunities to recharge EVs using renewable energy sources. However, **the practical and financial challenges are significant**.

Firstly, for this approach to be deployed at scale, battery design would need to be standardised. None of the major manufacturers are currently looking to do this.

Secondly, vehicle design would also need to be standardised so that batteries are readily accessible, and able to be 'swapped' using the same handling equipment. However, given that the battery pack for an average passenger car will weigh 250 to 300kg, battery location may need to be specifically designed for each vehicle to ensure good weight distribution and thus safe handling of the car (Arup and Cenex, 2008).

Thirdly, a business model needs to be developed which is attractive to the private sector. Private operators will need to make a huge upfront investment in purchasing batteries (costing approx. £100,000 each) but could only expect to rent them out for a few pounds (reflecting the cost for the amount of electricity provided). This is very different the business model for a conventional petrol station, where the price the retailer pays for petrol is easily covered by the amount they make selling petrol to consumers. The business model developed by Better Place[30] involves targeting high mileage consumers and encouraging them to drive more, in order to secure high returns from the 'per mile rates' paid by subscribers. This model is not compatible with policies aimed at reducing reliance on the private car.

In addition, the necessity for swap stations could be challenged by improvements in fast charge technology, which might prove to be a comparable and cheaper approach in time. The practicalities of delivering high speed and rapid-charge public recharging points will be addressed as part of the Manchester Plugged in Places pilot.

The practicalities of swapping batteries rather than plugging in for a recharge are being addressed by the EASTBAT EU funded project (started in March 2011), which is backed by Renault SA, Continental, Ernst & Young, TÜV Rheinland, KEMA and five leading European institutions. The project aims to solve the technical difficulties of battery swaps in a project that focuses on Denmark and Israel.

3.4.10. A10 – Induction charging research

Potential measure: Scottish Government commissions research into the potential for introducing induction charging (via electrified parking spaces and electrified roads) in Scotland.

Barrier(s) addressed: lack of recharging infrastructure; range anxiety issues associated with limited range of EVs.

Inductive charging uses the electromagnetic field to transfer energy between two objects. A charging station sends energy through inductive coupling to an electrical device, which stores the energy in the batteries. Inductive charging makes charging mobile devices (including EVs) more convenient; rather than having to connect a power cable, the unit can be placed on or close to a charge plate or could even be charged using electrified roads.

Induction pads capable of recharging cars with cords have already been developed and trialled (e.g. by Halo IPT[31]) and could be used to charge vehicles in parking lots, garages and driveways. Initial costs are estimated at NZ$2,000, but could fall to NZ$800 within four or five years[32].

[30] Better Place is currently working with Renault-Nissan to roll out battery swap infrastructure in Isreal. Due to its geo-political situation, Israel also has a strong incentive to become oil independent by 2020. The car fleet is dominated by company cars, and aligning with one manufacturer is much more feasible than elsewhere.
[31] http://www.haloipt.com/#n_home-intro

E-ways which allow vehicles to be charged on the go are also technically feasible, but Halo IPT do not expect e-ways to become a reality before 2020. The cost of getting charging lanes to most of the UK population has been estimated at £60 billion[33].

3.4.11. A11 – Qualifications for garage mechanics and quality insurance scheme for garages servicing, undertaking MOTs, and repairing EVs

Potential measure: Scottish Government develops an EV-specific qualification for garage mechanics and breakdown engineers (working for the AA, RAC, etc.); and a quality insurance scheme for garages servicing, undertaking MOTs, and repairing EVs (similar to the Good Garage Scheme, for example), to provide consumer confidence in the availability of appropriate support networks.

Barrier(s) addressed: lack of support networks.

The current garage trade has struggled to implement high standards and provide consistent training schemes for mechanics. Some form of compulsion for garages to join consumer-centred schemes and employ only fully qualified engineers and mechanics would provide consumer confidence in the availability of appropriate support networks. This would involve working with higher and further education colleges.

3.4.12. A12 – Working Group to address electricity generation and distribution requirements for EVs

Potential measure: A Working Group of relevant stakeholders from the energy and transport sectors, chaired by a Member of the Scottish Parliament, is tasked with addressing the electricity generation and distribution requirements for EVs.

Barrier(s) addressed: limited capacity of local electricity distribution networks to support large scale recharging of EVs; carbon-intensity of electricity generation during peak periods; uncertainty about future energy costs.

There is a narrow window of opportunity to ensure that the architecture of the smart grid takes proper account of the future needs of EVs (Royal Academy of Engineers, 2010). A Working Group would help ensure that appropriate action is taken in a timely manner.

The Group would need to work closely others involved in wider actions to decarbonise electricity generation in Scotland. This would include working with the electricity companies to ensure appropriate pricing tariffs are in place (to encourage consumers to charge vehicles outside periods of peak electricity demand), and provide reassurance to consumers about future energy costs.

The findings of the Working Group would need to be presented to the relevant Parliamentary Committee and actions agreed.

3.5. B – Alternative ownership models

These measures include car club schemes, battery leasing, vehicle and battery leasing and pay as you go contracts. They remove the purchase cost barrier, and address other barriers relating to risk aversion.

3.5.1. B1 – Car club schemes

Potential measure: Local authorities work with existing car club operators to introduce EVs into fleets and introduce EV-based car clubs in other cities. This would involve local authorities:

- ***engaging directly with existing car clubs to raise awareness of EVs and their benefits*** – for example car club members have already demonstrated support for sustainable travel options and are likely to place greater value on the environmental benefits of EVs than other consumers, and the lower running costs associated with EVs could provide financial benefits for car clubs;
- ***using car clubs instead of purchasing their own fleet cars*** – to strengthen the business case for car clubs to purchase EVs;

[32] http://www.wired.com/autopia/2010/11/ditch-the-cord-let-the-road-charge-your-ev/

[33] http://www.guardian.co.uk/environment/interactive/2010/oct/29/wireless-charging-electric-cars. Retrieved 9th March 2011.

- ***procuring vehicles directly for car clubs using their considerable purchasing power to lever favourable purchase prices or lease contracts*** – to address concerns from car club operators about purchase price and resale value (see also F1 – greater savings could be achieved if the Scottish Government procured EVs on behalf of all local authorities); and,
- ***work with manufacturers to set up a publicly funded electric car share scheme***, similar to the Paris Autolib project (see below).

Barrier(s) addressed: high purchase cost *(removes barrier)****; limited range of EVs*** *(allows consumers to vary their choice of vehicle depending on the type of journey they are making);* ***lack of recharging infrastructure*** *(recharging points could easily be provided at designated car club parking bays to allow batteries to be recharged when vehicles are not being used);* ***uncertainty about future resale value*** *(removes barrier);* ***lack of public awareness and knowledge*** *(allows members to test an EV, and makes the presence of EVs on the road a 'normal' occurrence);* ***aversion to new technology*** *(removes need to make purchase decision);* ***and weak image association*** *(allows members to test an EV).*

The last decade has seen the emergence of 'pay-as-you-drive' city-based car clubs (or car share schemes). In Scotland, Edinburgh and Glasgow both have City Car Club schemes. The Edinburgh scheme has approximately 150 vehicles and over 3,000 members[34]; while the Glasgow scheme is somewhat smaller.

Usage patterns of car club vehicles, consisting of predominantly short trips, make EVs a practical option for car clubs. Car clubs can also involve partnerships with medium to long distance mass transit providers (coach rail operators) to enable public transport to be used for the main leg of the journey, and an EV to be used for the first or last few kilometres which are generally unreachable by public transport. For example, the Swiss Railways' partnership with Mobility Car Sharing, called 'Click and Drive' gives members access to 800 vehicles located at 350 railway stations around Switzerland (WWF, 2008). This approach addresses range limitation concerns associated with EV ownership and also tackles the limitations associated with public transport use.

An EV-based car club would have positive wider sustainable transport impacts, by encouraging the right mode for the right journey; and positive social inclusion impacts by making EVs accessible to all.

Car clubs are identified in the recent Report on Proposals and Policies (RPP), *Low Carbon Scotland: Meeting the Emissions Reduction Targets 2010-2022* (Scottish Government, 2011), as a means of accelerating the introduction of EVs, if EVs were purchased preferentially by the clubs, and if charging points were installed at car club parking spaces. Car clubs are potentially viable in towns with a population greater than 25,000, although start-up funding may be necessary to take them to a point of viability.

Autolib – Electric car sharing scheme in Paris
Following on from the popularity of its bike rental scheme, Paris is planning to launch an electric-car sharing program. Known as the Autolib scheme (abbreviated from 'auto liberte'), and scheduled to be introduced next autumn, 3,000 battery powered cars will be stationed at 1,000 self-service hire points across the city with authorities selecting the four-seat Bluecar from French company Bollore for the project. To qualify to drive one of the vehicles, motorists will need a full driving licence and will have to subscribe for €12 a month. After that, they pay €5 for the first half hour and €6 for each subsequent 30minute slot. It is hoped that the scheme will attract between 160,000 and 200,000 subscribers as it bids to break even. Bollore is said to have invested around €60million in the project which is expected to cost more than €110million in total.[35]

3.5.2. B2 – Other ownership models

Potential measure: Encourage manufacturers to offer alternative ownership models to consumers in Scotland (battery-leasing, vehicle-leasing, pay-as-you- go contracts, etc) by promoting Scotland as an attractive market for manufacturers, and engaging with manufacturers to understand and influence their decisions about where to focus their sales strategy. Scottish Government or other public sector bodies work with manufacturers to 'trial' alternative ownership models amongst employees or as part of the vehicle procurement process, and publicise benefits.

[34] http://edinburghnews.scotsman.com/edinburgh/Entrepreneur-pumps-1m-into-expanding.5477606.jp Retrieved 01 March 2011.
[35] http://www.thegreencarwebsite.co.uk/blog/index.php/2010/12/17/paris-to-introduce-self-serve-electric-car-scheme/. Retrieved 23 February 2011.

Barrier(s) addressed: high purchase cost *(reduces barrier);* ***limited range of EVs*** *(some ownership models allow users to rent a conventional ICEV for longer trips);* ***uncertainty about future resale value*** *(reduces risk for consumers but manufacturers and lease providers will need to factor uncertainty into lease prices; some models guarantee the resale value of the vehicle);* ***aversion to new technology*** *(reduces risk to consumers, reassures consumers that the battery will be replaced under the contract if it become obsolete).*

The high cost of batteries, and the possibility of batteries needing to be replaced during the life of the vehicle, means that alternative models of car ownership may be required. Potential models include battery leasing (ownership of the vehicle and lease of the battery), vehicle leasing (extends the battery leasing model to the whole car), and contract or subscription arrangements which provide the consumer with a package that includes access to recharging infrastructure for a regular subscription or 'pay-as-you-go' fee. Some manufacturers allow EV owners to rent a conventional ICEV for longer trips, in order to overcome the current limitations of EVs in terms of size, speed and range. Peugeot's **'Mu' initiative** provides an example of this (see below). This approach is likely to be attractive to those drivers who only make a few longer trips each year – since the more days a conventional car is rented, the more costly the package becomes – and represents a sustainable and practical car ownership option.

Peugeot 'Mu' initiative[36]
The scheme allows users to exchange credits (or 'points') for hire of a range of vehicles and accessories (including scooters, bikes, roof boxes and child seats) available from Peugeot dealerships. Following trials in a number of French cities, and in Berlin, Milan and Madrid, it launched in the UK in 2010 at two dealerships in London and Bristol. Users pay a membership fee of £10. Typical costs are then £10 for a bike for a day, £40 for a Peugeot 308 for a day, and £140 for a Peugeot RCZ for the weekend. Purchasers of the Peugeot iOn electric car (to be launched in 2011) will automatically become members of Mu and may receive credits that can be used to rent vehicles through Mu.

The Scottish Government and local authorities have limited powers to directly influence the main manufacturers in this area, but promoting Scotland as an attractive sales market for EV manufacturers would encourage manufacturers to offer attractive ownership models to Scottish consumers. This measure therefore involves the Scottish Government and local authorities demonstrating their commitment to deliver other measures described in this chapter, and engaging with manufacturers to understand and influence their decisions about where to focus their sales strategy. This will be particularly important given the limited supply of EVs being manufactured over the next few years.

Scottish Government or other public sector bodies could also work with manufacturers to 'trial' an alternative ownership model amongst its employees or as part of its vehicle procurement process. This might involve the public sector taking on some of the risk associated with these new models, offering employees incentives to encourage them to use an alternative ownership model to purchase a new private vehicle, offering alternative models to employees currently offered a lease car, and procuring fleet and company cars using alternative models. Publicising the benefits and cost savings would be an important element of the trial.

3.6. C – Fiscal measures and subsidies – vehicle purchase incentives

3.6.1. Introduction

Purchase price is one of the most important factors influencing consumers' choice of vehicle and has been identified as one of the most significant barriers to EV uptake for consumers. Fiscal measures and subsidies can be used to reduce the magnitude of this barrier and ensure a more favourable price comparison between EVs and ICEVs – by directly subsidising the purchase cost of EVs, by providing incentives which enable some of the EV price premium to be offset, or by increasing the relative cost of purchasing an ICEV.

Potential measures include: subsidies for purchasing new and used EVs; scrappage incentives; a car registration tax with exemptions and rebates for EV owners; tax credits for purchasers of EVs, and; additional Enhanced Capital Allowance tax exemptions for businesses purchasing EVs.

Matters relating to current taxes are reserved to the UK Parliament. Incentives relating to Value Added Tax on new vehicles, tax credits, and Enhanced Capital Allowance tax exemption would require Scotland to press the UK Government for changes to be made at a UK level or to request additional devolved powers in

[36] www.mu.peugeot.co.uk

order to make changes in Scotland alone. However, the Scotland Bill (Section 80B) being debated by Parliament includes powers for the Scottish Parliament to add new devolved taxes. Incentives involving grants for purchasing an EV or 'scrapping' an ICEV are consistent with the Scottish Government's existing powers and would be easier to introduce.

Vehicle purchase incentives have the potential to influence a large number of consumers. An estimated 740,000 cars were purchased in Scotland in 2009; one quarter (186,000) were new vehicles and three-quarters (approx. 560,000) were second-hand (Table 1.1 in Scottish Government, 2010).

A number of national governments in Europe and elsewhere have already introduced various financial support packages to help stimulate the early uptake of vehicles; varying from just over £2,000 (in Ireland, Sweden and Canada) to over £10,000 in Japan (AEA, 2009). In general, it is not possible to evaluate the effectiveness of these support schemes as in most cases the financial packages have not been in place long enough to assess the impact on vehicle sales.

Scale of financial incentive required

Estimates of the scale of financial incentive needed to encourage EV purchase depend on assumptions about how consumers value running costs.

One approach is to offset in full the purchase cost premium for EVs, and ignore the fact that electricity costs for EVs are significantly lower than fuel costs for conventional vehicles. Under this scenario, CCC (2009) estimate that the initially level of support required ranges from £6,000 to £20,000, depending on the size of vehicle. This decreases to between £1,000 and £7,000 by 2020, due to a significant reduction in the cost of batteries. This may be thought of providing an upper bound for required support on the assumption that consumers are myopic (i.e. they fully discount EV operating cost savings).

An alternative approach is to assess the purchase cost premium of EVs, taking into account any operating cost savings. This assumes that consumers are rational economic agents (i.e. they discount operating cost savings at their cost of capital), and provides a lower bound on the level of price support. Under this scenario, CCC (2009) estimate that the initial level of price support required ranges from £1,500 to £7,000 per car. As the cost of batteries comes down, the level of support required decreases, with no support required beyond 2018.

In practice, the level of price support is likely to lie somewhere between these two extremes, and will depend on the pace at which EVs are rolled out. However, this analysis suggests that price support of at least £2,000 will be required to encourage EV uptake in the early years, and it is more likely that higher levels of support will be needed. For example, the UK CCC suggests that a much stronger incentive of £10,000 per vehicle may be required for the first 25,000 EVs sold.

Table 3.2 – Theoretical price support required to offset EV purchase cost premium

	Upper bound *(Consumers ignore operating cost savings)*	**Lower bound** *(Consumers fully consider operating cost savings)*
Price support required initially	£6,000 to £20,000 *(depending on size of vehicle)*	£1,500 to £7,000 *(depending on size of vehicle)*
Price support required in 2020	£1,000 to £7,000 *(depending on size of vehicle)*	£0 *(depending on size of vehicle)*
Total price to achieve 1.7 million EVs in UK by 2020	£9 billion	£800 million
Average support per vehicle	£5294 *(£9 billion / 1.7 million EVs = £5300)*	£470 *(£800 million / 1.7 million EVs = £470)*
Very c**rude estimate of price to achieve 290,000 EVs in Scotland by 2020**	**£1.5 billion** *(£5300 * 290,000 EVs)*	**£136 million** *(£470 * 290,000 EVs) (but could vary significantly depending on changes in battery costs, discount rates, distance travelled, and size of battery)*

Table 3.2 suggests that any effective price support incentive for Scotland is likely to cost at least £136 million between now and 2020, and probably significantly more given the evidence to suggest that private consumers tend to ignore a significant proportion of operating cost savings.

3.6.2. C1 – Grants for purchasing new EVs

From January 2011 motorists purchasing a qualifying ultra-low emission car will be able to receive a Plug-In Car Grant of 25% towards the cost of an EV, up to a maximum of £5,000. The original announcement earmarked £230 million for consumer grants which would have funded about 45,000 EVs. However, the Coalition has only committed £43 million for the scheme up to March 2012, which will fund up to 8,600 cars. This equates to approximately 800 EVs in Scotland if the grant is evenly allocated on a population basis. To ensure continued value for money for the taxpayer, the scheme and the level of subsidy provided will be regularly reviewed; with the first review taking place in January 2012. The grant is available to both private consumers and businesses.

The subsidy is of the order of magnitude which the CCC (2009) suggest is required for a medium-sized EV, if consumers fully consider and value operating cost savings. However, it is known that consumers discount future operating costs by as much as 60% (Arup and Cenex, 2008), suggesting the larger subsidies will be required for an initial period. The CCC (2009) suggests that the Plug-in Car Grant may be sufficient to encourage EV uptake, if combined with measures which spread some purchase costs over time (e.g. see alternative ownership models). Lane (2011) suggests that subsidies such as the Plug-in Car Grant will go some way to incentivising sales of ultra low carbon vehicles in the short term, but that further incentives are likely to be needed over the longer term to sustain consumer demand.

Two grant-based measures are proposed to encourage EV uptake in Scotland.

a) Provide £10,000 subsidy for first 25,000 EVs in Scotland to 'kickstart' uptake

Potential measure: Scottish Government provides a £10,000 subsidy for the first 25,000 EVs in Scotland (as recommended by the UK CCC), to 'kickstart' early uptake of EVs.

Barrier(s) addressed: high purchase cost *(directly reduces upfront purchase price of an EV);* ***aversion to new technology*** *(lower cost reduces one element of risk).*

Offering a £10,000 subsidy for Scottish purchasers would provide a strong incentive for 'kickstarting' EV uptake in Scotland, and would allow 'innovators' and 'early adopters' to heavily discount future operating costs when deciding whether to purchase an EV and provide significant compensation for the risks associated with being one of the first EV owners.

A £10,000 subsidy would reduce the cost of a Nissan Leaf to £20,999 and a Mitsubishi i-Miev to £18,990; reducing the price differential compared with a comparable ICEV[37] to less than £5,000. A number of research papers indicated that a price differential of £5,000 (Arup and Cenex, 2008) or 15% of the equivalent cost for an ICEV (Lane, 2011) would be acceptable to 'innovators' and 'early adopters'.

The subsidy could be available as a £5,000 'top up' to the UK Plug-In Car Grant; or as a full £10,000 subsidy if the Plug-In Car Grant is unavailable. The total budget required would be approximately £250 million[38].

b) Provide subsidies up until 2020 (or until 290,000 target reached)

Potential measure: Scottish Government provides subsidies up until 2020 (or until 290,000 target reached), of at least £5,000 in the initial years with level of subsidy reducing as EV uptake increases.

Barrier(s) addressed: high purchase cost *(directly reduces upfront purchase price of an EV);* ***aversion to new technology*** *(lower cost reduces one element of risk).*

It is likely that strong incentives will be required during most of the period until 2020, given that consumers' aversion to new technology doesn't disappear until levels of penetration have reached 15%. However, there is uncertainty about future funding for the UK Plug-in Car Grant. A commitment by the Scottish Government to ring fence funding to provide subsidies up until 2020, or until the 290,000 target has been reached, would

[37] For example, a VW Golf Bluemotion, which can average around 75 miles per gallon, has a tailpipe emissions rating of 99 g/km (equivalent to the 'well-to-wheel' CO2 emissions for a typical BEV), and also qualifies for a place in the tax-exempt VED band A, costs around £18,000 on the road.

[38] [£5,000 * 800 EVs (assuming £5,000 also comes from the UK Plug-In Grant)] **+** [£10,000 * 24,200 EVs] = **£246 million**.

send a strong signal to consumers and manufacturers about their commitment to electrification of road transport. Initial subsidies would need to be at least £5,000 (consistent with DfT's Plug-in Car Grant) and could then be reduced as EV uptake increases.

