

POWERING AHEAD: HOW TO PUT ELECTRIC VEHICLES ON SCOTLAND'S ROADS

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1. 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).

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.

The Scottish Government has committed to establishing a mature market for low carbon cars by 2020, and an electric vehicle charging infrastructure in Scottish cities². To achieve this transformation, the Scottish Government and local authorities across Scotland need to act now. Although there are sizeable barriers to the mass use of electric cars, the Scottish Government has many of the necessary powers to address these and, with the right policies in place, could put Scotland at the forefront of a revolution in road transport.

This paper reports on the findings of a report prepared by Atkins, *Electric Vehicles: Driving the change (April 2011)*³ and used to inform WWF Scotland's recent report, *Powering Ahead: how to put electric cars on Scotland's roads (Dec 2011)*⁴.

It provides a brief description of the different types of electric vehicles; identifies and ranks the barriers to greater electric vehicle use in Scotland; describes the range of policy measures which could be used to address these barriers and identifies the top priorities for the Scottish Government, local authorities and the rest of the public sector; and concludes by discussing recent developments in Scotland.

The above reports build on a previous report published by WWF Scotland, *Watt Car: The role of electric vehicles in Scotland's low carbon future (May 2010)*⁵. Based on independent analysis

provided by Element Energy, this report provided an assessment of the role electric vehicles will need to play in our sustainable transport future. Its headline conclusion described how even if traffic levels are successfully stabilised at those levels seen in 2001, it will still be necessary to replace at least 300,000 conventional cars with electric cars by 2020 if Scotland is to be confident of hitting its climate targets.

2. ELECTRIC VEHICLES

There are currently 4 types of electric vehicle (EV) on the market:

- **Parallel Hybrid** – Powered by a conventional petrol or diesel engine with regenerative braking technology that captures the energy generated under braking. This energy is converted into electricity which is usually used to power the vehicle at low speeds or boost the engine to improve fuel economy. The Toyota Prius and the Toyota and Lexus Hybrid SUV's use Parallel Hybrid technology.
- **Series Hybrid** – Powered entirely by an electric engine but with a small conventional engine used to keep the vehicle battery charged. The Vauxhall Ampera E-REV, with a 50 mile electric range, is expected to go on sale in the UK in 2012; and is currently on sale as the Chevrolet Volt in the US.
- **Plug-in Hybrid** – Capable of running on a rechargeable battery or a conventional petrol or diesel engine. 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.
- **Battery Electric** – Electric engine only, powered by a rechargeable battery pack. To date, pure EVs 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 EVs have been 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, and the Tata Indica Vista EV) or micro cars (e.g. the Smart Fourtwo electric drive). Their maximum range on one battery charge 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 and £25,990 respectively⁶ (after a £5,000 Plug-in Car Grant from the Government⁷); 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.

3. BARRIERS TO ELECTRIC VEHICLE UPTAKE

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, and demand different levels of government response.

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 an extensive literature review.

Table 1 – Ranking of barriers to EV uptake

Barrier	Overall ranking
High purchase price	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 values, due to uncertainty about the life expectancy of the battery	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 network (e.g. garages with appropriate skills and equipment)	Moderate significance
Lack of engineering skills	Moderate significance

Three barriers emerge as being highly significant: high purchase cost, limited range, and lack of sufficient charging infrastructure. Other significant barriers relate to uncertainty regarding resale value and limited supply of vehicles.

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 CO₂ 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 uncompetitive⁸.
- 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.

The collective impact of the barriers identified in Table 1 and the scale of the challenge is summed up by the fact that by the summer of 2011 only 2,500 out of the 28 million cars in the UK were electric, just 0.008% of the fleet⁹. Although there are already far more EV models available now, and more to come, their share of new car sales must increase to be close to 20% by 2020. Although this is a significant acceleration, it is backed by car manufactures

leading the EV charge. For instance, GM, makers of the Volt, has said that *"by the end of the decade, 20% of all car sales will be electric"*¹⁰.

The scale of transformation required is significant and will require targeted intervention by both national and local government to kick start the market and establish the right regulatory framework to protect consumers and ensure EVs fit with within a sustainable transport future. Car manufacturers are already carefully targeting the roll out of EVs to those countries and cities that have taken the steps needed to support the shift to this new transport technology. For instance, the battery swap company, Better Place is prioritising work in Denmark because of the tax incentives for EVs and, in the US, Ford has identified the 25 most electric-vehicle-ready cities and is now working with them to deliver its Focus electric car and other models¹¹.

4. POLICY INSTRUMENTS FOR OVERCOMING BARRIERS TO ELECTRIC VEHICLE UPTAKE

A range of potential policy measures are available, which can be categorised into six generic types (see Table 2).