This measure could be implemented in conjunction with C1a, with the subsidy reducing to £5,000 (for example) for the second 25,000 EVs, and then stepping down by £300 (for example) for each subsequent 25,000 EV milestone; reducing to £1,900 for the last 15,000 EVs. This would require a total budget of **£1.18 billion over the period to 2020**; averaging approximately **£147 million p.a.**[39]. If implemented without C1a, and assuming the subsidy started at £5,000 rather than £10,000 the budget would reduce to **£0.98 billion over the period to 2020** (or **£123 million p.a.**).

These figures are indicative only, and have been included to provide a broad indication of the scale of funding required. In practice, the Scottish Government would need to commission research to determine the optimum level of initial subsidy for Scotland and an appropriate rate of subsidy reduction. In addition, the Scottish Government should examine the feasibility of restricting the subsidy to those purchasing a first vehicle or selling a conventional vehicle (rather than purchasing an additional vehicle). This would minimise the risk of the measure encouraging the purchase of second or third vehicles.

3.6.3. C2 – Scrappage schemes designed to increase sales of EVs

Potential measure: Scottish Government introduces a scrappage scheme to encourage consumers to purchase EVs, with subsidies reducing as EV uptake increases.

Barriers addressed: high purchase cost *(allows some of the price premium associated with EVs to be offset);* ***aversion to new technology*** *(lower cost reduces one element of risk).*

Scrappage schemes currently exist in Italy and Czech Republic to encourage consumers to purchase low carbon vehicles; while the UK Government ran a vehicle discount or 'scrappage' scheme for all types of car from May 2009 to March 2010, to provide a boost to demand and immediate support on a short-term basis to the car industry and its supply chain in the wake of falling sales (see below).

The scheme would involve offering drivers a subsidy if they trade in a conventional car or van which is at least 10 years old, and purchase an EV instead. The subsidy would need to be at least equivalent to the £5,000 offered under the UK Plug-in Car Grant scheme. A larger subsidy could be offered in the early years and gradually reduced over time as uptake increases. This would help manage the cost of the policy.

A scrappage scheme would encourage consumers to exchange a conventional vehicle for an EV; rather than encouraging consumers to consider purchasing a second or third vehicle (which is a risk with purchase grants).

UK Vehicle Scrappage Scheme (2009-2010)[40]

Under the Vehicle Scrappage Scheme:

- consumers were offered £2,000 towards the a new car or van if they traded in a vehicle which was at least 10 years old and which they had owned for 12 months or more;
- the £2,000 scrappage incentive was made up of £1,000 from the UK Government and £1,000 from the motor industry; and
- £300 million was made available to fund the scrappage scheme.

In total, 372,000 vehicles were scrapped over the 11 months of the scheme[41]. Cars sales increased during the scheme and figures for February 2010 were 26% higher than the previous year[42]; but there were concerns that sales would reduce after the end of the scheme and the end of the reduced VAT rate of 15%.

[39] Assuming £4 million comes from the UK Plugged-In Grant (800 EVs * £5,000).

[40] http://webarchive.nationalarchives.gov.uk/+/www.direct.gov.uk/en/motoring/buyingandsellingavehicle/adviceonbuyingandsellingavehicle/dg_177693

[41] http://www.simplemotoring.co.uk/blog/motoring-news/the-scrappage-scheme-is-over-372401-cars-scrapped/

[42] Kumar, Nikhil (2010-03-05). "Car sales rise again as end of scrappage looms". The Independent (London). http://www.independent.co.uk/news/business/news/car-sales-rise-again-as-end-of-scrappage-looms-1916471.html. Retrieved 2010-04-09.

3.6.4. C3 – Grants for purchasing second hand EVs

Potential measure: Scottish Government provides grants for purchasing second hand EVs from specified dealers, with subsidies reducing as EV uptake increases.

Barrier(s) addressed: high purchase cost *(directly reduces upfront purchase price of an EV);* ***uncertainty about future resale value*** *(gives private consumers and fleet operators confidence that they will be able to sell their EV in the future);* ***aversion to new technology*** *(lower cost reduces one element of risk, also gives initial consumers confidence that they will be able to sell their EV in the future).*

Second-hand sales will be important in terms of achieving 'mass market' uptake in the medium term. Vehicles will need to be purchased from outside Scotland if Scottish target is to be met. The Committee for Climate Change envisages 1.7 million EVs in the UK by 2020, suggesting that a second-hand market is likely to be available towards the end of this period.

Uptake of grants would be low in the initial years, due to lack of EVs in the second-hand market. Early introduction of the scheme however, would give 'new' purchasers confidence that the second-hand market will be buoyant when they come to sell their vehicle.

3.6.5. C4 – Registration tax (increase 'first year rates')

Potential measure: Scottish Government lobbies the UK Government to increase the tax levied on the purchase of new vehicles ('first year rates'), scaled on the basis of CO_2 emissions.

Barrier(s) addressed: high purchase cost *(increases the relative cost of an ICEV).*Some European countries levy a registration tax for new vehicles scaled on the basis of CO_2 emissions. For example:

- in the Netherlands, hybrid vehicles with an Energy Efficiency Label A benefit from a maximum reduction in registration tax of €6,400, while for hybrid vehicles with a B Label, the maximum bonus is €3,200 - the registration tax is based on price and CO_2 emissions;
- in Portugal, EVs are totally exempt from the registration tax, while hybrid vehicles benefit from a 50% reduction - registration tax is based on engine capacity and CO_2 emissions.

In the UK vehicles registered and taxed for the first time are required to pay an administrative fee of £55. There is no registration tax, but VAT must be paid at the present rate (currently 20% of the pre-VAT purchase price) and from April 2010, anyone buying a new car must also pay a different rate of Vehicle Excise Duty ('car or road tax') for the first tax disc. 'First year rates' vary from nothing for Band A vehicles (up to 100gCO_2/km) to £950 for Band M vehicles (over 255gCO_2/km).

This measure would involve increasing the 'first year rates' for high carbon-emitting vehicles to give EV buyers a financial benefit of £2,000 to £5,000. Feedback from an attitudinal survey by the DfT (2011, Figure 4.3) found that 55% of respondents supported higher taxes to try and stop people buying cars with high CO_2 emissions and 26% were opposed. The survey did not specify whether taxes would be applied at the point of purchase or on an on-going basis.

Note, this measure would not actually reduce the cost of purchasing an EV.

3.6.6. C5 – Registration tax feebate scheme

Potential measure: Scottish Government works with the UK Government to design a feebate scheme for the UK which involves increasing the tax levied on the purchase of relatively high-emitting vehicles and providing rebates for lower-emitting vehicles. Subject to the findings the Scottish Government lobbies the UK Government to introduce a UK-wide feebate scheme[43].

Barrier(s) addressed: high purchase cost *(increases the relative cost of an ICEV and allows some of the price premium associated with EVs to be offset);* ***aversion to new technology*** *(lower cost reduces one element of risk).*

[43] Matters relating to VED are reserved to the UK Parliament, and the Calman Report (Scottish Commission on Devolution, 2009) recommended that it should remain a UK matter. However, Section 80B in the Scotland Bill, being debated by Parliament, includes powers for the Scottish Parliament to add new devolved taxes. This might enable the Scottish Government to introduce a feebate via a 'new' registration tax, which would need to be applied alongside VED and VAT.

Feebates are a particular type of purchase tax incentive which involves levying fees (in the form of car registration tax and value added tax, for example) on relatively high-emitting vehicles and providing rebates for lower-emitting vehicles. Revenues from fees can be used to fund rebates, creating a revenue-neutral incentive programme.

This measure would involve applying the 'first year rates' for Vehicle Excise Duty (VED) as a feebate scheme, and increasing the range of rates/rebate to give EV buyers a financial benefit of £2,000 to £5,000. This allows some of the price premium associated with EVs to be offset, and addresses the limitations of option C4.

Lane (2011) suggests that there strong evidence pointing to the success of feebates in encouraging EV uptake, citing examples from various countries. For example, in the Netherlands the market share of Band A and B cars increased from 9.8% to 19.3% following the introduction of purchase incentives in 2001 (Gartner, 2005); in France the average CO_2 emissions of the new car fleet fell by 6% - almost twice the comparable figure for the EU – in the year following the introduction of a new feebate[44] in 2008 (German and Meszler, 2010); and in Switzerland the introduction of a €2000 rebate for A-labelled cars (with an equivalent fee for the poorest fuel economy) has been estimated to have reduced new car CO_2 emissions by 4.3% within the first 12 months of implementation (Hann et al., 2009). German and Meszler (2010) suggest that purchase incentives such as feebates are successful because they help consumers to overcome their aversion to investing in new technologies and products where the benefits are unclear; and provide consumers with a more tangible financial benefit than potential future fuel savings. They also provide a clear pricing signal in support of low carbon vehicles which provides manufacturers with greater certainty when assessing the costs of bringing new technologies to the market. Coad et al. (2009) propose that the information part of feebates (i.e. the Fuel Economy Label) may be effective in encouraging 'intrinsically' environmentally motivated consumers to adopt lower emission cars, while the financial part may be more persuasive for 'extrinsically' motivated, less environmentally oriented, consumers.

Based on their global review for the International Council on Clean Transportation (ICCT), German and Meszler (2010) provide best practice advice for feebate policy design. They recommend that fees and rebates should be scaled continuously and linearly with CO_2 emissions or measures of fuel consumption. They also observe that most successful feebate schemes have incentive gradients of €18-€30 (£15-£25) per gCO_2/km for the range of emissions over which the feebates apply.

Lane (2011) notes that there are currently few studies which have designed a detailed feebate scheme for the UK, or assessed its likely effect, and recommends that further research is undertaken in this area.

3.6.7. C6 – Tax credits

Potential measure: Scottish Government lobbies the UK Government to introduce tax credits for purchasers of new EVs, which reduce as EV uptake increases.

Barriers addressed: high purchase cost *(allows some of the price premium associated with EVs to be offset);* ***aversion to new technology*** *(lower cost reduces one element of risk).*

Some countries offer tax credits to purchasers of new EVs. For example, in Belgium, purchasers of electric cars receive a personal **income tax reduction** of 30% of the purchase price (up to a €9,000); and the French government is offering a $6,600 tax credit for EV buyers through 2012.

There is some evidence (e.g. Lane, 2011) that tax credits are less tangible than upfront discounts or cash payments, and therefore less effective.

3.6.8. C7 – Enhanced capital allowances

Potential measure: Scottish Government lobbies the UK Government to provide additional Enhanced Capital Allowance tax exemptions for businesses. This measure would extend the existing scheme for low carbon cars until 2020, and widen it to include a larger range of vehicles (including electric vans) and recharging infrastructure.

Barriers addressed: high purchase cost *(allows some of the price premium associated with EVs to be offset);* ***aversion to new technology*** *(lower cost reduces one element of risk).*

[44] The French scheme offers rebates of €5,000 for <=60 gCO2 /km, €1,000 for <=95 gCO2 /km, €500 for <=115 gCO2 /km, €100 for <=125 gCO2 /km; has a zero-rating for 126–155 gCO2 /km; and charges fees of €200 for <=160 gCO2 /km, €750 for <=195 gCO2 /km, €1,600 for <=245 gCO2 /km and €2,600 for >245 gCO2 /km.

Enhanced Capital Allowances (ECAs) enable a business to claim 100% first-year capital allowances on their spending on qualifying plant and machinery. ECAs are designed to encourage companies to invest in particular assets or by particular sorts of businesses. There are currently three schemes for ECAs (which will apply until 2013), covering:

- energy-saving plants and machinery;
- low carbon dioxide emission cars and natural gas and hydrogen refuelling infrastructure; and
- water conservation plant and machinery.

Businesses can write off the whole of the capital cost of their investment in these technologies against their taxable profits for the period during which they make the investment. This can deliver a helpful cash flow boost and a shortened payback period[45].

3.7. D – Fiscal measures and pricing policies to reduce running costs

3.7.1. Introduction

A variety of fiscal measures are available to influence the cost of running a vehicle (known generally as circulation taxes). They are charged on a periodic basis, confer the right to use the public road network, and are imposed independently of the mileage driven. Within the existing UK tax structure, BEVs have been incentivised through exemption from Vehicle Excise Duty (or 'road tax'), through preferential benefit-in-kind rates for company cars (from April 2010, BEVs are zero-rated until 2015), and through Enhanced Capital Allowances relating to income tax (Lane, 2011). Similar taxes exist in other EU countries.

In addition, pricing policies such as congestion charging, low emission zones, or parking charges can be used to compensate for the added costs of purchasing an EV and to internalise the external costs/benefits of transport.

These measures incentivise use of EVs by increasing the running costs for ICEVs and minimising the running costs for EVs. Their effectiveness will depend on the extent to which consumers consider 'whole life costs' when making decisions about purchasing a car. There is strong evidence however, that **private consumers** tend to buy on the basis of capital (purchase) costs rather than running costs (see Section 2.2.1). This suggests that these measures are likely to be less effective than those targeted at initial purchase cost, unless supported by widespread and high profile education interventions which raise awareness of this benefit. Nevertheless, there is some evidence that running cost incentives (including those relating to company car tax, fuel duty, and congestion charging in London) have been effective at encouraging purchase of lower carbon emitting vehicles, but not at the scale required to achieve the level of EV uptake envisaged.

Lane (2011) suggests that circulation taxes are not sufficient in themselves to promote a significant switch to EVs, commenting that while very high circulation tax cost differentials could be used to stimulate adoption of EVs it is unlikely that these would be politically acceptable. AEA Energy and Environment (2008) report that because they are an annual charge rather than an upfront cost, circulation tax incentives tend to have a relatively limited effect on purchase decisions.

In the long term, incentives based around circulation taxes could result in a significant loss of revenue to central Government (see Section 2.4.2), which will need to be met through other mechanisms. Congestion charging or low emission zones have been identified as a possible source of replacement revenue, but charges imposed would need to be significant. Other forms of taxation are also likely to be required to compensate.

The Scottish Government do not currently have devolved powers to alter circulation taxes and apply different rates for Scotland. However, the Scottish Government can press for changes to be made to UK legislation or ask for additional devolved powers in order to make changes in Scotland alone.

[45] http://www.eca.gov.uk/; http://www.businesslink.gov.uk/bdotg/action/detail?itemId=1086394511&type=RESOURCES

3.7.2. D1 – Road pricing (congestion charging schemes, low emissions zones, road tolling)

Potential measure: Local authorities introduce road charging schemes (e.g. congestion charging, low emission zones, or road tolling) in urban centres, offering free or discounted access for EVs

Barrier(s) addressed: high purchase cost *(indirect impact - incentivises EV rather than ICEV purchase);* ***aversion to new technology*** *(lower operating costs reduce one element of risk);* ***limited value placed on environmental benefits by consumers*** *(lower operating costs for EVs will help highlight the environmental benefits of EVs).*

The Transport Scotland Act (2001) gives local authorities powers to introduce charging schemes covering specific roads, days of the week, and times of day; and vary the charges (which may be no charge) for different classes of motor vehicles, different numbers of occupants, and different distances travelled.

Congestion charging involves charging to drive in 'congested areas'; and charges can vary for different vehicle types. In low emissions zones charges may be imposed on the most polluting vehicles alongside other regulations, with exemptions granted to less polluting vehicles. Road tolling charges on the basis of distance travelled. Under all schemes, those who drive most pay most.

The London Congestion Charge Scheme (see below) has been a significant driver of the purchase of lower emission vehicles in and around London, and incentives to encourage purchase of low carbon vehicles have been included within congestion and road pricing schemes in Norway and Denmark.

London Congestion Charge Scheme
The first London Mayor introduced a 100% Alternative Fuel Discount (AFD) as part of the London Congestion Charge Scheme in 2003, worth over £2,000 per year to regular commuters driving in the charging zone. The scheme has been a significant driver of the purchase of lower emission vehicles. AEA Energy & Environment (2007) report that sales of hybrids (such as the Toyota Prius) have been particularly high in the region – whereas (in 2007) 12.5% of Toyota UK sales were in VED band B, 34% of the company's London sales were in band B. The AFD is also believed to be the reason that the majority (60%) of the UK's fleet of EVs are operated within the capital (Girard, 2010). From January 2011, the AFD was replaced by the Greener Vehicle Discount, which provides a 100% discount for cars that emit 100 gCO_2/km or less and are Euro 5 rated[46].

Some critics suggest that excluding low carbon vehicles from congestion-based charges does not contribute to reduced congestion; suggesting that schemes targeted at tackling both congestion and air quality would be more appropriate. This would involve applying charges relating to VED bands. Vehicles with the lowest carbon emissions (VED Band A: up to 100g$C0_2$/km) would pay least (or no charge). The charge would then increase in steps for each VED Band.

Exemptions associated with distance-based tolling schemes may be less effective at encouraging EV uptake if they target long distance trips. In contrast congestion charging and low emission zones generally target short trips in urban centres, for which EVs are well suited.

Road pricing is an effective demand management measure that significantly improves the effectiveness of other interventions to promote sustainable travel. It has been shown to be an effective carbon abatement measure (Atkins, 2009) and was included in early drafts of the Scottish Government's Report on Proposals and Policies.

Road pricing schemes often attract strong public opposition[47], and strong political leadership is required to implement them, backed by a strong national policy.

3.7.3. D2 – Workplace Parking Levy

Potential measure: Local authorities introduce workplace parking levies in urban centres, with exemptions for EV spaces.

[46] http://www.tfl.gov.uk/roadusers/congestioncharging/17094.aspx

[47] Note, residents in Edinburgh voted against the introduction of congestion charging in the city by a margin of about three to one in 2005. The residents of Manchester also voted against a two cordon congestion charge scheme in 2008; and 62% of respondents to Transport for London's public consultation on the Western Extension to the London Congestion Charge backed its removal.

Barrier(s) addressed: high purchase cost *(indirect impact - incentivises EV rather than ICEV purchase);* ***lack of recharging infrastructure*** *(encourages businesses to provide recharging points in existing parking spaces);* ***aversion to new technology*** *(lower operating costs reduce one element of risk);* ***limited value placed on environmental benefits by consumers*** *(lower operating costs for EVs will help highlight the environmental benefits of EVs).*

A Workplace Parking Levy (WPL) is a charge on employers that provide free or relatively cheap workplace parking. The charge is imposed on employers rather than employees; and it is up to the employer whether or not to pass the charge on to their employees. Money raised can be used to fund sustainable transport improvements. Nottingham City Council is seeking to introduce the first WPL scheme in the UK in April 2012. The cost of the levy is expected to be £279 per year per liable parking place[48].

WPL schemes have the effective of causing employers to remove guaranteed free parking at the trip end; reduce workplace parking spaces; and in some cases, the parking levy may be passed onto employees. These actions discourage employees from driving to work, and potentially reduce the attractiveness of owning a car.

A WPL scheme could be developed with exemptions for EV only bays (with allocated recharging points). This would encourage employers to convert existing parking bays to EV bays, and would provide employees with a strong incentive to switch to an EV. It could support other proposed measures to incentivise businesses to install recharging points (see A5).

WPL schemes represent an effective demand management measure that significantly improves the effectiveness of other interventions to promote sustainable travel. They have been shown to be an effective carbon abatement measure (Atkins, 2009).

As with road pricing schemes, this measure is likely to attract strong public opposition, and strong political leadership is required backed by a strong national policy.

New primary legislation is required to give local authorities the necessary powers to introduce a WPL scheme - the Transport Scotland Act (2001) only covered road user charging and did not included appropriate legislation for WPL schemes.

3.7.4. D3 – On-street parking charge policies

Potential measure: Local authorities introduce on-street parking charge policies which offer free or heavily discounted parking for EVs.

Barrier(s) addressed: high purchase cost *(indirect impact - incentivises EV rather than ICEV purchase);* ***lack of recharging infrastructure*** *(on-street recharging points provided);* ***aversion to new technology*** *(lower operating costs reduce one element of risk);* ***limited value placed on environmental benefits by consumers*** *(lower operating costs for EVs will help highlight the environmental benefits of EVs).*

Controlled parking zones (CPZs) restrict parking to specific areas during prescribed hours so only those drivers eligible to park can do so. CPZs in residential areas are often introduced to protect on-street resident spaces from being used by visitors or commuters. The role of controlled parking zones could be extended to help control carbon emissions by extending the coverage and relating the charge to vehicle emissions, in order to influence both the amount and type of car ownership. Many city centres and other areas of high parking demand already charge for on-street resident parking; but many do not.

There are some examples of emissions-related controlled parking schemes already in operation in Scotland and England (see below).

[48] http://www.nottinghamcity.gov.uk/index.aspx?articleid=2583

Edinburgh Residents' Parking Permit Scheme
In 2009, Edinburgh City Council approved a new residents' parking permits scheme aimed at rewarding environmentally friendly car use. Under the new scheme, parking permit charges will be graded according to vehicle size and CO_2 emissions levels; and there will be five categories for cars. Three of these will get a reduction in permit costs. The fourth will have no change in permit costs. Only residents whose cars fall into the fifth bandwidth (covering vehicles such as the Chrysler Voyager; the Jaguar X-Type; the Citroen C6; the Porsche Cayenne; and the Mercedes E280) will have to pay more for their parking permits. Households with more than one vehicle would pay more for second permits. It is estimated that 66 per cent of the current permit holders will pay less, 14 per cent will see no change and 20 percent will pay more.

Camden Residents' Parking Permit Scheme
The London Borough of Camden varies the cost of resident parking permits according to Vehicle Excise Duty bands, with vehicles in VED bands A to F (<= 150gCO_2/Km) paying £84 for 12 months and the highest emitting vehicles paying £163 for 12 months. Residents with EVs pay only £25 per year to park in the residential parking zones. They can also pay an additional £52 to park for free in a number of short-term pay-and-display bays, and an additional £52 to park in EV recharging bays offering free charging. These charges are waived if EV owners can prove (from their electricity bill) that the energy used to charge their electric vehicle is from a renewable source.

Parking permit schemes could provide a means encouraging EV uptake in Glasgow, Edinburgh and Aberdeen, where there are a high proportion of households without access to off-street parking. Differential charges applied across bands would need to be sufficient to incentivise drivers to switch to EV use. However, there is a risk that if the pricing structure is too aggressive, is will be seen as unfair in terms of targeting residents in smaller terraced houses with controlled parking, while having no impact on residents in large houses with drives and owning several high emitting vehicles.

On-street parking charges represent an effective demand management measure that significantly improves the effectiveness of other interventions to promote sustainable travel. The approach has been shown to be an effective carbon abatement measure (Atkins, 2009) and on-street parking charge proposals were included in early drafts of the Scottish Government's Report on Proposals and Policies.

This measure requires to the Scottish Government to strengthen planning guidance on the provision of recharging bays and infrastructure, as described in Section 3.4.7.

3.7.5. D4 – Vehicle Excise Duty (VED)

Potential measure: Scottish Government lobbies the UK Government to increase the price differentials between adjacent bands for vehicle excise duty to increase the financial benefit of EV ownership.

Barrier(s) addressed: high purchase cost *(indirect impact - incentivises EV rather than ICEV purchase);* ***aversion to new technology*** *(lower operating costs reduce one element of risk);* ***limited value placed on environmental benefits by consumers*** *(lower operating costs for EVs will help highlight the environmental benefits of EVs).*

Vehicle Excise Duty – colloquially known as road tax – is paid by the registered keepers of vehicles. VED is collected by the UK Driver and Vehicle Licensing Authority (DVLA). In Scotland it raises £200m a year.

For cars registered on or after 1 March 2001, the rate is based on fuel type and CO_2 emissions; with Band A cars (up to 100g$C0_2$/km) paying nothing and Band M cars (over 255g$C0_2$/km) paying £435 per year[49].

Within the conventional car market, there is much evidence to suggest that VED is not (at current levels) a sufficiently strong price signal to incentivise the purchase of lower CO_2 cars; the adjacent band differentials have (historically) been too small to have had a significant impact on purchasing behaviour (Anable et al., 2008). However, VED could be expected to have an impact if the differential between bands was big enough, and if applied as a feebate.

[49] http://www.direct.gov.uk/en/Motoring/OwningAVehicle/HowToTaxYourVehicle/DG_10012524. Retrieved 9th March 2011.

The UK Government has previously looked at the possibility of scrapping fuel duty and incorporating all car-based tax within VED, scaled according to fuel type and CO_2 emissions. A key factor against this approach was the fact that it would weaken incentives to reduce car mileage.

3.7.6. D5 – Fuel tax

Potential measure: Scottish Government lobbies the UK Government to increase fuel duty.

Barrier(s) addressed: high purchase cost *(indirect impact - incentivises EV rather than ICEV purchase);* ***aversion to new technology*** *(lower operating costs reduce one element of risk);* ***limited value placed on environmental benefits by consumers*** *(lower operating costs for EVs will help highlight the environmental benefits of EVs).*

In the UK there is a fuel duty that is applied to all hydrocarbon fuels, including unleaded petrol, diesel, LPG, biodiesel, bioethanol and other fuels that are used in cars. The rate of the fuel duty is usually set during the budget, and consists of an additional tax that is applied to the petrol before it is sold. This fuel duty is applied before VAT, so whenever the fuel duty rate is raised, additional VAT is placed on top of it.

Long term increase in fuel duty could encourage consumers to switch to EVs. Lane (2011, p21) cites evidence from both the UK and US that increases in fuel prices result in a preference for fuel-efficient vehicles and changes in driving habits. In response to the fuel price peaks in 2008, followed by the global economic downturn, the UK market has seen a marked shift to smaller, more fuel-efficient cars, with the 'biggest drop in new car CO_2 on record – falling 3.6% in the second quarter of 2008 and then 55.5% in 2009 (SMMT, 2008; Next Green Car, 2009). In addition, a public attitude survey by DfT (2011) shows that fuel cost are the most important cost when buying a car, after purchase cost.

3.7.7. D6 – Company car tax

Potential measure: Scottish Government lobbies the UK Government to provide further company car tax benefits. An extension to the current exemption could be considered as well as higher tax rates for more polluting vehicles.

Barrier(s) addressed: high purchase cost *(indirect impact - incentivises EV rather than ICEV purchase);* ***aversion to new technology*** *(lower operating costs reduce one element of risk);* ***limited value placed on environmental benefits by consumers*** *(lower operating costs for EVs will help highlight the environmental benefits of EVs).*

When a company car is made available for the **private use** of an employee, a 'benefit in kind' value is calculated in relation to the car, and a tax is applied to this value based on fuel type, carbon dioxide emissions and a car's list price. The 'benefit in kind' value is 15% of the car's list price for the most fuel efficient vehicles. The value increases to a maximum of 35% of the car's list price, in 1% steps for every 5gCO_2/km. Tax is then charged at either 20% or 40% depending on the employees earnings. There is an extra charge is applied if the employee is provided with free or subsidised fuel for private use.

Table 3.3 illustrates the level of tax typically paid in 2010/11, using a Ford Mondeo and an Audi A4 as an example. As from April 2010, electric cars receive a five year exemption from company car tax and electric vans a five year exemption from van benefit charge. It is too early to say what impact this is having on EV uptake. An extension to this exemption could be considered as well as higher tax rates for more polluting vehicles. Company car tax could potentially be applied as a feebate, by increasing the amount of company tax levied on high emitting vehicles and providing a rebate for electric or low carbon vehicles.

Historically data shows that, until the fuel price peaks in 2008, the company car tax system was the main incentive driving the reduction of new conventional car CO_2 emissions. Up until the fuel price peaks in 2008 new company car CO_2 emissions reduced on average by 1.4% per annum, by comparison with a corresponding figure of only 0.9% per annum for private cars (SMMT, 2007). However, even the incentives offered by the company car tax system have not succeeded in stimulating the market for BEVs or other types of ultra low carbon vehicles, to date (Lane, 2011, p40).

Table 3.3 – Company car payments – illustrative examples

	Ford Mondeo 1.6 Zetec	Audi A4 Avant2.0 TDI
Percentage charge	18%	19%
Benefit in kind	£3,477	4992
Tax payable at 20%	£695	£988
Tax payable at 40%	£1391	£1997

3.8. E – Awareness, information and training measures

The following measures to raise the profile and visibility of EVs on the roads, and address issues relating to lack of public awareness and knowledge, and low desirability. They do not necessarily address the most significant barriers relating to purchase prise, range anxiety and lack of infrastructure; and are therefore unlikely to make a significant contribution to encouraging EV uptake on their own. However, their role is likely to be important in encouraging wider uptake across the mass market, once measures are in place to address price, range anxiety and lack of infrastructure.

3.8.1. E1 – Demonstration projects

Potential measure: Scottish Government supports a high profile EV demonstration project, to raise awareness and knowledge about EVs, focusing on locations with a high concentration of early adopters to stimulate adoption nationwide.

Barrier(s) addressed: lack of public awareness and knowledge; aversion to new technology; weak image association.

There has been a rapid rise in the number of pilot projects testing EVs, many of which have received significant public support. For instance in Paris, an agreement between state energy company EDF and Renault-Nissan will trial over 100 electric cars and vans; alongside plans to launch a 4,000 EV car sharing scheme and put in place 1,400 recharging points.

Lane (2011) reports that in contrast to the low level of knowledge about BEVs, real-world consumer trials of BEVs indicate that high levels of consumer acceptance. In particular, acceptance is found to increase during the trials, suggesting that in general, ultra low carbon vehicles perform better than consumer expectations and challenge their preconceptions.

In the 'smart move' trial conducted by Cenex (the Centre for Excellence for low carbon and fuel cell technologies), the vehicles exceeded the public's expectations on all monitored performance criteria (most notably top speed), leading to 72% of drivers to state that they would use an EV as their regular car, compared with 47% before the trial (Carroll, 2010). Among the corporate participants, 58% of fleet users were more positive about EVs following on-road tests, and 88% of fleet managers were more positive about incorporating BEVs into their fleets following the trial.

AEA Energy and Environment (2008) advise that demonstration projects should be supported by a range of co-ordinated measures, which might include subsidies for vehicle purchase or conversion, subsidies for investment in infrastructure, common procurement platforms to centralise purchase of vehicles, public-private partnerships and voluntary agreements with stakeholders involved in the programme, and regular communication with the public.

A high profile demonstration project, supported by the Scottish Government, could help raise awareness about EVs, address low levels of knowledge about EVs amongst the public, dispel some misconceptions and help make the presence of EVs on the road a 'normal' occurrence. Demonstration projects will need to focus on locations with a high concentration of early adopters to stimulate adoption nationwide.

3.8.2. E2 – Provide opportunities for consumers to test drive EVs

Potential measure: Scottish Government and local authorities provide opportunities for consumers to test drive EVs, using existing networks or through a national network of test-drive centres. This could involve encouraging newly qualified drivers to consider purchasing an EV, encouraging car

clubs to offer EV test drives, and taking test vehicles to large employers and large public venues (e.g. shopping centres, motor and air shows, etc).

Barrier(s) addressed: lack of public awareness and knowledge; aversion to new technology; weak image association.

Lane (2010) demonstrates that the experience of driving an EV is important in changing consumer attitudes towards EVs and catalysing the emerging market. New drivers could be provided with the opportunity to test drive an EV on passing the practical driving test. This would provide an opportunity to influence attitudes at a time when individuals are thinking about purchasing a vehicle. Lane (2010) also suggests that existing car club members could also be offered test drives of EVs to widen the experience base. He also suggests that research should be conducted to assess the feasibility of providing consumers with the opportunity to test-drive ultra low carbon vehicles, either using existing networks or through a national network of test-drive centres. Cairns (2011) observes that early adopters of EVs have much in common with those drivers most likely to join a car club.

3.8.3. E3 – Customer information about EVs and where to charge them

Potential measure: Scottish Government develops a website which includes all the information the public needs to know about EVs, including how and where to charge them. The website could refer users to the Energy Saving Scotland Advice Centres for more information[50]. Local authorities also disseminate information.

Barrier(s) addressed: lack of public awareness and knowledge; aversion to new technology; weak image association, limited value placed on environmental benefits by consumers.

Lane (2011) comments that there is no official UK Government website which focuses specifically on ultra low carbon vehicles. This contrasts with the situation in the US, where the Environmental Protection Agency, which performs many of the functions of the UK's Vehicle Certification Agency, provides environmental information for consumers. In the UK, this service is currently provided by private sector websites including WhatGreenCar, Clean Green Cars, and Green Car Guide. There are also some developments at a local level. The North East have set up a 'Charge Your Car' website, as part of the Plugged-In Places project (www.chargeyourcar.org.uk); and in London, the Mayor plans to launch a new website containing everything the public needs to know about EVs and recharging points, including details about where the nearest one can be found. In Ireland, the ESB (the Electricity Supply Board) has developed as website to support and support of electric cars (ecars) in Ireland (http://www.esb.ie/main/ecars/index.jsp).

A major review of public attitudes to climate change and transport behaviour conducted for the Department for Transport (2011) highlighted that information provision is necessary, but rarely sufficient to encourage pro-environmental behaviours, including the purchasing of low emission vehicles (Anable et al., 2006). Anable et al. (2006) cites evidence from Collins et al. (2003) which provides evidence to suggest that, for a policy to be successful, providing information needs to be accompanied by other measures implemented in parallel, including the development of the required infrastructure to enable change; effective incentives and disincentives; and a level of user-acceptance of the policy measure in question. However, Lane (2011) also reports that academic literature on promoting pro-environmental behaviour also maintains that, without the provision of relevant and authoritative information, consumers are not able to engage with the policy and are less likely to be aware of the opportunities to act.

3.8.4. E4 – Public promotion campaigns

Potential measure: Scottish Government part-funds a high profile publicity campaign, involving the principle EV manufacturers. Local authorities undertake local promotion campaigns.

Barrier(s) addressed: lack of public awareness and knowledge; aversion to new technology; weak image association, limited value placed on environmental benefits by consumers.

High profile publicity campaigns are commonly used to get messages across to the public, on matters relating to health (smoking, drinking, cancer awareness) and road safety (speeding, drink-driving). As with information initiatives, publicity campaigns alone are unlikely to significantly change car purchase behaviour but are still likely to have an important role to play as part of a package of mutually supporting measures.

[50] Funded by the Scottish Government and managed by the Energy Saving Trust, the local network of advice centres operates across Scotland giving free, impartial energy efficiency advice to householders, community groups, businesses and the public sector.

3.8.5. E5 – Eco-driving training

Potential measure: Scottish Government and local authorities encourage potential EV drivers to undertake eco-driver training. This could involve offering free-training to newly qualified drivers and those considering purchasing an EV.

Barrier(s) addressed: limited range of EVs.

Eco-driving involves smarter and more fuel-efficient driving. It involves planning ahead (anticipating traffic flow, preparing early for junctions, traffic lights and so on), maintaining a consistent steady speed, checking tyre pressures frequently, and avoiding dead weight and aerodynamic drag.

Eco-driving is particularly important for EVs as it can significantly increase the range of such vehicles. A study by Cenex and Millbrook (cited by the Energy Trust) shows that energy consumption for EVs varies significantly depending on the style of driving. From the most efficient to the least efficient driver the improvements in journey efficiency for 3 routes tested showed an improvement of 47% for the city circuit, 13% for the hill circuit and 90% for the high speed circuit.

Range anxiety is a significant concern for drivers. The Energy Trust suggests that it is particularly important that EV drivers receive eco-driving training, to give them greater confidence regarding vehicle range and allow drivers to get maximum use and satisfaction from EVs. They suggest that recipients of grants for electric vehicles should receive eco-driving training.

The Energy Trust is also in favour of ways of increasing participation in eco-driving training more generally. In addition, to eco-driving forming part of the driving test, they suggest that the renewal of the photographic section of driving licences presents a key opportunity for the promotion of eco-driving. The requirement to provide a certificate of completion of eco-driver training (carried out up to a year before the renewal request) could significantly increase drivers' ability to drive more energy efficiently, particularly if this training were provided free of charge. They would like to see the Scottish Government and the Scottish Parliament use their influence with the UK government to help achieve this for Scottish drivers.

Eco-driving training could however, reduce the desire or need for EVs in the short term, by increasing the fuel efficiency of ICEVs.

3.9. F – Other Government leadership measures

In addition to the above types of approaches, Governments can lead the uptake of EVs by demonstrating good practice in procuring its own fleet vehicles, funding research and development, providing a clear policy steer outlining its commitment to EV growth, and potentially, by introducing mandates specifying that fleet sales must comprise a certain proportion of EVs by 2020.

3.9.1. F1 – Public sector procurement of low carbon vehicles for own fleet

Potential measure: The Scottish Government, local authorities and other public sector organisations support an earlier than average switch to low carbon emissions vehicles for public sector fleet vehicles (cars and vans) through procurement policies, etc. This would involve:

- ***the Scottish Government extending funding for the Low Carbon Vehicle Procurement Support Scheme (or similar) to enable public sector cars to be replaced with electric vehicles, where appropriate;***
- ***the Scottish Government setting a target for 100% of public sector fleets to be electric, where appropriate;***
- ***the Scottish Government procuring EVs on behalf of all local authorities to increase purchasing power and maximise savings negotiated with manufacturers;***
- ***the Scottish Government commissioning specialist firms to convert existing ICE models (e.g. vans, minibuses) to electric platforms where appropriate EV models are not currently available; and***

- ***the Scottish Government and local authorities ensuring that procurement policies (e.g. the Scottish Procurement Policy Handbook) require public sector organisations to purchase electric rather than convention vehicles, where practical to do so.***

Barrier(s) addressed: high purchase cost; lack of public awareness and knowledge *(increases awareness and visibility)****; limited supply of EVs*** *(provides a strong signal to manufacturers that Scotland is an attractive sales market for EV manufacturers)****.***

National and local governments wield significant purchasing power since they procure and operate large fleets of vehicles. Local authorities and other public sector organisations can support an earlier than average switch to low carbon emissions vehicles for public sector fleet vehicles (cars and vans) through use of financial incentives, procurement policies, etc. This approach provides a clear sign of Government support and belief in battery powered technology, and can provide much needed investment certainty for the private sector (and particularly manufacturers), who may otherwise be hesitant to invest in the development of EV and associated infrastructure. It would also create an initial pool of EV users and in the medium term create an important second-hand market, which will be essential if EVs are to make significant inroads into the private 'mass market' fleet.

In 2010, the French government announced that it will purchase 50,000 EVs for government fleet use over the next five years, significantly more than most governments have committed to. It has assembled a group of 20 corporations, utility companies and other large fleet owners to purchase all the EVs, most of which will come from Renault and Peugeot-Citroen.

Low Carbon Vehicle Procurement Support Scheme[51,52]

In Scotland, a £4.3 million **Low Carbon Vehicle Procurement Support Scheme**[53,54] enables public bodies to fund the price difference between a traditionally-powered vehicle and a low carbon equivalent (including vehicles powered by electricity, biomethane, biodiesel, bioethanol, hydrogen and PHEVs). The scheme makes £3.6m available to Community Planning Partnerships (CPPs) to provide financial support for the procurement or lease of low carbon vehicles. The scheme is intended to bridge the cost gap between a conventional vehicle and its low carbon counterpart; assumed to be £20k for a car and £40k for a van, dependent upon size of vehicle, fuel type and supplier. The funding may also be used to provide support for the installation of publicly accessible recharging/fuelling infrastructure. Each Council has been offered a funding allocation varying from £65,000 to £215,000). The bigger the population covered by the CPP the larger the allocation.

Assuming a cost differential of £12,000 for an electric car, this could pay for just under 300 new electric cars, approximately 15% of the local authority car fleet. This level of subsidy could replace the entire public sector car fleet with EVs in 6 to 7 years. The size of the public sector fleet in Scotland is estimated at approximately 2,000 cars and 15,000 light goods vehicles[55].

3.9.2. F2 – Government research

Potential measure: Scottish Government supports and funds research needed to enable rapid EV uptake.

Barrier(s) addressed: various.

Given the challenges associated with significant and rapid EV uptake, there is a need for significant public spending on research relating to battery development, consumer behaviour, and other initiatives to foster cost reductions.

Lane (2011) identifies a need for research in four key areas relating to:

[51] http://www.scotland.gov.uk/News/Releases/2010/06/16110208. Retrieved 2nd March 2010.
[52] http://www.transportscotland.gov.uk/files/documents/roads/letter_to_cpps.pdf. Retrieved 2nd March 2010.
[53] http://www.scotland.gov.uk/News/Releases/2010/06/16110208. Retrieved 2nd March 2010.
[54] http://www.transportscotland.gov.uk/files/documents/roads/letter_to_cpps.pdf. Retrieved 2nd March 2010.
[55] The Office of Government Commerce estimates that, collectively, the public sector has the UK's largest vehicle fleet, comprising well over 290,000 passenger and commercial vehicles (*Office of Government Commerce, 2006. Getting Better Value from Your Fleet).* This equates to approximately 25,000 vehicles in Scotland, if scaled on the basis of population. In addition, survey data from 23 local authorities, collected to inform the Scottish Government's *Consultation on Low Carbon Vehicles (2009),* shows that 9% of public sector vehicles are cars (i.e. 2,250) and 61% are light goods vehicles (i.e. 15,250).

- *informing the consumer* (research to assess the future requirements for UK consumer-focused information regarding ultra low carbon vehicles, with a particular focus on web-based sources);

- *understanding the consumer* (research to assess the most effective methods of conveying life cycle information to UK consumers, particularly to take into account life cycle implications; research should be conducted to understand the extent and importance of symbolism attributed to ultra low carbon vehicles in the UK);

- *incentivising the consumer* (research should be conducted to design and assess the likely effectiveness of a technology-neutral UK purchase 'feebate' scheme; research should be conducted to explore low-cost methods of supporting UK consumers who want to charge EVs at home); and

- *improving policy and innovation* (research into the scale of UK public access recharging locations is required for adoption of electric vehicles; research to compare local authority policies supporting EVs, with a view to assessing the potential for further integration and standardisation across Scotland and the UK; research to assess the suitability of the current 'New European Drive Cycle' - the current industry standard test cycle used for calculating fuel consumption figures - for reflecting the full emissions impact of EVs).