Measures combine 'sticks' to discourage purchase of conventional internal combustion engine vehicles, and 'carrots' to encourage electric vehicle uptake. It is assumed that strong incentives will be needed throughout the period to 2020. Technology aversion is generally a barrier to uptake of new technologies until market penetration has reached at least 15%, suggesting the need for strong incentives until 2020 and beyond.

Table 2 – Summary of measures considered

A - Infrastructure and support services measures	Action for Scottish Gov	Action for local gov
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	Action for Scottish Gov	Action for local gov
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		
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	✓	

Many of the measures identified are either already being implemented elsewhere in the world (e.g. scrappage scheme in Italy; Peugeot's 'Mu' initiative in France – *see below*), are the subject of previous research and evidence (e.g. work place parking levy), or reflect initial intentions of the Scottish Government (e.g. proposed target of 100% of the public sector fleet be alternatively powered by 2020¹²).

Peugeot's 'Mu' initiative¹³

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. Purchasers of the Peugeot iOn electric car will automatically become members of Mu and are then expected to receive credits that can be used to rent vehicles through Mu meaning they have full access to a range of transport modes.

Market model for charging infrastructure in the Netherlands¹⁴

In the Netherlands, EnergieNed, the Dutch organisation for energy producers, traders and suppliers, and Netbeheer Nederland, the Dutch organization of grid operators, commissioned a study to design the market model for EV recharging infrastructure. Within the preferred market model, the charging point operator is responsible for operating the recharging point, for settlement, and for granting access to the recharging station. The electricity 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.

All measures are considered to be realistic proposals for encouraging EV uptake. However, a minority 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.

5. ASSESSMENT OF POTENTIAL MEASURES

A high level assessment of the identified measures was undertaken against a range of criteria (effectiveness, impact on wider policy areas including sustainable transport and social inclusion, deliverability, public acceptability and affordability) to identify 'priority areas' for action.

The assessment 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)¹⁵.

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 significant uptake of electric vehicles.

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.

6. PRIORITY MEASURES

The assessment process described above was used to prioritise the measures into three groups – top priorities, secondary priorities, and tertiary priorities.

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 300,000 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'.

The top priorities identified through the assessment process are presented in Table 3. They represent a powerful package of measures, and if successfully implemented would ensure that Scotland is well-placed to decarbonise road transport, reduce dependency on oil, maintain good mobility levels, and grow the Scottish economy.

Table 3 – Priority measures designed to tackle the most significant barriers and increase electric vehicle uptake in Scotland

No.	Measures to increase uptake of electric vehicles
1	Publish a high profile EV Strategy and Action Plan for Scotland , setting out a clear vision supported by targets for 2020, 2015 and 2030. This should be supported by an EV Infrastructure Strategy for Scotland , for the provision and roll out of appropriate recharging infrastructure, and describing how drivers will use the infrastructure.
2	Work with relevant stakeholders in Scotland, the rest of the UK, and across Europe, to set technical standards, specifications and regulations for implementing recharging infrastructure .

3	Commission a review of market models for recharging infrastructure in Scotland and implement the recommendations of the review. This would involve taking in to account the UK Plug-In Infrastructure Strategy ¹⁶ , working with energy providers, electricity retailers, EV manufacturers, private infrastructure providers and the public sector, to ensure consistent and appropriate pricing and payment approaches.
4	Scottish Government and local authorities provide funding for publicly accessible recharging points .
5	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.
6	Scottish Government provides a £10,000 subsidy* for the first 25,000 EVs sold 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. <i>*£5,000 assumed to come from the UK Plug-In Grant for the first EVs in Scotland.</i>
7	Scottish Government introduces a scrappage scheme to encourage consumers to purchase EVs, with subsidies reducing as EV uptake increases.
8	Scottish Government provides grants for purchasing second hand EVs from specified dealers with subsidies reducing as EV uptake increases.
9	National and local government work together to 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.
10	Publish 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.

11	Publish national planning guidance on the provision of recharging bays and infrastructure as part of a parking strategy which supports wider sustainable transport objectives.
12	Update building regulations to set out minimum requirements regarding the provision of electrical infrastructure and recharging points in all new buildings.
13	Set up a Working Group co-chaired by the Transport and Energy Ministers of stakeholders from the energy and transport sectors and including consumer groups, tasked with addressing the electricity generation and distribution requirements for EVs .
14	Local authorities work with existing car club operators to introduce EVs into fleets and introduce EV-based car clubs in other cities.
15	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 (e.g. extending funding for the Low Carbon Vehicle Procurement Support Scheme); and a 2020 target for 100% of public sector fleets to be electric, where appropriate.
16	Scottish Government should lobby the EU to tighten the EU target for the emissions-intensity of new cars and vans produced by manufacturers.

The overall propriety is to put in place an EV Strategy and Action Plan for Scotland to provide clarity on policy priorities, describe support mechanisms, define the intended market model, identify R&D support and set out the route map for an established charging infrastructure (Measure 1).