Further potential areas of research include:

- developments in battery technology – Scotland already has a headstart through work undertaken to date by Scottish universities and companies such as Axeon;

- the location of 'likely' early adopters of EVs using segmentation analysis to allow measures to be effectively targeted; and

- skills and training needed to support EV uptake.

The UK Government has already earmarked £80m for supporting research and development (R&D) activities, mostly channelled through the Technology Strategy Board (TSB)[56], an important player on the EV landscape. The TSB is coordinating R&D activity and running demonstration projects to identify barriers and seek solutions to mass uptake. Its two main programmes are jointly, and largely equally, funded by government and the car industry, with about £250m in total committed over five years.

3.9.3. F3 – Funding to convert specific vehicles to electric platforms

Potential measure: Scottish Government provides funding to small firms which specialise in converting specific vehicles to electric platforms, e.g. taxis, minibuses and larger family cars (as part of a wider demonstration project).

Barrier(s) addressed: limited performance and limited choice of vehicles in comparison with ICEVs *(will increase choice of vehicle types and models)**.***

This would help address concerns about lack of choice (identified as a high significance barrier). Although relevant to specific fleets only and applicable to a small number of vehicles, 'conversions' could act as a demonstrator for technology and address barriers for specific fleets (including taxis, vans, heavy goods vehicles, buses, etc). This would benefit Scottish companies such as Allied who provide adapted Peugeot vans as EVs.

3.9.4. F4 – A high profile EV Strategy and Action Plan for Scotland, setting out a clear vision supported by targets or milestones

Potential measure: Scottish Government publishes a high profile EV Strategy and Action Plan for Scotland, setting out a clear vision supported by targets or milestones.

Barrier(s) addressed: limited supply of EVs *(will promote Scotland an attractive sales market for EV manufacturers);* ***aversion to new technology*** *(reassures consumers that purchasing an EV is a practical and sensible option). In addition, manufacturers have huge resources at their disposal, and it is likely that they will be able to find solutions to address demand-related barriers (relating to* ***limited range of EVs****,* ***lack***

[56] Funded by the Department for Business, Innovation and Skills, the TSB supports collaborative R&D through Knowledge Transfer Networks.

***of public awareness and knowledge about EVs**, and **weak image associations**) and supply related barriers (relating to **limited performance and choice of vehicles**, **alternative ownership models**, and issues of **standardisation and interoperability**), provided they have enough certainty that this is where the future market lies.*

A high profile policy document, setting out a clear vision for the future, will help provide certainty to manufacturers about future demand, and will reassure potential consumers that purchasing an EV is a practical and sensible option. Targets or milestones will indicate the magnitude of uptake expected, and the scale of infrastructure envisaged. Manufacturers have huge resources at their disposal, and it is likely that they will be able to find solutions to address demand-related barriers (relating to range, public knowledge about EVs, and image concerns) and supply related barriers (relating to performance and choice of vehicles, routes to market, standardisation and interoperability), provided they have enough certainty that this is where the future market lies.

3.9.5. F5 – Mandate specifying proportion of EV sales by major manufacturers

Potential measure: Scottish Government lobbies the EU to introduce a mandate specifying that sales by main manufacturers operating in the EU must comprise a certain proportion of zero emission vehicles by 2020.

***Barrier(s) addressed: limited supply of EVs**. Would also provide a strong incentive for manufacturers to address **high purchase cost** and **range anxiety** barriers, and address **lack of public awareness and knowledge about EVs**.*

This approach has enjoyed some success in the past. The best known example is the California Zero Emission Vehicle (ZEV) rule which was adopted in 1990 to combat urban air pollution. The approach proved high controversial and in 2008 the California Air Resources Board reduced the number of zero emission vehicles sales required by 70%, requiring just 7,500 electric and hydrogen fuel cell cars to be sold between 2012 and 2014, and relaxed the rules relating to PHEVs. The rules apply to Ford, General Motors, Toyota, Chrysler, Honda and Nissan Motor Co. Smaller car companies could be bound by the mandate if their sales increase.

This measure would need to be applied at an EU-wide level, otherwise it would deter manufacturers from investing in Scotland.

3.9.6. F6 – Government action to encourage private sector to convert to EVs

Potential measure: The Scottish Government and local authorities encourage EV uptake amongst the private sector by:

- ***increasing awareness or increasing the focus placed on a business' corporate social responsibility*** (the voluntary actions that a business can take, over and above compliance with minimum legal requirements, to address both its own competitive interests and the interests of wider society);
- ***engaging directly with businesses with large utility-based fleets undertaking less than 100 miles a day, to encourage conversion to EVs; and***
- ***measures to increase awareness amongst businesses of the financial and other benefits of EV use.***

Barrier(s) addressed: lack of public awareness and knowledge, aversion to new technology.

Private sector business could play a significant role in the uptake of EVs, contributing directly towards the target of 290,000 EVs by 2020, as well as increasing the visibility of EVs on Scottish roads and increasing general awareness amongst the public.

A number of organisations are already looking at converting some or part of their fleet to EV. For example, Nissan and car rental firm, Europcar, have formed a partnership which will give customers the opportunity to

rent an EV[57]; and BT has converted four vans to electric to trial their suitability for wider use in their Openreach fleet and get some idea of what the long term cost benefits might be[58].

3.9.7. F7 – Lobbying to increase the EU target for the emissions-intensity of new cars and vans

Potential measure: Scottish Government lobbies the EU to increase the EU target for the emissions-intensity of new cars and vans produced by manufacturers.

Barrier(s) addressed: limited supply of EV, high purchase price *(greater availability of EVs will bring down price). Would also provide a strong incentive for manufacturers to address* ***high purchase cost*** *and* ***range anxiety*** *barriers, and address* ***lack of public awareness and knowledge about EVs****.*

This would encourage the major manufacturers to increase the volume of EVs produced. An emissions target was initially set in 1995 and was intended to reduce average new car emissions to 120 g/km by 2005. However, before it became legally-binding, the target was postponed or weakened four times (T&E, 2010). Manufacturers are well on their way to meeting the new target of 130 gCO_2/km by 2015, and 95 gCO_2/km by 2020, suggesting that a more stringent target would still be realistic.

3.10. Potential measures: contribution to main barriers

The table below presents each measure's potential contribution to addressing the main barriers; and considers whether the identified measures address each barrier sufficiently, highlighting any gaps.

[57] http://www.thegreencarwebsite.co.uk/blog/index.php/2009/05/27/nissan-signs-electric-car-alliance-with-europcar/
[58] http://www.thinkbroadband.com/news/4484-bt-looks-towards-electric-vehicles-to-reduce-carbon-emissions.html

Table 3.4 - Potential measures: contribution to barriers

Barriers	A - Infrastructure and support services measures	B - Alternative ownership models	C - Fiscal measures and subsidies: vehicle purchase incentives	D - Fiscal measures and pricing policies: running cost incentives	E - Awareness, information and training measures	F - Other Government leadership measures	Do identified measures address barriers sufficiently?
Very high significance							
High purchase cost	A9 – Battery swap feasibility study (battery swap operators retain ownership of battery)	Remove purchase cost barrier: B1 – Car clubs B2 – Alternative ownership models (battery-leasing, vehicle-leasing, pay-as-you- go contracts, etc).	Direct impact: C1 – Grants for purchasing new EVs C2 – Scrappage scheme C3 – Grants for second-hand EVs C4 – Registration tax C5 – Registration tax feebate C6 – Tax credits C7 – Enhanced Capital Allowances	Indirect impact: D1 - Road pricing D2 - Workplace Parking Levy D3 - On-street parking charge policies D4 - Vehicle Excise Duty D5 - Fuel tax D6 - Company car tax	-	F1 – Public sector fleet procurement -	**Yes** – Range of measures identified which will reduce the purchase price, allow some of the purchase price to be offset against other purchase related benefits, or remove the purchase cost barriers through alternative ownership models. Running cost incentives (Type B) will compensate for high purchase cost and incentivise EV purchase.
Limited range of EVs	Infrastructure measures will address 'range anxiety' issues: A1 – Infrastructure Strategy A4 – Publically accessible recharging points A5 – Incentives for workplace recharging infrastructure A6 – Support for home recharging A7 – Planning guidance A8 – Building regulations A9 – Battery swap A10 – Induction charging research	B1 – Car clubs (allows consumers to vary their choice of vehicle depending on the type of journey they are making) B2 – Alternative ownership models (some ownership models allow users to rent a conventional ICEV for longer trips)	C7 – Enhanced Capital Allowances (for workplace recharging infrastructure)	-	E5 – Eco-driver training	F2 – Research -on the scale of infrastructure required in Scotland; - on the likely location of early adopters, to allow measures to be targeted; - to explore low cost measures to support and incentivise home recharging; - to determine infrastructure requirements for long distance journeys, requiring recharging on-route.	**Partly – Measures do not sufficiently address the fact that EVs do not currently represent a practical option for journeys of more than about 100 miles, which requires batteries to be recharged on route. For example. It is not currently feasible to use an EV to drive from the Borders to the Highlands without significant time out on route for battery recharging.** 'Battery swap' is unlikely to be a realistic proposal for Scotland and on-route 'induction charging' is a long way off.

Barriers	A - Infrastructure and support services measures	B - Alternative ownership models	C - Fiscal measures and subsidies: vehicle purchase incentives	D - Fiscal measures and pricing policies: running cost incentives	E - Awareness, information and training measures	F - Other Government leadership measures	Do identified measures address barriers sufficiently?
Lack of recharging infrastructure	A4 to A10 (see above)	B1 – Car clubs (easier for operators to charge vehicles, e.g. in designated parking bays)	C7 – Enhanced Capital Allowances (for workplace recharging infrastructure)	-	-	F2 – Research (see above)	**Partly** *(see above)*
Including….							
…no agreed standards, specifications and regulations for recharging infrastructure	A2 – Government action to agree technical standards, specifications and regulations for recharging infrastructure	-	-	-	-	-	**Yes** – Identified measure should address barrier, if implemented successfully. Will require challenging joint working arrangements and agreement across different sectors.
…no agreed market model to support expansion of EVs	A3 – Government action to agree market model for infrastructure identifying roles and responsibilities	-	-	-	-	-	
…limited capacity of local electricity distribution networks	A12 – Working Group to address electricity generation and distribution requirements for EVs	-	-	-	-	-	**Yes** – Identified measure should address barrier, if implemented successfully. Will require challenging joint working arrangements and agreement across different sectors. It is also important that the Scottish Government's wider commitment to decarbonise electricity generation is progressed rapidly.
…carbon-intensity of electricity generation during peak periods	A12 – Working Group to address electricity generation and distribution requirements for EVs					-	

Barriers	A - Infrastructure and support services measures	B - Alternative ownership models	C - Fiscal measures and subsidies: vehicle purchase incentives	D - Fiscal measures and pricing policies: running cost incentives	E - Awareness, information and training measures	F - Other Government leadership measures	Do identified measures address barriers sufficiently?
High significance							
Uncertainty about future resale value	-	B1 – Car clubs B2 – Alternative ownership models (battery-leasing, vehicle-leasing, pay-as-you- go contracts, etc)	C3 – Grants for second-hand EVs (gives private consumers and fleet operators confidence that they will be able to sell their EV in the future)	-	-	-	**Partly –** Alternative ownership models will reduce risk for consumers, but manufacturers and lease providers will need to factor uncertainty into lease prices. **Barrier will diminish with time.**
Limited supply of EVs	All proposed interventions will contribute to making Scotland an attractive sales market for EV manufacturers	All proposed interventions will contribute to making Scotland an attractive sales market for EV manufacturers	All proposed interventions will contribute to making Scotland an attractive sales market for EV manufacturers	All proposed interventions will contribute to making Scotland an attractive sales market for EV manufacturers	All proposed interventions will contribute to making Scotland an attractive sales market for EV manufacturers	F1 – Public sector fleet procurement / F4 – EV Strategy and Action Plan for Scotland (will promote Scotland an attractive sales market for EV manufacturers). F5 - Mandate specifying proportion of EV sales by major manufacturers F7 - EU target for the emissions-intensity of new cars and vans	**Partly** – Measures should address barrier if implemented successfully, but strong lobbying will be required by Scottish Government to influence EU target and there are significant delivery charges associated with F6.
Lack of public awareness and knowledge	-	B1 – Car clubs (allows members to test an EV)	-	-	E1 – Demonstration project E2 – Test drive opportunities E3 – Information website E4 – Publicity campaign	F1 – Public sector fleet procurement (increases awareness and visibility) F2 – Research - to assess the future requirements of Scottish customer-focused information - to assess the most effective methods of conveying life cycle implications F6 – Government action to encourage private sector support (increases awareness and visibility)	**Yes** – Range of measures identified which should address barrier, if implemented successfully and at a sufficient level of intensity.

Barriers	A - Infrastructure and support services measures	B - Alternative ownership models	C - Fiscal measures and subsidies: vehicle purchase incentives	D - Fiscal measures and pricing policies: running cost incentives	E - Awareness, information and training measures	F - Other Government leadership measures	Do identified measures address barriers sufficiently?
Limited performance and limited choice of vehicles in comparison with ICEVs	-	-	-	-	-	F2 – Research - to improve performance F3 – Funding to convert specialist vehicles (to increase choice of vehicle types and models)	**Partly** – Improvements in performance and range of vehicles available will need to come from the main manufacturers.
Aversion to new technology	A2 – Government action to agree technical standards, specifications and regulations for recharging infrastructure A3 – Government action to agree market model for infrastructure identifying roles and responsibilities (will ensure that the experiences of early adopters are positive and provide the wider mass market with confidence to invest in EVs)	B1 – Car clubs and B2 – Alternative ownership models (reduce risks)	C1, C2, C3, C5, C6, C7 (lower cost reduces element of risk; C3 - gives initial consumers confidence that they will be able to sell their EV in the future)	D1 to D6 (lower operating costs reduce one element of risk)	E1 to E4 (see above).	F4 –EV Strategy and Action Plan for Scotland (reassures consumers that purchasing an EV is a practical and sensible option).	**Yes** – Range of measures identified which should address barrier, if implemented successfully and at a sufficient level of intensity.
Weak image association		B1 – Car clubs (allows members to test an EV)	-	-	E1 – Demonstration project E2 – Test drive opportunities E3 – Information website E4 – Publicity campaign	F2 – Research - to understand and assess the importance of symbolism attributed to EVs	**Yes** – Range of measures identified which should address barrier, if implemented successfully and at a sufficient level of intensity.
Limited value placed on environmental benefits by consumers	-	-	-	D1 to D6 (lower operating costs for EVs will help highlight the environmental benefits of EVs)	E3 – Information website E4 – Publicity campaign	-	**Yes** – Range of measures identified which should address barrier, if implemented successfully and at a sufficient level of intensity.

Barriers	A - Infrastructure and support services measures	B - Alternative ownership models	C - Fiscal measures and subsidies: vehicle purchase incentives	D - Fiscal measures and pricing policies: running cost incentives	E - Awareness, information and training measures	F - Other Government leadership measures	Do identified measures address barriers sufficiently?
Medium significance							
Uncertainty about future energy costs	A12 – Working Group to address electricity generation and distribution requirements for EVs	-	-	-	-	-	**Partly** – Firm commitments from electricity providers will be difficult to achieve.
Limited environmental benefits associated with current models	A12 – Working Group to address electricity generation and distribution requirements for EVs *(increased reliance on electricity generated from renewable sources will increase the environmental credentials of EVs)*.	-	-	-	-	-	**Yes** – Barrier will diminish overtime if the Scottish Government's wider commitment to decarbonise electricity generation is progressed rapidly.
Lack of support networks (e.g. garages with appropriate skills and equipment)	A12 - Qualifications for garage mechanics and quality insurance scheme for garages	-	-	-	-	-	**Yes** – In addition. business sector is expected to respond to demand.
Lack of engineering skills	-					F2 – Research - looking at skills and training needed to support EV uptake	**Partly** - Sector expected to respond to demand.

4. Assessment of potential measures

4.1. Assessment process

The measures outlined in Chapter 3 have been assessed against a range of criteria in order to determine which will be most effective at driving the uptake of EVs. The criteria are broadly based on those used to inform the Scottish Transport Appraisal Guidance (STAG). In addition, measures have been categorised as 'weak', 'moderate', and 'strong' (or similar) against each of the criteria, drawing on evidence from existing research.

The process represents a high level and primarily qualitative assessment, rather than a detailed appraisal of the proposed measures. It is recognised that this type of approach always involves an element of subjectivity in terms of how measures are 'scored', and to mitigate the level of subjectivity, the assessment scores have been reviewed and debated by a range of individuals in the Atkins' study team representing different areas of interest.

It is also important to stress that the process is simply designed to help determine which measures are likely to be most effective at driving the uptake of EVs, by informing the comparison of options, illustrating some of the strengths and weaknesses associated with different measures, and highlighting issues for further consideration. No attempt is made to weight the various criteria or rank different options.

4.2. Assessment criteria

Each intervention has been categorised against the following criteria:

a) Fleet affected

A '✓' symbol is used to indicate whether the measure will encourage EV uptake amongst the private, corporate and public fleet. A '✓' symbol indicates that the measure will be particularly effective.

b) Barriers addressed

A '✓' is used to indicate which barriers will be addressed by the measure. Specific columns are provided for the three barriers of 'very high' significance. 'Lack of infrastructure' also refers to associated barriers, i.e. lack of agreed standards, specifications and regulations; lack of an agreed market model; capacity of local electricity distribution networks; and low carbon electricity generation.

c) Effectiveness

Measures are categorised as strong, moderate or weak based on the following questions:

- Will main barriers to EV uptake be addressed?
- Evidence of effectiveness from existing research?
- Scale of contribution to target of 290,000 EVs on Scotland's roads by 2020?

d) Potential for adverse impacts on wider policy areas

Measures are categorised as having a low, moderate or high potential for adverse impacts on wider policy areas relating to transport, social inclusion, energy, sustainability, and the economy. Where measures have a strong or moderate adverse impact on wider policy areas, it may be politically unacceptable to introduce the measure or there may be a need to identify appropriate mitigation measures.

Wider sustainable transport impacts - It is recognised that any measures which encourage or enable consumers to purchase an EV will reduce long-term operating costs for those who do so. While this could increase the attractiveness of car travel relative to public transport / walk / cycle modes, it is assumed that measures to encourage EV uptake will be delivered as part of a *wider sustainable transport strategy* which also involves significant improvements for public transport / walk / cycle modes. In addition, it is anticipated

that the majority of EV purchasers / users will be existing car owners / users. For the purposes of this assessment, it has been assumed that most measures will not have an adverse impact on wider sustainable transport objectives. Some measures, which increase the cost of driving an ICEV, could actually have a positive impact on sustainable transport objectives but are likely to have social inclusion impacts (see below).

Social inclusion impacts – Adverse social inclusion impacts occur where public spending disproportionately benefits certain groups of individuals (e.g. affluent consumers) more than others (e.g. less affluent consumers). The scale of potential impacts varies for different measures:

- Some measures (e.g. car clubs) seek to make EVs accessible to all groups, including the third of Scottish households who do not currently have access to a car – these measures therefore have a *positive social inclusion impact*.

- Some measures (e.g. vehicle purchase incentives) seek to make EVs accessible to more people, but will only benefit those who can afford the higher purchase cost of an EV – these groups will also benefit from reduced running costs in the long term, while those who cannot access the measures won't. However, it is assumed that any investment in measures to encourage existing car users to switch to EVs will be part of a *wider sustainable transport strategy* and will be accompanied by significant investment in other sustainable travel measures which will benefit all, particularly those without access to a car. This approach will help to *minimise any social inclusion impacts*. The cost of owning and running a conventional vehicle will not change for those who cannot afford an EV.

- Some measures (e.g. running cost incentives) increase the cost of driving a conventional ICEV. These measures will impact on all members of society but will impact most on less affluent consumers who cannot afford an EV. Significant cost increases will increase the proportion for whom car ownership will become an unaffordable option, and will therefore have an *adverse social inclusion impact*. These measures therefore need to be complemented by measures which seek to make EVs accessible to all, such as car clubs and alternative ownership models; as well as significant investment in other sustainable travel measures.

Distributional impacts – Adverse distributional impacts occur where public spending disproportionately benefits groups and individuals in certain locations only (e.g. urban rather than rural locations).

e) Deliverability

Are there feasibility constraints relating to technology requirements, legal issues, timescales, and other similar factors?

f) Public acceptability

Will the measure be popular or acceptable to the public? For example, is there evidence that similar policies have attracted significant public opposition in the past.

g) Affordability

Does the proposed measure represent a low, medium, or high cost measure for the Scottish Government, in terms of initial implementation and on-going running costs?

For the purpose of this assessment, each measure has been assessed on its own merits, assuming that it is implemented in isolation from other supporting interventions. However, in practice, it is vital that measures to encourage EV uptake are delivered as part of a wider sustainable transport strategy which also involves significant improvements for public transport / walk / cycle modes.

4.3. Results of assessment process

The results from the assessment are presented in Appendix B

5. Key Findings

5.1. Barriers to EV uptake

The hierarchy of barriers that has emerged from the research is summarised in Table 5.1.Table 5.1 – Ranking of barriers

Barrier	Overall ranking
High purchase cost	Very high significance
Limited range of EVs (and range anxiety issues)	Very high significance
Lack of recharging infrastructure (and issues relating to implementation and operation of infrastructure)	Very high significance
Uncertainty about future resale value	High significance
Limited supply of EVs	High significance
Lack of public awareness and knowledge about EVs	High significance
Limited performance and limited choice of vehicles	High significance
Aversion to new technology	High significance
Weak image association	High significance
Limited value placed on environmental benefits by consumers	High significance
Uncertainty about future energy costs	High significance
Limited environmental benefits associated with current models	Moderate significance
Lack of support networks (e.g. garages with appropriate skills and equipment).	Moderate significance
Lack of engineering skills	Moderate significance

The research has identified that many of the identified barriers are equally applicable to private, public and corporate fleets.

Local authority fleets are expected to be least affected by the identified barriers, due to a need to show leadership by demonstrating support for the technology required to meet CO_2 reduction targets. Company car owners are expected to be more affected by the barriers. High mileage and a preference for larger, high performing models means that company car users are likely to be more adverse to driving an EV than other consumers.

High purchase price could be expected to be less of a concern in the context of public and corporate fleets, given the strong buying powers of the organisations concerned and greater appreciation of whole life costs. However, public sector fleet managers have reported that they are unlikely to buy EVs for their fleets unless incentivised to do so by the Government, because the overall cost is currently seen as being uncompetitive (see Section 2.2.2).

The **limited range of EVs** and **lack of recharging infrastructure** is likely to be less of a concern for corporate utility and public sector fleets where daily mileage is predictable and less than the maximum range of a single battery charge, and where infrastructure can be provided in a depot to allow overnight recharging.

Scheduling tools may be required to manage recharging, and the electricity supply may need to be upgraded as historically, many premises were built with limited provision of power for the building and car park.

5.2. Effectiveness of measures

An assessment of the measures that could be available to Scottish Government and local authorities in Scotland to influence the uptake of EVs has been undertaken as part of this study, and this indicates that there is a hierarchy of measures in terms of effectiveness.

Alternative ownership models (Type B) and fiscal measures and subsidies relating to the purchase price of vehicles (Type C) are most effective because they directly address the 'high purchase price' barrier, identified as being of 'very high significance'. **Infrastructure measures and support services (Type A) also score highly as effective measures** in their own right, because they address the 'very high significance' barriers relating to 'range anxiety' and 'lack of infrastructure'. These measures need to be prioritised first.

Fiscal measures and pricing policies relating to running costs (Type D) provide an indirect means of addressing the 'high purchase price' barrier, providing consumers are willing to offset some of the purchase price against long term running cost savings. While there is some evidence that fuel price increases (for example) have resulted in a shift towards more fuel efficient cars, there is also evidence that private consumers tend to heavily discount future running cost when deciding which car to purchase (Arup and Cenex, 2008).

Measures relating to **awareness, information and training** (Type E) are unlikely to be effective measures in their own right. They should be seen as secondary, support measures which will be important in growing the EV market, once barriers relating to 'high purchase price', 'range anxiety', and 'lack of infrastructure' have been addressed. This does not mean that there is not a case for implementing or continuing to implement some of them now, as part of a strategy to shift mindsets, but it needs to be recognised that these measures on their own will not achieve the target of 290,000 EVs on Scottish roads by 2020.

Similarly some measures categorised as **other Government leadership measures** (Type F), tend not to address the 'very high significance barriers' directly, and are unlikely to be effective measures in their own right.

5.3. Prioritisation of measures

Table 5.2 prioritises the measures into three groups – top priorities, secondary priorities, and tertiary priorities – and shows which fleet sectors will be affected by each measure. The prioritisation of measures reflects the findings of the assessment process described in Chapter 4.

The **'top priorities'** are those measures which have been identified as being most effective in addressing the **'very high significance' barriers** relating to 'high purchase cost', 'limited range of EVs', and 'lack of recharging infrastructure'. These measures need to be implemented as a matter of urgency, if the target of 290,000 EVs on Scotland's roads by 2020 is to be met. They include infrastructure and support measures, alternative ownership models, vehicle purchase incentives, and other Government leadership measures (procurement policies and lobbying to increase the EU target for the emissions intensity of new cars and vans produced by manufacturers.

Secondary priorities are those measures that have been shown to be most effective at addressing the 'high significance barriers'. These measures will be important in driving EV uptake across the 'early adopter market', and will need to follow the implementation of the top priority measures.

Tertiary priorities are those measures which may be needed to expand EV uptake to the mass market, or are areas where Government action may be required if the private sector does not succeed in addressing barriers identified as being of 'moderate significance'.

Many of these measures complement each other. An EV Strategy and Action Plan for Scotland will be essential in terms of providing a clear framework for Government action, and will need to combine measures from all three categories in an integrated manner.

5.4. Conclusion

Despite the challenges, there are a number of ways in which both national and local government can work to increase the number of EVs in Scotland, within a wider sustainable transport strategy which also involves significant improvements for public transport, walk and cycle modes. Action is required now if the target of 290,000 EVs on Scotland's roads by 2020 is to be met.

However, Scotland cannot act alone in tackling the barriers to EV uptake. The car industry operators on a global scale and uptake in Scotland will be affected by what happens in the rest of Europe, North America, Japan, and rapidly emerging economies such as China and India. An important role for the Scottish Government will therefore be to influence decisions made at a UK and EU level, in order to drive growth of the EV sector and to ensure that decisions made by other legislators are consistent with and reflect the ambitions of the Scottish Government.

Table 5.2 – Prioritisation of measures

Measure (see Chapter 3 for full description)	Type of measure	Private	Company cars	Utility vehicles	Local authority
		Fleet sectors affected			
Top priorities – Address 'very high' significance barriers (purchase price, limited range, lack of infrastructure)					
F4 - Scottish Government publishes a high profile **EV Strategy and Action Plan for Scotland**, setting out a clear vision supported by targets or milestones. *Although this measure does not directly address the 'very high significance' barriers, it is seen as vital in terms of providing a clear framework for Government action and informing the implementation of other measures.*	F – Other Government leadership measure	✓	✓	✓	✓
A1 - Scottish Government develops an **EV Infrastructure Strategy for Scotland**, setting out a clear vision for the future, presenting a strategy for the provision and roll out of appropriate recharging infrastructure, and describing how drivers will use the infrastructure (see A3). This should be part of a broader EV Strategy and Action Plan for Scotland (see F4).	A – Infrastructure and support measures	✓	✓	✓	✓
A2 - Scottish Government works with relevant stakeholders in Scotland, the rest of the UK, and across Europe, to **set technical standards, specifications and regulations for implementing recharging infrastructure**.	A – Infrastructure and support measures	✓	✓	✓	✓
A3 - Scottish Government commissions a **review of the possible market models for recharging infrastructure** in Scotland and implements the recommendations of the review. This would involve working with relevant stakeholders to identify key roles and responsibilities for energy providers, electricity retailers, EV manufacturers, private infrastructure providers and the public sector; specify pricing and payment approaches; and agree customer interface requirements (single or multiple points of contact).	A – Infrastructure and support measures	✓	✓	✓	✓
A4 - Scottish Government and local authorities provide **funding for publically accessible recharging points**.	A – Infrastructure and support measures	✓	✓	✓	✓
A5 - Scottish Government and local authorities **incentivise businesses to install recharging points**. This would involve engaging directly with the largest businesses with employee car-parks to highlight the benefits of encouraging use of EVs rather than conventional vehicles; by providing free advice; and by providing match funding to 'innovator' and 'early adopter' businesses wishing to install recharging points in existing parking spaces. These measures would be most effective if linked to exemption from a Workplace Parking Levy (see D2).	A – Infrastructure and support measures	✓	✓	✓	✓
A6 - Scottish Government prepares **advice for residents on home recharging and guidance for electricians on the type of facilities needed** (including issues to be considered in communal parking areas). Local authorities to disseminate information.	A – Infrastructure and support measures	✓	✓	×	×
A7 - Scottish Government provides **national planning guidance** on the provision of recharging bays and infrastructure in local authority areas as part of a parking strategy which supports wider sustainable transport objectives.	A – Infrastructure and support measures	✓	✓	✓	✓
A8 - Scottish Government updates **building regulations** to set out minimum requirements regarding the provision of electrical infrastructure and recharging points in new buildings.	A – Infrastructure and support measures	✓	✓	✓	✓

Measure (see Chapter 3 for full description)	Type of measure	Private	Company cars	Utility vehicles	Local authority
		Fleet sectors affected			
A12 - A **Working Group** of relevant stakeholders from the energy and transport sectors, chaired by a Member of the Scottish Parliament, is tasked with addressing the **electricity generation and distribution requirements for EVs**.	A – Infrastructure and support measure	✓	✓	✓	✓
B1 - Local authorities work with existing **car club** operators to introduce EVs into fleets and introduce EV-based car clubs in other cities. This would involve local authorities: engaging directly with existing car clubs to raise awareness of EVs and their benefits; using car clubs instead of purchasing their own fleet cars; procuring vehicles directly for car clubs using their considerable purchasing power to lever favourable purchase prices or lease contracts; and working with manufacturers to set up a publicly funded electric car share scheme.	B – Alternative ownership model	✓	×	×	✓
B2 - Encourage manufacturers to offer **alternative ownership models** to consumers in Scotland by promoting Scotland as an attractive market for manufacturers, and engaging with manufacturers to understand and influence their decisions about where to focus their sales strategy. Scottish Government or other public sector bodies work with manufacturers to 'trial' alternative ownership models amongst employees or as part of the vehicle procurement process, and publicise benefits.	B – Alternative ownership model	✓	✓	✓	✓
C1 - Scottish Government provides a **£10,000 subsidy*** for the first 25,000 EVs in Scotland (as recommended by the UK CCC), to 'kickstart' early uptake of EVs, **£5,000** for the second 25,000 EVs in Scotland, and reducing for subsequent 25,000 EV milestones. **£5,000 assumed to come from the UK Plug-In Car for the first EVs in Scotland (approximately 800, based on the current committed budget).*	C – Vehicle purchase incentive	✓	×	✓	×
C2 - Scottish Government introduces a **scrappage scheme** to encourage consumers to purchase EVs, with subsidies reducing as EV uptake increases.	C – Vehicle purchase incentive	✓	×	✓	×
C3 - Scottish Government provides **grants for purchasing second hand EVs** from specified dealers, with subsidies reducing as EV uptake increases.	C – Vehicle purchase incentive	✓	×	✓	×
F1 - Scottish Government, local authorities and other public sector organisations support an earlier than average switch to low carbon emissions vehicles for public sector fleet vehicles (cars and vans) through **procurement policies** (extending funding for the Low Carbon Vehicle Procurement Support Scheme; a target for 100% of public sector fleets to be electric, where appropriate; Scottish Government procuring EVs on behalf of all local authorities; commissioning specialist firms to convert existing ICE models; and ensuring sustainable procurement policies are in place). *Will not significantly increase uptake on its own, but the public sector needs to show leadership and demonstrate support for the new technology required to meet CO_2 reduction targets.*	F – Other Government leadership measure	×	×	×	✓
F7 - Scottish Government lobbies the EU to increase the EU target for the emissions-intensity of new cars and vans produced by manufacturers. *Greater availability of EVs will bring down price.*	F – Other Government leadership measure	✓	✓	✓	✓

Measure (see Chapter 3 for full description)	Type of measure	Private	Company cars	Utility vehicles	Local authority
		Fleet sectors affected			
Secondary priorities – Address 'high' significance barriers					
A10 - Scottish Government commissions research into the potential for introducing **induction charging** (via electrified parking spaces and electrified roads) in Scotland.	A – Infrastructure and support measure	✓	✓	✓	✓
C5 - Scottish Government works with the UK Government to design a **feebate** scheme for the UK which involves increasing the tax levied on the purchase of relatively high-emitting vehicles and providing rebates for lower-emitting vehicles. Subject to the findings the Scottish Government lobbies the UK Government to introduce a UK-wide feebate scheme.	C – Vehicle purchase incentive	✓	✓	✓	×
C6 - Scottish Government lobbies the UK Government to introduce **tax credits** for purchasers of new EVs, which reduce as EV uptake increases.	C – Vehicle purchase incentive	✓	✓	✓	×
C7 - Scottish Government lobbies the UK Government to provide additional **Enhanced Capital Allowance tax exemptions** for businesses. This measure would extend the existing scheme for low carbon cars until 2020, and widen it to include a larger range of vehicles (including electric vans) and recharging infrastructure.	C – Vehicle purchase incentive	×	✓	✓	×
D1 - Local authorities introduce **road charging schemes** (e.g. congestion charging, low emission zones, or road tolling) in urban centres, offering free or discounted access for EVs.	D – Running cost incentive	✓	✓	✓	✓
D2 - Local authorities introduce **workplace parking levies** in urban centres, with exemptions for EV spaces.	D – Running cost incentive	✓	✓	✓	✓
D3 - Local authorities introduce **on-street parking charge policies** which offer free or heavily discounted parking for EVs.	D – Running cost incentive	✓	✓	✓	✓
E2 - Scottish Government and local authorities provide opportunities for consumers to **test drive EVs**, using existing networks or through a national network of test-drive centres. This could involve encouraging newly qualified drivers to consider purchasing an EV, encouraging car clubs to offer EV test drives, and taking test vehicles to large employers and large public venues (e.g. shopping centres, motor and air shows, etc).	E – Awareness, information and training measure	✓	✓	✓	✓
E3 - Scottish Government develops a **website** which includes all the information the public needs to know about EVs, including how and where to charge them. The website could refer users to the Energy Saving Scotland Advice Centres for more information. Local authorities also disseminate information.	E – Awareness, information and training measure	✓	✓	✓	✓
F2 - Scottish Government supports and funds **research** needed to enable rapid EV uptake.	F – Other Government leadership measure	✓	✓	✓	✓
F3 - Scottish Government provides **funding to small firms which specialise in converting specific vehicles to electric platforms**, e.g. taxis, minibuses and larger family cars (as part of a wider demonstration project).	F – Other Government leadership measure	✓	✓	✓	✓

Measure (see Chapter 3 for full description)	Type of measure	Private	Company cars	Utility vehicles	Local authority
		Fleet sectors affected			
F5 - Scottish Government lobbies the EU to introduce a **mandate specifying that sales by main manufacturers operating in the EU must comprise a certain proportion of zero emission vehicles** by 2020.	F – Other Government leadership measure	✓	✓	✓	✓
F6 - Scottish Government and local authorities **encourage EV uptake amongst the private sector** by: increasing awareness or increasing the focus placed on a business' corporate social responsibility; engaging directly with businesses with large utility-based fleets undertaking less than 100 miles a day, to encourage conversion to EVs; and measures to increase awareness amongst businesses of the financial and other benefits of EV use.	F – Other Government leadership measure	×	✓	✓	×
Tertiary priorities					
A9 - Scottish Government conducts a feasibility study into the potential to trial a network of **battery swap stations**. *Private sector expected to pursue this if considered or proven to be an effective approach.*	A – Infrastructure and support measure	✓	✓	✓	✓
A11 - **Qualifications for garage mechanics** and **quality insurance scheme for garages** servicing, undertaking MOTs, and repairing EVs *Private sector expected to respond to consumer demand. EVs will be serviced by manufacturers for first three years.*	A – Infrastructure and support measure	✓	✓	✓	✓
C4 - Scottish Government lobbies the UK Government to increase the tax levied on the purchase of new vehicles ('**first year rates**'), scaled on the basis of CO_2 emissions. *Does not actually reduce the cost of purchasing an EV.*	C – Vehicle purchase incentive	✓	✓	✓	×
D4 - Scottish Government lobbies the UK Government to increase the price differentials between adjacent bands for **vehicle excise duty** to increase the financial benefit of EV ownership. *Evidence that private consumers heavily discount future running costs when deciding which car to purchase, and that road tax is the least important tax when buying a car.*	D – Running cost incentive	✓	✓	✓	×
D5 - Scottish Government lobbies the UK Government to increase **fuel duty**. *Evidence that private consumers heavily discount future running costs when deciding which car to purchase. Significant implementation challenges, including very strong opposition.*	D – Running cost incentive	✓	✓	✓	✓
D6 - Scottish Government lobbies the UK Government to provide further **company car tax benefits**. An extension to the current exemption could be considered as well as higher tax rates for more polluting vehicles. *Electric cars already receive a five year exemption from company car tax and electric vans a five year exemption from van benefit charge (2010 to 2015).*	D – Running cost incentive	×	✓	×	×

Measure (see Chapter 3 for full description)	Type of measure	Private	Company cars	Utility vehicles	Local authority
		Fleet sectors affected			
E1 - Scottish Government supports a **high profile EV demonstration project**, to raise awareness and knowledge about EVs, focusing on locations with a high concentration of early adopters to stimulate adoption nationwide. *Unlikely to be an effective measure on its own, but needs to be part of a longer term strategy. Actual numbers able to take part in the demonstrating project will be limited.*	E – Awareness, information and training measure	✓	✓	✓	✓
E4 - Scottish Government part-funds a **high profile publicity campaign**, involving the principle EV manufacturers. Local authorities undertake local promotion campaigns. *Unlikely to be an effective measure on its own, but needs to be part of a longer term strategy.*	E – Awareness, information and training measure	✓	✓	✓	✓
E5 - Scottish Government and local authorities encourage potential EV drivers to undertake **eco-driver training**. This could involve offering free-training to newly qualified drivers and those considering purchasing an EV. *Unlikely to be an effective measure on its own, but needs to be part of a longer term strategy.*	E – Awareness, information and training measure	✓	✓	✓	✓

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A. Ranking of barriers

A.1. Overview of evidence

Tables A.1 and A.2 summarise the evidence used to rank the barriers to EV uptake, based on

- views from key stakeholders about the importance of an identified list of barriers, provided in responses to an email questionnaire (Column 2);
- evidence from other research reports (Column 3); and
- expertise within the Atkins' study team regarding the complexity of the barrier and scale of resultant benefits (Column 4 and 5).

Each barrier has been given an overall ranking (very high significance, high significance, or medium significance) based on the information summarised in Columns 2 to 5, and evidence presented in the main report.

Table A.1 – Summary of evidence: demand related barriers

Description	Stakeholder views on significance of barriers: High = 3 pts, Medium = 2 pts, Low = 1 pt	Top 3 barriers identified in other reports: Reference (date): Rank of barrier (where 1 is the most significant barrier)[59]	Complexity of barrier: 1 to 3 (most complex)	Scale of benefits: 1 to 3 (most benefits)	Overall ranking
Demand-related barriers					
High purchase cost / uncertainty about future resale values	Score = 23 (H, H, H, H, H, M, H, H)	Which (2011): 2 Lane (2011): 1 GfK (2010): 2(=) Cenex (2010): 1(=) (fleet EVs) WWF Scotland (2010): 1(=) Element Energy (2009): 1 AEA (2009): 1(=)	3	3	Very high significance
Limited range of EVs	Score = 20 (H, H, H, M, H, M, L, H)	DfT (2011): 2 Which (2011): 1 GfK (2010): 2(=) Cenex (2010): 1 (=) (fleet EVs) WWF Scotland (2010): 1 Element Energy (2009): 2 AEA (2009): 1(=)	3	3	Very high significance
Lack of public awareness and knowledge about EVs	Score = 19 (H, H, H, H, L, M, M, M)	DfT (2011) - 3	1	3	High significance
Limited performance and limited choice of vehicles in comparison with ICEVs	Score = 19 (H, H, M, H, M, M, L, M)	Cenex (2010) - 3(=) (fleet EVs)	2	3	High significance
Aversion to new technology	Score = 14 (M, M, L, M, H, M, L, L)	-	2	2	High significance
Weak image association	Score = 13 (L, M, L, M, M, M, L, M)	-	2	3	High significance
Limited environmental benefits associated with current EVs compared with the most efficient new diesel models	Score = 9 (L, L, L, L, L, M, L, L)	-	2	1	Moderate significance

[59] An (=) sign has been used where reports simply identify the most important barriers, rather than attempting to rank them; or where ranks are tied.