Significant progress has been made on this front since the publication of the Atkins and WWF Reports. On 28th March 2012, Keith Brown MSP, Minister for Transport and Infrastructure, announced a new collaboration between government, industry, WWF Scotland and other key stakeholders to advance wholesale adoption of electric vehicles (EVs) in Scotland^{18,19}. **E-cosse** (www.e-cosse.net) has been jointly initiated by Transport Scotland and WWF Scotland, and aims to establish Scotland as an EV pioneer, maximizing the economic, environmental and social benefits of EVs as an integral part of a sustainable transport system and a smart energy grid.

A key focus is the delivery of three key activities, which will commence from April 2012:

- **Establishment of an EV Strategy Board:** a high-level forum of leaders from government and industry to promote policies and programmes that advance EV adoption and maximise economic opportunities for Scotland.
- **Preparation of an EV Roadmap:** expert stakeholders will work with Transport Scotland to develop a shared vision and set future priorities and actions to advance wholesale adoption of EVs.
- **EV Readiness Initiative:** work to establish a portfolio of projects to advance EV adoption and implement the recommendations of the roadmap.

By engaging a range of stakeholders in this process, E-cosse will create shared commitments across government and industry. The initiative has been established with the support of experts from a number of leading organisations who will continue to play a crucial role. This includes: Allied Vehicles, Axion, Dundee City Council, EVAS, IBI Group, Nissan, Scottish Power, Serco, Siemens and SSE. Other organisations will also be encouraged to join this initiative and provide support in realising the full potential of EVs to contribute to the economic, environmental and social transformation of Scotland.

7. SUMMARY AND CONCLUSIONS

The Climate Change (Scotland) Act 2009 requires the almost complete decarbonisation of the transport sector. This means that alongside a massive shift in investment away from roads and towards active travel, public transport and smarter measures¹⁷, Scotland must replace its fossil fuelled cars with low carbon vehicles. In order to achieve this, the embryonic electric vehicle market needs to be supported and encouraged by effective government interventions. This paper presents a powerful package of measures that, if adopted by national and local government, would ensure Scotland is at the forefront of the EV revolution.

While the scale of the challenge is significant, 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.

Notes

1. Scottish Government (2009) Meeting Scotland's Statutory Climate Change Target.
2. See <http://www.scotland.gov.uk/Resource/Doc/346760/0115345.pdf>
3. Atkins (2011) Electric Vehicles: Driving the change. The full report provides detailed descriptions of each barrier and its relative impact on the public, corporate and private car fleets before setting out detailed policy analysis of the most effective policy measures to overcome these and increase the uptake of EVs. The full report can be found at http://scotland.wwf.org.uk/what_we_do/tackling_climate_change/electric_vehicles/
4. WWF Scotland (2011) Powering Ahead: how to put electric cars on Scotland's roads. See assets.wwf.org.uk/downloads/powering_ahead_web.pdf
5. See http://scotland.wwf.org.uk/what_we_do/tackling_climate_change/electric_vehicles/ for full report and supporting material.
6. www.mitsubishi-cars.co.uk; www.nissan.co.uk
7. See <http://www.dft.gov.uk/pgr/sustainable/olev/grant1/>
8. 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.
9. See <http://www.racfoundation.org/media-centre/98375>
10. See <http://www.thisismoney.co.uk/money/markets/article-2023141/General-Motors-forecasts-4m-electric-vehicles-year-built-2020.html> Nick Reilly, boss of Vauxhall Opel said, "I believe that by the end of the decade 20% of all car sales will be electric."
11. See <http://green.autoblog.com/2011/04/21/ford-25-most-electric-vehicle-readycities/>
12. See <http://www.scotland.gov.uk/Resource/Doc/277292/0083254.pdf>
13. See www.mu.peugeot.co.uk
14. See <http://www.accenture.com/nl-en/Pages/insight-changing-game-plug-inelectric-vehicle-pilots.aspx> for full report from Accenture.
15. Arup and Cenex (2008) Investigation into the Scope for the Transport Sector to Switch to Electric Vehicles and Plugin Hybrid Vehicles.

16. See <http://www.dft.gov.uk/publications/plug-in-vehicle-infrastructure-strategy>
17. Smarter Travel Choices measures include: school and workplace travel plans that encourage the use of 'greener' transport modes like walking, cycling and buses, personalised travel planning, promotion of walking, cycling and public transport, car clubs and car sharing schemes, tele-working, teleconferencing and home shopping.
18. The EVent: Powering Scotland through Electric Vehicle Technology, Scotsman Conferences in association with Jewel & Esk College, Edinburgh, 28 March 2012.
19. See http://assets.wwf.org.uk/downloads/microsoft_word_e_cosse_stakeholder_briefing_march_2012.pdf