Table A.2 – Summary of evidence: supply- related barriers

Description	Stakeholder views on significance of barriers: High = 3 pts, Medium = 2 pts, Low = 1 pt	Top 3 barriers identified in other reports: Reference (date): Rank of barrier (where 1 is the most significant barrier)	Complexity of barrier: 1 to 3 (most complex)	Scale of benefits: 1 to 3 (most benefits)	Overall ranking
Supply-related barriers					
Lack of recharging infrastructure ***including…***	Score = 20 (M, H, M, M, M, M, H, H)	DfT (2011): 1 GfK (2010): 1 WWF Scotland (2010): 1 Element Energy (2009): 2 AEA (2009): 1(=)	3	3	Very high significance
No agreed standards, specifications and regulations for recharging infrastructure / No agreed market model to support expansion of Evs	Score = 18 (H, M, M, M, M, H, H, L)		3	2	
Limited capacity of local electricity distribution networks to support large scale recharging of vehicles	Score = 12 (L, L, L, L, M, M, L, H)		2	1	
Carbon-intensity of electricity generation during peak periods	Score = 13 (L, L, H, L, L, H, -, H)		1	1	
Lack of support networks (e.g. garages with appropriate skills and equipment).	Score = 17 (H, L, M, M, L, H, H, M)		2	2	Moderate significance
Lack of engineering skills	Score = 12 (H, L, L, L, L, M, L, M)		2	2	Moderate significance

Barriers have been coloured red, orange or green to highlight different stakeholder views regarding the significance of barriers (Column 2) and to highlight different levels of coverage of barriers in other reports which have sought to rank the various barriers (Column 3).

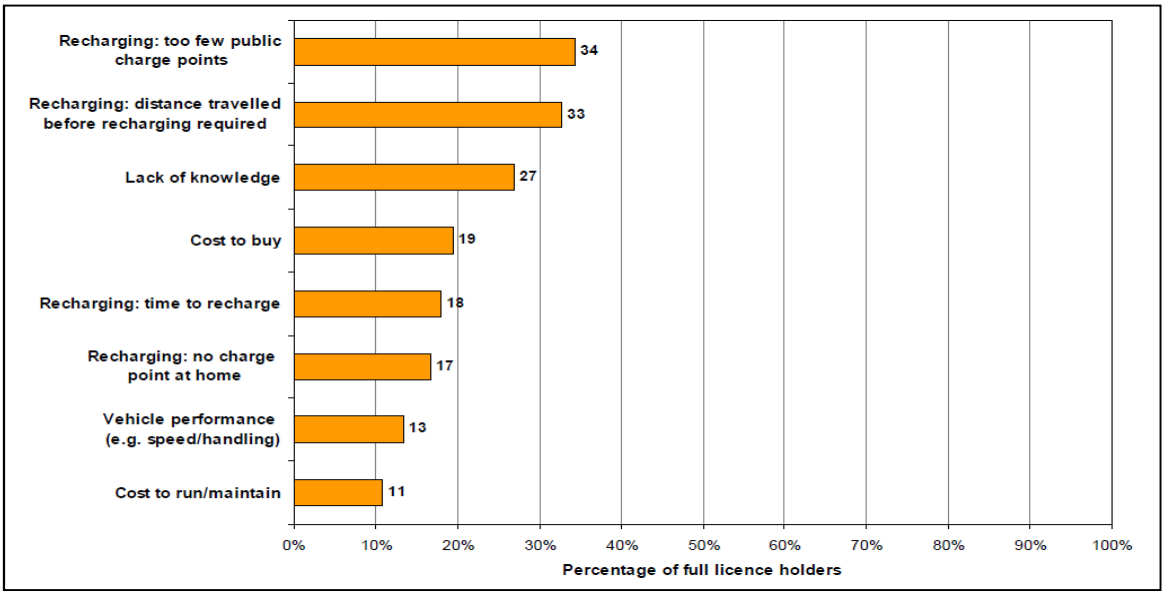
A.2. Barriers identified in other reports

A number of other studies undertaken over the last two years have also sought to prioritise the barriers to EV uptake. Appendix A identifies the top three barriers identified in each of these reports in order to highlight the issues which are most frequently mentioned.

A more detailed summary of the findings from each of the reports considered is presented below.

Department for Transport (2011) - DfT's survey of public attitudes to climate change and the impact of transport (2011) asked members of the public what they perceived to be the main barriers to purchasing EVs. Availability of **recharging points**, **vehicle range**, **lack of knowledge** about EVs, and **cost** to buy are all important barriers (Figure A.1).

Figure A.1 –Perceived barriers to EV uptake (DfT, 2011)



Which (2011) - A survey of 2,110 members of the public by the magazine *Which?*, found that 71% were concerned about EVs being limited to short journeys, and 50% thought that electric cars are too expensive.

Deloitte (2011) – A survey of 4,760 European consumers found that just 16% see themselves as potential early adopters of EV technology, even though 53% say they might be willing to consider buying or leasing an electric car at some point in the future.

More than 80% of European consumers surveyed said that convenience to charge, range, and the cost to charge were all key considerations when buying or leasing an EV. Three-quarters of European consumers surveyed (74%) said that before they would consider purchasing an EV, they would expect it to be able to travel 300 miles between charges – much higher than what is currently available – and 67% said the battery must take no longer than two hours to charge. However UK consumers were most positive about EVs, being the most willing to pay a premium for an electric model and the least demanding about driving range. UK consumers revealed that they consider the ability to travel at least 200 miles between charges to be the tipping point, especially in London and the South East.

Across Europe, the majority (57%) of respondents who say they may be willing to consider an electric vehicle expect to pay the same or less for an EV than they do for a regular car. Only 24% of the same group say they would be willing to pay a premium.

Lane (2011) - Lane (2011) argues that the supply side of the low carbon vehicle market is coming under control with a wide range of vehicles about to be brought to the market, but how we create meaningful consumer demand for the product is not. This points to barriers such as **price**, **desirability** and **awareness of issues such as reliability, resale value, range and practicality, and fuel efficiency**. The report also identifies **purchase price** as a key barrier to their adoption by the mass market, and identifies purchase price as one of the most important factors influencing vehicle choice.

GfK (2010) - GfK Automotive interviewed 5,053 UK citizens online between 16th and 30th November 2010 to gather views on barriers to owning an EV:

- 68% were concerned about limited availability of recharging points;
- 64% were concerned about the price of electric cars;
- 64% were concerned about limited battery range; and
- 54% were concerned about the time taken to charge battery.

Cenex (2010) - Following a trial of four electric Smart vehicles, Cenex (2010) surveyed 10 fleet managers from local councils (7), private companies (2) and Newcastle University (1). Range and purchase price were identified as the main barriers to fleets integration, followed by charging times and reliability. Organisations did not consider installing infrastructure at base or the lack of public recharging points to be barriers to the incorporation of EVs into their fleets.

WWF Scotland (2010) - WWF's *Watt Car?* report mentions 'three key barriers' – initial price premium, infrastructure provision, and a constrained driving range.

Element Energy (2009a) - Element Energy (2009a) analysed international literature on EV adoption, and undertook a survey of 47 private and fleet EV owners and 231 individuals considering purchasing an EV, to identify the main barriers to uptake considering the relative disutilities of EV ownership. They concluded that **high capital on-cost** was the biggest barrier to EV adoption, followed by **limited range** and **concerns about recharging infrastructure**. All three factors were of high importance to commercial / company car owners, along with **time to recharge** and **lack of choice**. Many company car owners are required to travel long distances on a regular basis, making these factors particularly pertinent. Results from the survey are shown in Table A.2.

Table A.2 – Relative importance of EV disutility factors (Element Energy, 2009a)

	High price	Limited range	Time to charge	Inconvenience of recharging	No recharging points	Lack of power or performance	Unfamiliarity	Lack of choice
Household EV owners	+++	++	+	+	++	+	+	++
Household EV considers	+++	++	+	+	++	+	+	++
Commercial EV owners	+++	+++	+++	++	+++	++	+	+++
Commercial EV considers	+++	++	+	+	++	+		+

AEA (2009) - AEA (2009) report that there are several barriers to the extensive uptake of EV and PHEV technology that will need to be overcome before mass-market penetration can be achieved. These barriers include:

- limited vehicle range, due to the current limitations of battery technology;
- high capital costs associated with vehicle batteries; and
- limited availability of recharging infrastructure.

B. Assessment of measures

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A – Infrastructure and support services measures

Measure (see Chapter 3 for full description)	Private fleet	Company cars	Utility vehicles	Public fleet	Barriers addressed: Purchase cost	Range anxiety	Lack of infrastructure, etc	High significance barriers	Med. significance barriers	**Effectiveness in addressing barriers by 2020** (very effective, moderately effective, less effective) **and numbers targeted by measure** (very large, large, medium, small)[1]	**Potential for adverse impacts on wider policy areas** (low, medium, high) *Positive impacts or comments shown in italics.*	**Deliverability: challenges and risks (technical, legal, political support, etc.)** (no significant challenges or risks, some challenges or risks, very significant challenges and risks)	**Public and stakeholder acceptability** (unlikely to attract significant opposition, some opposition likely, strong opposition likely)	**Affordability** (low cost = less than £10 million; medium cost = £10-100 million; higher cost = more than £100 million) *Cost estimates are very broad approximations only.*
A1 – Scottish Government develops an EV Infrastructure Strategy for Scotland, setting out a clear vision for the future, presenting a strategy for the provision and roll out of appropriate recharging infrastructure, and describing how drivers will use the infrastructure (see A3). This should be part of a broader EV Strategy and Action Plan for Scotland (see F4).	✓	✓	✓	✓	-	-	✓	-	-	**Very effective** – Infrastructure for recharging EVs is vital. The strategy would ensure a coherent and efficient approach to the development of recharging infrastructure. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**No significant challenges or risks** Will require engagement with UK and EU Governments to ensure strategy is compatible with that being pursued elsewhere.	**Unlikely to attract significant opposition**	**Low cost**
A2 –Scottish Government works with relevant stakeholders in Scotland, the rest of the UK, and across Europe, to set technical standards, specifications and regulations for implementing recharging infrastructure.	✓	✓	✓	✓	-	-	✓	✓	-	**Very effective** – Clarity on technical standards, specifications and regulations is an essential part of providing infrastructure to recharge EVs. Will ensure that the experiences of early adopters are positive and provide the wider mass market with confidence to invest in EVs, i.e. addresses 'aversion to new technology' barrier. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**Some challenges or risks** Will require complex and challenging joint working arrangements across a number of organisations and sectors, which may not be used to working together. Will require engagement with UK and EU Governments to ensure strategy is compatible with that being pursued elsewhere.	**Unlikely to attract significant opposition**	**Low cost**
A3 –Scottish Government commissions a review of the possible market models for recharging infrastructure in Scotland, and implements the recommendations of the review…..	✓	✓	✓	✓	-	-	✓	✓	-	**Very effective** – Clarity on the roles and responsibilities of key players, pricing and payment approaches and customer interface arrangements is an essential part of providing infrastructure to recharge EVs. Will ensure that the experiences of early adopters are positive and provide the wider mass market with confidence to invest in EVs, i.e. addresses 'aversion to new technology' barrier. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**Some challenges or risks** Will require complex and challenging joint working arrangements across a number of organisations and sectors, which may not be used to working together. Will require engagement with UK and EU Governments to ensure strategy is compatible with that being pursued elsewhere.	**Unlikely to attract significant opposition**	**Low cost**
A4 – Scottish Government and local authorities provide funding for publically accessible recharging points.	✓	✓	✓	✓	-	✓	✓	-	-	**Very effective** – Infrastructure for recharging EVs is vital. A number of reports (e.g. Element Energy, 2009) indicate that a widespread and highly visible publicly available recharging network needs to be in place to address 'range anxiety' concerns and encourage EV adoption. WWF Scotland (2010) estimates that post 2020, the number of EVs in the stock will exceed the number of households with off-street parking. This implies that some on-street recharging points will be required outside the homes of EV owners, particularly where vehicles cannot be charged at work. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**Some challenges or risks** Minimum density of public recharging points required for consumers no longer to see this as a barrier remains an area of uncertainty. Possible planning issues to be addressed relating to the sitting of recharging points.	**Some opposition likely** Some strong opposition likely in a small proportion of residential areas where residents are against on-street recharging points on aesthetic grounds. For example, there have been a number of campaigns against street clutter in recent years; and Transport for London have experienced strong opposition to the sitting of cycle hire stands in some parts of London.	**Medium cost** The CCC (2009) estimate that an extensive network of charging points might cost around £1.4bn at a UK level; or (very approximately) £112 million for Scotland.

[1] Numbers targeted by measure (based on rough estimate): Small = less than 100,000 people; Medium = 100,000 to 500,000 people; Large = 500,000 to 2 million people; Very large = more than 2 million people, i.e. all potential EV drivers (in other words, all drivers in Scotland). Note, there were 2.256 million people registered in Scotland in 2009.

Measure (see Chapter 3 for full description)	Private fleet	Company cars	Utility vehicles	Public fleet	Barriers addressed: Purchase cost	Range anxiety	Lack of infrastructure, etc	High significance barriers	Med. significance barriers	**Effectiveness in addressing barriers by 2020** (very effective, moderately effective, less effective) **and numbers targeted by measure** (very large, large, medium, small)[1]	**Potential for adverse impacts on wider policy areas** (low, medium, high) *Positive impacts or comments shown in italics.*	**Deliverability: challenges and risks (technical, legal, political support, etc.)** (no significant challenges or risks, some challenges or risks, very significant challenges and risks)	**Public and stakeholder acceptability** (unlikely to attract significant opposition, some opposition likely, strong opposition likely)	**Affordability** (low cost = less than £10 million; medium cost = £10-100 million; higher cost = more than £100 million) *Cost estimates are very broad approximations only.*
A5 – Scottish Government and local authorities incentivise businesses to install recharging points. This would involve engaging directly with the largest businesses with employee car-parks to highlight the benefits of encouraging use of EVs rather than conventional vehicles; by providing free advice; and by providing match funding to 'innovator' and 'early adopter' businesses wishing to install recharging points in existing parking spaces.....	✓	✓	✓	✓	-	✓	✓	-	-	**Very effective** – Infrastructure for recharging EVs is vital. Analysis by Element Energy (2009) shows that work-based recharging points will provide an important opportunity to recharge EVs, at a much lower cost than publically available recharging solutions. WWF Scotland (2010) estimate that 220,000 workplace recharging points are required in Scotland by 2020. **Numbers targeted by measure: Medium** (based on the above estimate of recharging points required – not all employees can park at work).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**Some challenges or risks** No experience of delivering this measure on a large scale – likely to be some obstacles to overcome.	**Unlikely to attract significant opposition** Contributes to businesses Corporate and Social Responsibility duty and other environmental responsibilities.	**Low cost** Initially three-pin plug sockets (level 2: 240 volts AC at 13 amps) are likely to account for the majority of workplace recharging points; but as the number of EVs increases, businesses may require more sophisticated infrastructure to enable recouping of electricity costs and more efficient recharging.
A6 – Scottish Government prepares advice for residents on home recharging and guidance for electricians on the type of facilities needed (including issues to be considered in communal parking areas). Local authorities to disseminate information.	✓	✓	×	×	-	✓	✓	-	-	**Very effective** – Infrastructure for recharging EVs is vital. Analysis by Element Energy (2009) shows that home-based recharging points will provide an important opportunity to recharge EVs, at a much lower cost than publically available recharging solutions. Lane (2011) notes that there is currently little or no home-recharging support for consumers contemplating owning an EV, and suggests that uptake could be more effectively promoted by supporting consumers wanting to recharge. Other research has identified a general lack of knowledge about how EVs work. **Numbers targeted by measure: Medium** (only 175,000 households in Aberdeen, Edinburgh and Glasgow have adequate off-street parking, WWF Scotland, 2010).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**Some challenges or risks** No experience of delivering this measure on a large scale – likely to be some obstacles to overcome.	**Unlikely to attract significant opposition**	**Low cost** Initially three-pin plug sockets (level 2: 240 volts AC at 13 amps) are likely to account for the majority of home-based (off-street) recharging points. These recharging points need to be fitted correctly. Manufacturers are likely to provide free or discounted recharging points fitting services for EV buyers.
A7 – Scottish Government provides national planning guidance on the provision of recharging bays and infrastructure in local authority areas as part of a parking strategy which supports wider sustainable transport objectives.	✓	✓	✓	✓	-	✓	✓	-	-	**Very effective** – Will help deliver a network of publically accessible recharging points, and provide guidance to local authorities. Supports options A1 and A4 above. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**No significant challenges or risks** Requires changes be made to planning guidance, e.g. *Scottish Planning Policy (SPP)* and associated documents by the Scottish Government.	**Unlikely to attract significant opposition**	**Low cost** Limited costs associated with updating the relevant documents.
A8 – Scottish Government updates Building Regulations to set out minimum requirements regarding the provision of electrical infrastructure and recharging points in new buildings.	✓	✓	✓	✓	-	✓	✓	-	-	**Very effective** – Will ensure recharging points are installed in all new residential, workplace and other public buildings. Future-proofs new development. **Numbers targeted by measure: Small** (but, depends on scale of new development undertaken).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**No significant challenges or risks** Requires changes be made to building regulations by Scottish Government.	**Unlikely to attract significant opposition**	**Low cost** Limited costs associated with updating the relevant documents.

Measure (see Chapter 3 for full description)	Private fleet	Company cars	Utility vehicles	Public fleet	Barriers addressed: Purchase cost	Range anxiety	Lack of infrastructure, etc	High significance barriers	Med. significance barriers	**Effectiveness in addressing barriers by 2020** (very effective, moderately effective, less effective) **and numbers targeted by measure** (very large, large, medium, small)[1]	**Potential for adverse impacts on wider policy areas** (low, medium, high) *Positive impacts or comments shown in italics.*	**Deliverability: challenges and risks (technical, legal, political support, etc.)** (no significant challenges or risks, some challenges or risks, very significant challenges and risks)	**Public and stakeholder acceptability** (unlikely to attract significant opposition, some opposition likely, strong opposition likely)	**Affordability** (low cost = less than £10 million; medium cost = £10-100 million; higher cost = more than £100 million) *Cost estimates are very broad approximations only.*
A9 – Scottish Government conducts a feasibility study into the potential to trial a network of battery swap stations.	✓	✓	✓	✓	✓	✓	✓	-	-	**Very effective** – Offers a quick and attractive means for recharging EVs, addresses consumer concerns relating to 'range anxiety', and reduces purchase cost because batteries are leased. Operators of the battery swap stations retain ownership of the battery, removing the high purchase cost barrier. Battery swap enables 100% of veh-kms to be undertaken by EV, if a comprehensive network of battery swap stations is available. **Numbers targeted by measure: Very large** (all potential EV drivers).	**High** **Adverse sustainable transport impacts** – business model encourages consumers to drive more to reduce subscription costs.	**Very significant challenges and risks** Requires manufacturers to standardise battery design to a limited number of models and to design EVs with easily accessible batteries - requires a great degree of co-ordination between car manufacturers, battery suppliers, and policymakers. A business model needs to be developed which is attractive to the private sector and does not encourage consumers to drive more. The necessity for swap stations could be challenged by improvements in fast charge technology, which might prove to be a comparable and cheaper approach in time.	**Some opposition likely** Likely to be a popular measure with the general public, due to the speed and convenience with which batteries can be recharged. However, there is likely to be opposition from incumbent providers (i.e. oil companies) who might be threatened by the new technology. Also likely to be strong opposition from environmental organisations and groups, due to lack of compatibility with wider policies to reduce the amount of travel undertaken by car.	**Higher cost** A 100 battery swap stations across Scotland, each storing 200 batteries at £10,000 each, would cost approx. £200 million. Land and development costs at up to million per site would increase overall cost to **£400 million**.
A10 – Scottish Government commissions research into the potential for introducing induction recharging (via electrified parking spaces and electrified roads) in Scotland.	✓	✓	✓	✓	-	✓	✓	-	-	**Moderately effective** – Charges EVs on the go, removing range anxiety issues and concerns about lack of recharging infrastructure. However, those involved in developing the technology don't expect to see it becoming a feasible option before 2020. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy. *Positive environmental benefits - Spreads demand for electricity across the day.*	**Very significant challenges and risks** Technology still at a very early stage. Has yet to be fully tested. Requires manufacturers to design EVs to be able to use this technology. Risk that large amounts of money will be invested in the 'wrong' option. (see above).	**Unlikely to attract significant opposition**	**Higher cost** The cost of getting recharging lanes to most of the UK population has been estimated at £60 billion[2] **(approx. £6 billion in Scotland)**.
A11 – Scottish Government develops an EV-specific qualification for garage mechanics and breakdown engineers (working for the AA, RAC, etc.); and a quality insurance scheme for garages servicing, undertaking MOTs, and repairing EVs (similar to the Good Garage Scheme, for example), to provide consumer confidence in the availability of appropriate support networks.	✓	✓	✓	✓	-	-	-	-	✓	**Less effective/may not be required** – Would provide consumer confidence in the availability of appropriate support networks (medium significance barrier). However, not a priority until a second-hand market for EVs develops. While new vehicles are under guarantee, they will be serviced and MOTed at the original manufacturer's outlet. Garages and training providers are likely to respond to consumer demand, without Government intervention. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**No significant challenges or risks** Requires joint working with higher and further education colleges, and other training and qualification bodies.	**Unlikely to attract significant opposition** The current garage trade has struggled to implement high standards and provide consistent training schemes for mechanics. Some form of compulsion for garages to join consumer-centred schemes and employ only fully qualified engineers and mechanics is likely to increase consumer satisfaction.	**Low cost** Small cost associated with setting up and rolling out qualification (could be designed to be self-financing).
A12 – A Working Group of relevant stakeholders from the energy and transport sectors, chaired by a Member of the Scottish Parliament, is tasked with addressing the electricity generation and distribution requirements for EVs.	✓	✓	✓	✓	-	-	✓	-	-	**Strong** – There is a narrow window of opportunity to ensure that the architecture of the smart grid takes proper account of the future needs of EVs (Royal Academy of Engineers, 2010). EV environmental performance relies on improved carbon intensity of energy mix. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**Some challenges or risks** Will require strong joint working across a range of organisations.	**Unlikely to attract significant opposition**	**Low cost** Limited costs associated with setting up and running a Working Group. However, subsequent actions likely to require strong investment in the power sector, although some of this will be funded through private sector investment.

[2] http://www.guardian.co.uk/environment/interactive/2010/oct/29/wireless-charging-electric-cars. Retrieved 9th March 2011.

B – Alternative ownership models

Measure (see Chapter 3 for full description)	Barriers addressed: Private fleet	Company cars	Utility vehicles	Public fleet	Purchase price	Range anxiety	Lack of infrastructure, etc	High significance barriers	Med. significance barriers	**Effectiveness in addressing barriers by 2020** (very effective, moderately effective, less effective) **and numbers targeted by measure** (very large, large, medium, small)	**Potential for adverse impacts on wider policy areas** (low, medium, high) *Positive impacts or comments shown in italics.*	**Deliverability: challenges and risks (technical, legal, political support, etc.)** (no significant challenges or risks, some challenges or risks, very significant challenges and risks)	**Public and stakeholder acceptability** (unlikely to attract significant opposition, some opposition likely, strong opposition likely)	**Affordability** (low cost = less than £10 million; medium cost = £10-100 million; higher cost = more than £100 million) *Cost estimates are very broad approximations only.*
B1 – Local authorities work with existing car club operators to introduce EVs into fleets and introduce EV-based car clubs in other cities……..	✓	×	×	✓	✓	✓	-	✓	-	**Less effective –** Removes the purchase cost barrier, and helps address other barriers relating to 'aversion to new technology', 'lack of knowledge about EVs', 'lack of recharging infrastructure', and 'range anxiety' (assuming that some ICEVs are available for longer trips). However, the number of car club vehicles is currently small and is likely to remain small in the context of the target of 300,000 EVs on Scotland's roads by 2020. Unlikely to be an effective measure on its own. **Numbers targeted by measure: Large** (all drivers living in urban areas).	**Low** **Adverse distributional impacts** - targets urban population only. *Positive sustainable transport impacts - consistent with wider transport policy objectives.* *Positive social inclusion impacts – makes EVs accessible to all.*	**No significant challenges or risks**	**Unlikely to attract significant opposition**	**Low cost** There are currently about 200 car club vehicles in Scotland. A significant subsidy of £10,000 per vehicle, to encourage conversion to EVs over a three year period would cost £2 million.
B2 – Encourage manufacturers to offer alternative ownership models to consumers in Scotland (battery-leasing, vehicle-leasing, pay-as-you-go contracts, etc) by promoting Scotland as an attractive market for manufacturers, and engaging with manufacturers to understand and influence their decisions about where to focus their sales strategy. Scottish Government or other public sector bodies work with manufacturers to 'trial' alternative ownership models amongst employees or as part of the vehicle procurement process, and publicise benefits.	✓	✓	✓	✓	✓	-	-	✓	-	**Very effective** Encourages manufacturers to develop ownership models which limit financial risks to consumers. Can reduce purchase cost of new EV, and other barriers relating to 'aversion to new technology', 'uncertainty about future resale values', and 'limited range of EVs' (some ownership models allow users to rent a conventional ICEV for longer trips). **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**No significant challenges or risks** However, the Scottish Government has limited scope to influence the decisions of manufacturers, and will need to compete with other parts of the world.	**Unlikely to attract significant opposition**	**Low cost** Assumed that manufactures will take a lead on this.

C - Fiscal measures and subsidies – vehicle purchase incentives

Measure (see Chapter 3 for full description)	Barriers addressed: Private fleet	Company cars	Utility vehicles	Public fleet	Purchase price	Range anxiety	Lack of infrastructure, etc	High significance barriers	Med. significance barriers	**Effectiveness in addressing barriers by 2020** (very effective, moderately effective, less effective) **and numbers targeted by measure** (very large, large, medium, small)	**Potential for adverse impacts on wider policy areas** *Positive impacts or comments shown in italics.*	**Deliverability: challenges and risks (technical, legal, political support, etc.)** (no significant challenges or risks, some challenges or risks, very significant challenges and risks)	**Public and stakeholder acceptability** (unlikely to attract significant opposition, some opposition likely, strong opposition likely)	**Affordability** (low cost = less than £10 million; medium cost = £10-100 million; higher cost = more than £100 million) *Cost estimates are very broad approximations only.*
C1a – Scottish Government provides a £10,000 subsidy for the first 25,000 EVs in Scotland (as recommended by the UK CCC), to 'kickstart' early uptake of EVs. Examine feasibility of restricting subsidy to those purchasing a first vehicle or selling a conventional vehicle (rather than purchasing an additional vehicle).	✓	×	✓	×	✓	-	-	✓	-	**Very effective – Significantly reduces upfront purchase cost of a new EV.** Also reduces 'aversion to new technology' (lower cost reduces one element of risk). **Numbers targeted by measure: Medium** – influences decisions of all those purchasing a new vehicle; approx. 200,000 per year in Scotland (Table 1.1 in Scottish Government, 2010).	**Moderate** Minimal **adverse social inclusion impacts**, if implemented as part of a wider sustainable transport strategy – but benefit still only accessible to those who can afford the higher purchase cost of an EV. *May encourage purchase of second or third vehicles, unless restrictions placed on applications.*	**No significant challenges or risks** Consistent with Scottish Government's spending powers.	**Unlikely to attract significant opposition** Likely to be a popular measure.	**Higher cost** Approximately **£250 million**: [£0 * 800 EVs (assuming £5,000 also comes from the UK Plug-In Grant)] + [£10,000 * 24,200 EVs] = £246 million.
C1b – Scottish Government provides subsidies up until 2020 (or until 290,000 target reached), of at least £5,000 in the initial years with level of subsidy reducing as EV uptake increases. Examine feasibility of restricting subsidy to those purchasing a first vehicle or selling a conventional vehicle (rather than purchasing an additional vehicle).	✓	×	✓	×	✓	-	-	✓	-	**Very effective – Reduces upfront purchase cost of a new EV until 300,000 target has been reached.** Also reduces 'aversion to new technology' (see above). **Numbers targeted by measure: Medium** – influences decisions of all those purchasing a new vehicle; approx. 200,000 per year in Scotland (Table 1.1 in Scottish Government, 2010).	**Moderate** Minimal **adverse social inclusion impacts**, if implemented as part of a wider sustainable transport strategy – but benefit still only accessible to those who can afford the higher purchase cost of an EV. *May encourage purchase of second or third vehicles, unless restrictions placed on applications.*	**No significant challenges or risks** Consistent with Scottish Government's spending powers.	**Unlikely to attract significant opposition** Likely to be a popular measure.	**Higher cost** Approx. **£0.98 billion** over the period to 2020 (or **£123 million p.a.**): E.g. (24,200 EVs * £5,000) + (25,000 EVs * £4,700) + (25,000 EVs * £4,400) + (25,000 EVs * £4,100) + (25,000 EVs * £3,800) + (25,000 EVs * £3,500) + (25,000 EVs * £3,200) + (25,000 EVs * £2,900) + (25,000 EVs * £2,600) + (25,000 EVs * £2,300) + (25,000 EVs * £2,000) + (15,000 EVs * £1,700). Cost would vary according to the rate of subsidy reduction applied.
C2 – Scottish Government introduces a scrappage scheme to encourage consumers to purchase EVs, with subsidies reducing as EV uptake increases.	✓	×	✓	×	✓	-	-	✓	-	**Very effective – Reduces the cost of purchasing a new EV by allowing some of the purchase cost to be offset**. Also reduces 'aversion to new technology' (see above). UK Scrappage Scheme' in 2009/10 resulted in 372,000 vehicles being scrapped; and new car sales increased by 26%. Not applicable to corporate and public sector fleets which tend not to include older vehicles. **Numbers targeted by measure: Medium** – influences decisions of all those purchasing a new vehicle; approx. 200,000 per year in Scotland (Table 1.1 in Scottish Government, 2010).	**Low** Minimal **adverse social inclusion impacts**, if implemented as part of a wider sustainable transport strategy – but benefit still only accessible to those who can afford the higher purchase cost of an EV. *Positive sustainable transport impacts – encourages vehicle replacement rather than purchase of an additional vehicle.*	**No significant challenges or risks** Consistent with Scottish Government's spending powers.	**Unlikely to attract significant opposition** Likely to be a popular measure.	**Medium cost** The cost of providing a subsidy of £5,000 to scrap 15,000 vehicles p.a. in the initial years would cost **£75 million p.a.** (assuming this policy supports 50% of EVs purchased, and assuming a linear progression towards the 2020 target).
C3 – Scottish Government provides grants for purchasing second hand EVs from specified dealers, with subsidies reducing as EV uptake increases.	✓	×	✓	×	✓	-	-	✓	-	**Very effective – Reduces the cost of purchasing a second-hand EV by allowing some of the purchase cost to be offset**. Also provides confidence to consumers that they will be able to sell their car in the future, and reduces the risks involved in purchasing new technology. Second-hand sales will be important in terms of achieving 'mass market' uptake in the medium term, but EVs will need to be purchased from outside Scotland if Scottish target is to be met. Not applicable to public and corporate fleets, which tend not to purchase second hand vehicles. **Numbers targeted by measure: Large** – Influences decisions of all those purchasing a second-hand vehicle; approx. 600,000 per year in Scotland (approximately a three-quarter of cars bought in the UK in 2009 were 'used').	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy – makes (second-hand) EVs affordable for most consumers.	**No significant challenges or risks** Consistent with Scottish Government's spending powers.	**Unlikely to attract significant opposition** Likely to be a popular measure.	**Medium cost** Likely to be significantly cheaper than providing subsidies for purchasing new EVs. For example, the provision of a £2,500 subsidy for the purchase of 15,000 EVs p.a. would cost approx. **£37.5 million p.a**. (assuming this policy supports 50% of EVs purchased, and assuming a linear progression towards the 2020 target).

Measure (see Chapter 3 for full description)	Private fleet	Company cars	Utility vehicles	Public fleet	Barriers addressed: Purchase price	Range anxiety	Lack of infrastructure, etc	High significance barriers	Med. significance barriers	**Effectiveness in addressing barriers by 2020** (very effective, moderately effective, less effective) **and numbers targeted by measure** (very large, large, medium, small)	**Potential for adverse impacts on wider policy areas** *Positive impacts or comments shown in italics.*	**Deliverability: challenges and risks (technical, legal, political support, etc.)** (no significant challenges or risks, some challenges or risks, very significant challenges and risks)	**Public and stakeholder acceptability** (unlikely to attract significant opposition, some opposition likely, strong opposition likely)	**Affordability** (low cost = less than £10 million; medium cost = £10-100 million; higher cost = more than £100 million) *Cost estimates are very broad approximations only.*
C4 – Scottish Government lobbies the UK Government to increase the tax levied on the purchase of new vehicles ('first year rates'), scaled on the basis of CO_2 emissions.	✓	✓	✓	×	(✓)	-	-	-	-	**Moderately effective** – Increases the cost of purchasing an ICEV and reduces the price premium for EVs, but **does not actually reduce the cost of purchasing an EV**. In the longer term, also reduces the cost differential between EVs and ICEVs in the second-hand market. **Numbers targeted by measure: Medium** – influences decisions of all those purchasing a new vehicle; approx. 200,000 per year in Scotland (Table 1.1 in Scottish Government, 2010).	**Moderate** Minimal **adverse social inclusion impacts**, if implemented as part of a wider sustainable transport strategy – but benefit still only accessible to those who can afford the higher purchase cost of an EV. Possible **adverse economic impact** – consumers may choose to purchase new EVs from England.	**Very significant challenges and risks** Scottish Government does not currently have powers to increase 'first year rates'; although the Scotland Bill (currently being debated by Parliament) includes powers for the Scottish Parliament to add new devolved taxes (Section 80B) and might provide a possible mechanism.	**Some opposition likely** Likely to be very unpopular with the public, especially if applied in addition to current VAT - represents a significant cost increase for new ICEV purchase. However, a recent public attitude survey (DfT, 2011) showed that 55% of respondents supported higher taxes to stop people buying cars with higher CO_2 emissions and 26% were opposed.	**Low cost** New source of revenue for the Scottish Government.
C5 – Scottish Government works with the UK Government to design a feebate scheme for the UK which involves increasing the tax levied on the purchase of relatively high-emitting vehicles and providing rebates for lower-emitting vehicles. Subject to the findings the Scottish Government lobbies the UK Government to introduce a UK-wide feebate scheme.	✓	✓	✓	×	✓	-	-	✓	-	**Very effective** – The introduction of a new car registration tax for Scotland, in the form of a feebate scheme, would address the limitations of C4, and **would reduce the cost of purchasing an EV by allowing some of the purchase cost to be offset, and would reduce the purchase price differential between EVs and ICEVs.** Lane (2011) suggests that there is strong evidence pointing to the success of feebates in encouraging EV uptake in other EU countries. **Numbers targeted by measure: Medium** – influences decisions of all those purchasing a new vehicle; approx. 200,000 per year in Scotland (Table 1.1 in Scottish Government, 2010).	**Moderate** **Adverse social inclusion impacts** - increases cost of driving a new (and second hand) ICEV, for those who cannot afford the purchase price of an EV.	**Very significant challenges and risks** Scottish Government does not currently have powers to increase 'first year rates'; although the Scotland Bill (currently being debated by Parliament) includes powers for the Scottish Parliament to add new devolved taxes (Section 80B) and might provide a possible mechanism.	**Some opposition likely** Peters et al. (2008) note that feebates yield acceptance rates equal to those for purely informational measures – rates which are already known to be high. Lyons et al. (2004) observe that the public generally prefer revenue-neutral policies to revenue-generating systems of taxation. However, likely to be some opposition from manufacturers and potential buyers of high emitting vehicles.	**Low cost** Revenue neutral incentive (designed to be self-financing).
C6 - Scottish Government lobbies the UK Government to introduce tax credits for purchasers of new EVs, which reduce as EV uptake increases.	✓	✓	✓	×	✓	-	-	✓	-	**Very effective – Reduces the cost of purchasing a new EV by allowing some of the purchase cost to be offset**. Also reduces 'aversion to new technology' (see above). Time delay in receiving credit can reduce effectiveness of this type of approach. In addition, tax credits are less tangible than cash payments or initial reduction in purchase price. **Numbers targeted by measure: Medium** – influences decisions of all those purchasing a new vehicle; approx. 200,000 per year in Scotland (Table 1.1 in Scottish Government, 2010).	**Moderate** Minimal **adverse social inclusion impacts**, if implemented as part of a wider sustainable transport strategy – but benefit still only accessible to those who can afford the higher purchase cost of an EV.	**Some challenges and risks** The Scotland Bill (currently being debated by Parliament) includes powers for the Scottish Parliament to add new devolved taxes (Section 80B).	**Unlikely to attract significant opposition** Likely to be a popular measure.	**Medium cost** Initially, a rebate of £2,500 awarded to 25,000 purchasers p.a. would cost approx. **£62.5 million p.a.** (assuming this policy supports 50% of EVs purchased, and assuming a linear progression towards the 2020 target).
C7 – Scottish Government lobbies the UK Government to provide additional Enhanced Capital Allowance tax exemptions for businesses. This measure would extend the existing scheme for low carbon cars until 2020, and widen it to include a larger range of vehicles (including electric vans) and recharging infrastructure.	×	✓	×	×	✓	-	-	✓	-	**Moderately effective – Reduces the cost of purchasing a new EV by allowing some of the purchase cost to be offset**. Also reduces 'aversion to new technology' (see above). But… …electric cars already receive up to 100% allowance in the accounting period when they were bought (although this due to expire in 2013). Unclear what impact this has had to date, put potential to provide an effective incentive as a wider range of vehicles become available. Businesses more cost sensitive than private consumers. **Numbers targeted by measure: Small** – About 40,000 (there were 174,000 company cars registered in Scotland in 2009 – only about a quarter are likely to be replaced each year).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy - targets businesses only.	**Very significant challenges and risks** The Scottish Government do not currently have devolved powers to define Enhanced Capital Allowances.	**Unlikely to attract significant opposition** Likely to be a popular measure.	**Medium cost**

D - Fiscal measures and pricing policies – running cost incentives

Measure (see Chapter 3 for full description)	Barriers addressed: Private fleet	Company cars	Utility vehicles	Public fleet	Purchase price	Range anxiety	Lack of infrastructure, etc	High significance barriers	Med. significance barriers	**Effectiveness in addressing barriers by 2020** (very effective, moderately effective, less effective) **and numbers targeted by measure** (very large, large, medium, small)	**Potential for adverse impacts on wider policy areas** *Positive impacts or comments shown in italics.*	**Deliverability: challenges and risks (technical, legal, political support, etc.)** (no significant challenges or risks, some challenges or risks, very significant challenges and risks)	**Public and stakeholder acceptability** (unlikely to attract significant opposition, some opposition likely, strong opposition likely)	**Affordability** (low cost = less than £10 million; medium cost = £10-100 million; higher cost = more than £100 million) *Cost estimates are very broad approximations only.*
D1 – Local authorities introduce road pricing schemes (e.g. congestion charging, low emission zones, or road tolling) in urban centres, offering free or discounted access for EVs	✓	✓	✓	✓	(✓)	-	-	✓	-	**Moderately effective - Indirect impact on high purchase cost (incentivises EV rather than ICEV purchase).** Also reduces 'aversion to new technology' (lower operating costs reduce one element of risk). The 100% Alternative Fuel Discount for EVs in the London Congestion Charge zone has been a significant driver of the purchase of lower emission vehicles, including EVs, in the area (AEA Energy and Environment, 2007). **Numbers targeted by measure: Large** – All potential EV drivers in urban areas.	**Moderate** **Adverse social inclusion impacts** - increases cost of driving an ICEV, for those who cannot afford the purchase price of an EV. *Positive sustainable transport impacts - consistent with wider demand management transport policy objectives, including congestion and local air quality.*	**Some challenges and risks** The Transport (Scotland) Act 2001 made Scottish road pricing schemes possible, providing revenue generated is spent on transport projects. Strong political leadership required to implement scheme backed by a strong national policy.	**Strong opposition likely** Residents in Edinburgh voted against the introduction of congestion charging in the city by a margin of three to one in 2005. Similar levels of opposition likely elsewhere.	**Medium cost** Cost of Edinburgh congestion charging scheme estimated at between £8 and 11 million, plus administration costs; but expected to generate approx. £1 billion over 20 years.
D2 – Local authorities introduce workplace parking levies in urban centres, with exemptions for EV spaces.	✓	✓	✓	✓	(✓)	✓	-	✓	-	**Moderately effective - Indirect impact on high purchase cost (incentivises EV rather than ICEV purchase). Addresses lack of recharging infrastructure if existing spaces are converted to EV recharging bays.** Also reduces 'aversion to new technology' (lower operating costs reduce one element of risk). Provides employees with a strong incentive to switch to an EV. **Numbers targeted by measure: Medium** (very rough estimate – not all employees can park at work).	**Moderate** **Adverse social inclusion impacts** - increases cost of driving an ICEV, for those who cannot afford the purchase price of an EV. *Positive sustainable transport impacts - consistent with wider demand management transport policy objectives, including congestion and local air quality.*	**Some challenges and risks** New primary legislation required to give local authorities the necessary powers to introduce a WPL scheme. Strong political leadership required to implement scheme backed by a strong national policy, but development costs and timescales likely to be less than for road pricing schemes. No WPL schemes are currently in place in the UK, although the Nottingham scheme is due to commence from April 2012.	**Strong opposition likely** Strong opposition likely, particularly from business community.	**Low cost**
D3 - Local authorities introduce on-street parking charge policies which offer free or heavily discounted parking for EVs.	✓	✓	✓	✓	(✓)	✓	-	✓	-	**Moderately effective - Indirect impact on high purchase cost (incentivises EV rather than ICEV purchase). Addresses lack of recharging infrastructure if existing spaces are converted to EV recharging bays.** Also reduces 'aversion to new technology' (lower operating costs reduce one element of risk). Limited evidence from elsewhere to determine impact on EV uptake (London Borough of Richmond upon Thames scheme discontinued in January 2011), but free parking likely to be an attractive incentive if parking is generally limited and expensive. **Numbers targeted by measure: Medium** – Approx. 350,000 households in Aberdeen, Glasgow and Edinburgh do not have adequate off-street parking.	**Moderate** **Adverse social inclusion impacts** - increases cost of driving an ICEV, for those who cannot afford the purchase price of an EV, and those living in houses or flats without off-street parking. Has no impact on residents in larger houses with off-street parking. *Positive sustainable transport impacts - consistent with wider demand management transport policy objectives, including congestion and local air quality.*	**No significant challenges or risks.**	**Some opposition likely** Some strong opposition likely in specific locations, but in general, unlikely to attract same level of opposition as other measures and may be welcomed where parking availability is limited. Edinburgh proposed scheme consultation showed 73% of respondents in favour overall, and 68% of parking permit holders in favour	**Low cost** Could potentially be designed to be self-financing. A scheme has already been agreed for Edinburgh, estimated to cost the Council approximately £50,000 per annum
D4 – Scottish Government lobbies the UK Government to increase the price differentials between adjacent bands for vehicle excise duty to increase the financial benefit of EV ownership.	✓	✓	✓	×	(✓)	-	-	✓	-	**Less effective - Indirect impact on high purchase cost (incentivises EV rather than ICEV purchase).** Also reduces 'aversion to new technology' (lower operating costs reduce one element of risk). Evidence that **private consumers** tend to heavily discount future running costs when deciding which car to purchase (Arup and Cenex, 2008). Evidence that VED is not a sufficiently strong price signal to incentivise purchase of lower CO_2 cars (Anable et al., 2008). Public attitude survey (DfT, 2011) shows that road tax is least important cost when buying a car. However, expected to have an impact if differential between bands is big enough. Some government-owned fleet vehicles are exempt from paying VED. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Moderate** **Adverse social inclusion impacts** - increases cost of driving an ICEV, for those who cannot afford the purchase price of an EV.	**Significant challenges and risks.** The Scottish Government does not currently have devolved powers to set VED, and the Commission on Scottish Devolution (2009) concluded that VED is not a strong candidate for devolution, although it might be a suitable candidate for assignment.	**Strong opposition likely** Public attitude survey (DfT, 2011) showed that 55% of respondents supported higher taxes to stop people buying cars with higher CO_2 emissions and 26% were opposed. However, a significant increase in VED is likely to be **very unpopular**.	**Higher cost** Revenue generating for the Scottish Government in the short-term, but likely to result in a significant loss of revenue in the longer-term as EV take-up increases (although could potentially be designed to be self-financing). Other forms of taxation may be required to compensate.

D5 – Scottish Government lobbies the UK Government to increase fuel duty.	✓	✓	✓	✓	(✓)	-	-	✓	-	**Moderately effective - Indirect impact on high purchase cost (incentivises EV rather than ICEV purchase).** Also reduces 'aversion to new technology' (lower operating costs reduce one element of risk). Evidence that **private consumers** tend to heavily discount future running costs when deciding which car to purchase (Arup and Cenex, 2008); however evidence from the US and UK that increases in fuel prices result in a preference for fuel-efficient vehicles (Lane, 2011). Public attitude survey (DfT, 2011) shows that fuel cost are the most important cost when buying a car, after purchase cost. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Moderate** **Adverse social inclusion impacts** - increases cost of driving an ICEV, for those who cannot afford the purchase price of an EV. *Positive sustainable transport impacts - discourages ICEV users to reduce annual mileage.*	**Significant challenges and risks.** The Scottish Government does not currently have devolved powers to set fuel duty, and the Commission on Scottish Devolution (2009) concluded that fuel duty is not a suitable candidate for devolution.	**Strong opposition likely** Public attitude survey (DfT, 2011) showed that 55% of respondents supported higher taxes to stop people buying cars with higher CO_2 emissions and 26% were opposed. However, a significant increase in fuel duty is likely to be **very unpopular**. Previous increases in fuel duty have lead to high profile protests.	**Higher cost** Revenue generating for the Scottish Government in the short-term, but likely to result in a significant loss of revenue in the longer-term as EV take-up increases (although could potentially be designed to be self-financing). Other forms of taxation may be required to compensate.
D6 – Scottish Government lobbies the UK Government to provide further company car tax benefits. An extension to the current exemption could be considered as well as higher tax rates for more polluting vehicles.	×	✓	×	×	(✓)	-	-	✓	-	**Less effective (current exemptions are already extensive) - Indirect impact on high purchase cost (incentivises EV rather than ICEV purchase).** Also reduces 'aversion to new technology' (lower operating costs reduce one element of risk). Businesses are more likely to consider whole life costs than private consumers. Historically data shows that, until the fuel price peaks in 2008, the company car tax system was the main incentive driving the reduction of new conventional car CO2 emissions. However, electric cars already receive a five year exemption from company car tax and electric vans a five year exemption from van benefit charge (2010 to 2015 period). **Numbers targeted by measure: Medium** – There were 174,000 company cars registered in Scotland in 2009.	**Moderate** Minimal **adverse social inclusion impacts**, if implemented as part of a wider sustainable transport strategy – but benefit only available to those with a company car (generally more affluent individuals).	**Significant challenges and risks.** The Scottish Government do not currently have devolved powers to set company car tax.	**Unlikely to attract significant opposition.** Likely to be a popular measure.	**Medium cost** Loss of revenue to Scottish Government as EV take-up increases (although could potentially be designed to be self-financing). Other forms of taxation may be required to compensate.

E – Awareness, information and training measures

Measure (see Chapter 3 for full description)	Barriers addressed: Private fleet	Company cars	Utility vehicles	Public fleet	Purchase cost	Range anxiety	Lack of infrastructure, etc	High significance barriers	Med. significance barriers	**Effectiveness in addressing barriers by 2020** (very effective, moderately effective, less effective) **and numbers targeted by measure** (very large, large, medium, small)	**Potential for adverse impacts on wider policy areas** *Positive impacts or comments shown in italics.*	**Deliverability: challenges and risks (technical, legal, political support, etc.)** (no significant challenges or risks, some challenges or risks, very significant challenges and risks)	**Public and stakeholder acceptability** (unlikely to attract significant opposition, some opposition likely, strong opposition likely)	**Affordability** (low cost = less than £10 million; medium cost = £10-100 million; higher cost = more than £100 million) *Cost estimates are very broad approximations only.*
E1 – Scottish Government supports a high profile EV demonstration project, to raise awareness and knowledge about EVs, focusing on locations with a high concentration of early adopters to stimulate adoption nationwide.	✓	✓	✓	✓	-	-	-	✓	-	**Less effective / Unlikely to be an effective measure on its own** Doesn't address 'very high significance barriers', but does address 'lack of awareness and knowledge about EVs', 'aversion to new technology' and 'weak image association'. Also increases visibility of EVs on the roads. Evidence that the experience of driving an EV is important in improving attitudes towards EVs (Lane 2011; Cenex, 2010). However, most demonstration projects involve a relatively small number of vehicles (less than 100), and the impact on EV uptake is likely to be limited in terms of scale. **Numbers targeted by measure: Small** – Actual numbers able to take part in demonstration project will be limited.	**Low** **Adverse distributional impacts** – likely to benefit those in specific locations only.	**No significant challenges or risks** Requires partnership with an EV manufacturer and other suppliers (recharging points, etc)	**Unlikely to attract significant opposition.**	**Low cost** Cost likely to be low if manufacturer provides vehicles Scotland Plugged-in-Places project estimated total cost: £3m Greater Manchester Plugged-in-Places project estimated total cost: £9m
E2 – Scottish Government and local authorities provide opportunities for consumers to test drive EVs, using existing networks or through a national network of test-drive centres. This could involve encouraging newly qualified drivers to consider purchasing an EV, encouraging car clubs to offer EV test drives, and taking test vehicles to large employers and large public venues (e.g. shopping centres, motor and air shows, etc).	✓	✓	✓	✓	-	-	-	✓	-	**Moderately effective, but, unlikely to be an effective measure on its own.** Doesn't address 'very high significance barriers', but does address lack of awareness and knowledge about EVs', 'aversion to new technology' and 'weak image association'. Also increases visibility of EVs on the roads. Evidence that the experience of driving an EV is important in improving attitudes towards EVs (Lane 2011; Cenex, 2010). However, scale of impact expected to be limited. In 2009/10, there were 55,000 newly qualified drivers in Scotland[3]. A 10% EV uptake would results in an additional 5,000 EV on the road (one-sixth of the average annual EV target). Taking test vehicles to larger employers and large public venues could increase the number of consumers able to test drive an EV. **Numbers targeted by measure: Large** – All those purchasing a new or second-hand vehicle; approx. 800,000 per year in Scotland.	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy. Nationwide scheme so no distributional impacts.	**Some challenges and risks** Requires EVs to be available for this purpose within existing car clubs in Edinburgh and Glasgow. A strong partnership with an EV manufacturer would aid delivery.	**Unlikely to attract significant opposition.** Likely to be a popular measure.	**Low cost** Cost estimated to be at least £5 million, if Government purchased 100 EVs (£25,000*100 = £2.5 million) and employed 100 people to market and run the scheme for a year (£25,000*100 = £2.5 million).
E3 – Scottish Government develops a website which includes all the information the public needs to know about EVs, including how and where to charge them. The website could refer users to the Energy Saving Scotland Advice Centres for more information . Local authorities also disseminate information.	✓	✓	✓	✓	-	-	-	✓	✓	**Moderately effective, but, unlikely to be an effective measure on its own.** Doesn't address 'very high significance barriers', but does address lack of awareness and knowledge about EVs', 'aversion to new technology', 'weak image association', and could help to address 'limited value placed on environmental benefits by consumers. No official UK website which focuses specifically on EVs. Potential consumers need to be informed that EVs are a viable option when considering purchasing a vehicle. Evidence that the provision of relevant information, provided by a recognised authority, enables consumers to engage with policies and informs them of opportunities to act (Lane, 2011); however, information provision needs to be accompanied by other measures implemented in parallel, including the development of required infrastructure, effective incentives and disincentives, and a level of user-acceptance of the policy measure in question (Anable et. al., 2006). **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**No significant challenges or risks**	**Unlikely to attract significant opposition.**	**Low cost** Web-design costs are low in comparison to other interventions considered.

[3] RSIS Report 8A – Tests Conducted by Test Centre (Car practical driving test pass and fail statistics for Scotland, Driving Standards Agency website). (http://www.dft.gov.uk/dsa/category.asp?cat=760)

Measure (see Chapter 3 for full description)	Barriers addressed: Private fleet	Company cars	Utility vehicles	Public fleet	Purchase cost	Range anxiety	Lack of infrastructure, etc	High significance barriers	Med. significance barriers	**Effectiveness in addressing barriers by 2020** (very effective, moderately effective, less effective) **and numbers targeted by measure** (very large, large, medium, small)	**Potential for adverse impacts on wider policy areas** *Positive impacts or comments shown in italics.*	**Deliverability: challenges and risks (technical, legal, political support, etc.)** (no significant challenges or risks, some challenges or risks, very significant challenges and risks)	**Public and stakeholder acceptability** (unlikely to attract significant opposition, some opposition likely, strong opposition likely)	**Affordability** (low cost = less than £10 million; medium cost = £10-100 million; higher cost = more than £100 million) *Cost estimates are very broad approximations only.*
E4 – Scottish Government part-funds a high profile publicity campaign, involving the principle EV manufacturers. Local authorities undertake local promotion campaigns.	✓	✓	✓	✓	-	-	-	✓	✓	**Less effective / Unlikely to be an effective measure on its own** – Doesn't address 'very high significance barriers', but does address lack of awareness and knowledge about EVs', 'aversion to new technology', 'weak image association', and could help to address 'limited value placed on environmental benefits by consumers. Evidence that the provision of relevant information, provided by a recognised authority, enables consumers to engage with policies and informs them of opportunities to act (Lane, 2011); however, information provision needs to be accompanied by other measures implemented in parallel, including the development of required infrastructure, effective incentives and disincentives, and a level of user-acceptance of the policy measure in question (Anable et. al., 2006). **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**No significant challenges or risks**	**Unlikely to attract significant opposition.**	**Low cost** Marketing campaign costs are low in comparison to other interventions considered. Recent health campaigns (cancer awareness) cost approx. £10m for the UK[4]. Cost of road safety campaigns in Northern Ireland: approx. £1.5 million a year[5].
E5 – Scottish Government and local authorities encourage potential EV drivers to undertake eco-driver training. This could involve offering free-training to newly qualified drivers and those considering purchasing an EV.	✓	✓	✓	✓	-	✓	-	✓	-	**Less effective / Unlikely to be an effective measure on its own** Eco-driving can significantly increase the range of EVs; by 47% in a city driving context, and by 90% in a higher speed context (Cenex and Millbrook). Addresses consumer concerns relating to 'range anxiety' (identified as one of the main barriers for consumers). However, in the short term, eco-driving training may negate the need or demand for EVs by increasing the fuel efficiency of ICEVs. **Numbers targeted by measure: Small** (55,000 newly qualified drivers in Scotland in 2009).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy. *Contributes to wider transport policies relating to road safety and CO_2 emissions, but could also reduce environmental incentive for switching to an EV.*	**Some challenges and risks** Uptake of courses likely to be low if offered on a voluntary basis. The benefits of eco-driving for EV owners are not obvious when compared to providing eco-driving training to ICEV owners. Measures to get the message across to potential consumers would need to be put in place. A strategy for the provision of eco-driving training would need to be developed, to ensure that there is sufficient capacity to meet demand for training.	**Unlikely to attract significant opposition** (unless mandatory).	**Medium cost** Cost estimated at approx. £13.75 million, based on providing free training (£250 per person) to 55,000 newly qualified drivers p.a.

[4] http://www.dh.gov.uk/en/MediaCentre/Pressreleases/DH_123898 Retrieved 7th March 2011.
[5] http://www.roadsafetyni.gov.uk/index/publicity/publicityfaqs.htm#Publicity_FAQs-Q5 Retrieved 7th March 2011.

F – Government leadership measures

Measure (see Chapter 3 for full description)	Barriers addressed: Private fleet	Company cars	Utility vehicles	Public fleet	Purchase cost	Range anxiety	Lack of infrastructure, etc	High significance barriers	Med. significance barriers	**Effectiveness in addressing barriers by 2020** (very effective, moderately effective, less effective) **and numbers targeted by measure** (very large, large, medium, small)	**Integration with wider policy areas** *Positive impacts or comments shown in italics.*	**Deliverability: challenges and risks (technical, legal, political support, etc.)** (no significant challenges or risks, some challenges or risks, very significant challenges and risks)	**Public and stakeholder acceptability** (unlikely to attract significant opposition, some opposition likely, strong opposition likely)	**Affordability** (low cost = less than £10 million; medium cost = £10-100 million; higher cost = more than £100 million) *Cost estimates are very broad approximations only.*
F1 – The Scottish Government, local authorities and other public sector organisations support an earlier than average switch to low carbon emissions vehicles for public sector fleet vehicles (cars and vans) through procurement policies, etc. …….	×	×	×	✓	✓	-	-	✓	-	**Moderately effective. Unlikely to be an effective measure on its own, but important in terms of public sector demonstrating leadership and support for EVs.** Addressed 'high purchase cost' barrier. Also addresses 'lack of public awareness and knowledge' (increases awareness and visibility) and 'limited supply of EVs' (provides a strong signal to manufacturers). Already £4.3 million dedicated to the Low Carbon Vehicle Procurement Support Scheme by the Scottish Government in June 2010. **Numbers targeted by measure: Small** - The size of the public sector fleet in Scotland is estimated at approx. 2,000 cars and 15,000 light goods vehicles.	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy - targets public sector only.	**Some challenges and risks** Will require strong joint working across a range of public sector organisations, with some organisations potentially opposing a change of fleet (due to costs, range anxiety, etc)	**Unlikely to attract significant opposition.**	**Medium cost** Cost to Government estimated to be approx. £**75 million**, to support conversion of 50% of the public sector fleet, based on financial support of £5,000 for cars and £10,000 for light good vehicles.
F2 – Scottish Government supports and funds research needed to enable rapid EV uptake.	✓	✓	✓	✓	-	✓	-	✓	✓	**Moderately effective. Unlikely to be an effective measure on its own.** Lane (2011) identifies the importance of research in developing the EV market (including development of a wider range of vehicles: vans, heavy goods vehicles, buses). This includes research into driver behaviour as well as technology development (batteries). Already some public funds allocated to research in these areas at UK (Low Carbon Vehicle Partnership, Office for Low Emission Vehicles), EU and international level and significant private sector investment. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**Some challenges and risks** Will require strong joint working across a range of public and private sector organisations and might be better undertaken at a UK or EU level	**Unlikely to attract significant opposition.**	**Medium cost** Some financial support from Government required but can also be matched by private sector investment.
F3 – The Scottish Government provides funding to small firms which specialise in converting specific vehicles to electric platforms, e.g. taxis, minibuses and larger family cars (as part of a wider demonstration project).	✓	✓	✓	✓	-	-	-	✓	✓	**Less effective. Unlikely to be an effective measure on its own.** Applies to specific fleets only and to a small amount of vehicles but likely to act as demonstrator for technology and address barriers for specific fleets (including taxis, vans, heavy goods vehicles, buses, etc). **Numbers targeted by measure: Small.**	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**No significant challenges and risks** **S**imilar to other business support mechanisms currently in place although legal issues to be considered (competition law).	**Unlikely to attract significant opposition.**	**Medium cost** Some financial support from Government required but could also be matched by private sector investment and would potentially result in job creation in Scotland.
F4 – Scottish Government publishes a high profile EV Strategy and Action Plan for Scotland, setting out a clear vision supported by targets or milestones.	✓	✓	✓	✓	-	-	-	✓	✓	**Moderately effective. Unlikely to be an effective measure on its own, but essential in terms of providing a clear framework for Government action.** Should address 'limited supply of EVs' (will promote Scotland as an attractive sale s market for EV manufacturers) and reassure potential consumers that purchasing an EV is a practical and sensible option. Manufacturers have huge resources at their disposal, and it is likely that they will be able to find solutions to address demand-related barriers (relating to range, public knowledge about EVs, and image concerns) and supply related barriers (relating to performance and choice of vehicles, routes to market, standardisation and interoperability), provided they have enough certainty that this is where the future market lies. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**Some challenges and risks** Significant challenges involved in specifying a strategy for the development of a publicly accessible network, due to the number and range of interests involved.	**Unlikely to attract significant opposition.**	**Low cost** Cost of preparing a strategy document expected to be low compared with other interventions considered here, if the cost of measures set out within the strategy are not included.

Measure (see Chapter 3 for full description)	Barriers addressed									**Effectiveness in addressing barriers by 2020** (very effective, moderately effective, less effective) **and numbers targeted by measure** (very large, large, medium, small)	**Integration with wider policy areas** *Positive impacts or comments shown in italics.*	**Deliverability: challenges and risks (technical, legal, political support, etc.)** (no significant challenges or risks, some challenges or risks, very significant challenges and risks)	**Public and stakeholder acceptability** (unlikely to attract significant opposition, some opposition likely, strong opposition likely)	**Affordability** (low cost = less than £10 million; medium cost = £10-100 million; higher cost = more than £100 million) *Cost estimates are very broad approximations only.*
	Private fleet	Company cars	Utility vehicles	Public fleet	Purchase cost	Range anxiety	Lack of infrastructure, etc	High significance barriers	Med. significance barriers					
F5 – Scottish Government lobbies the EU to introduce a mandate specifying that sales by main manufacturers operating in the EU must comprise a certain proportion of zero emission vehicles by 2020.	✓	✓	✓	✓	✓	✓	-	✓	-	**Very effective** – Would address the 'limited supply of EVs'. Would also provide a strong incentive for manufacturers to address purchase cost and range anxiety barriers, and address public awareness and knowledge barriers. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**Very significant challenges and risks** Significant challenges involved in specifying the right target and the right scope for the scheme, as shown in the California Air Resources Board scheme. Significant risk of Scottish Government being seen as picking winners and potentially backing the wrong technology in the medium to long term	**Strong opposition likely** Likely to be strongly opposed by manufacturers.	**Medium cost** – Cost of preparing the policy expected to be low compared with other interventions considered here, but extensive consultation required. Could potentially result in income for EU Governments if manufacturers are penalised financially for missing targets.
F6 – The Scottish Government and local authorities encourage EV uptake amongst the private sector……	×	✓	✓	×	-	-	-	✓	-	**Moderately effective** – Does not address 'very high significance' barriers, but would address 'lack of public awareness and knowledge' and 'aversion to new technology' in the private sector. **Numbers targeted by measure: Medium** – There were 174,000 company cars registered in Scotland in 2009.	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**No significant challenges or risks**	**Unlikely to attract significant opposition.**	**Low cost.**
F7 – Scottish Government lobbies the EU to increase the EU target for the emissions-intensity of new cars and vans produced by manufacturers.	✓	✓	✓	✓	✓	✓	-	✓	-	**Very effective** – Would address the 'limited supply of EVs'. Would also provide a strong incentive for manufacturers to address purchase cost and range anxiety barriers, and address public awareness and knowledge barriers. **Numbers targeted by measure: Very large** (all potential EV drivers).	**Low** No significant adverse impacts, if implemented as part of a wider sustainable transport strategy.	**Significant challenges and risks** The initial target was postponed or weakened for times before it became legally binding.	**Strong opposition likely** Likely to be strongly opposed by manufacturers.	**Medium cost** – Cost of preparing the policy expected to be low compared with other interventions considered here, but extensive consultation required.