LOW CARBON VEHICLES IN SCOTLAND - THE WAY AHEAD

Steven Fraser
Atkins
John Curtis
Scottish Government

1. INTRODUCTION

Low Carbon Vehicles have the potential to make a significant contribution to the Scottish Government's commitment to reducing CO2 emissions as set out in the Climate Change (Scotland) Act 2008.

This paper presents the findings of the Scottish Government's Consultation on Low Carbon Vehicles, and discusses in more detail the current status of electric vehicles (EVs), examining the economic and technological constraints which must be overcome if EVs are to penetrate the mass market.

1.1. The Climate Change Act

The key driver behind the development of a Low Carbon Vehicles (LCV) market in Scotland is the Scottish Government's (SG) commitment to reducing CO_2 levels, as set out in the Climate Change Act (Scotland) 2009.

The Act creates a legally binding target of an 80% cut in carbon emissions across all sectors by 2050 (on 1990 levels)[i], meaning that Scottish emissions will need to be cut by at least 42% (on 1990 levels) by 2020.

1.2. Policy options for transport

To help to meet these carbon reduction targets, the SG's Climate Change Delivery Plan commits it to almost completely decarbonising road transport by 2050, with significant progress to be made by 2030[ii].

There are four main types of measure that are likely to contribute the majority of the emissions savings from the transport sector[iii]. These are:

- Improved fuel / carbon efficiency of cars (including LCV technology);
- Smarter Choice Measures (including car pooling, home working, car clubs, investment in public transport and sustainable modes);
- Eco-driving; and
- Better integration of land use and transport resulting in a reduced need to travel.

The Low Carbon Economic Strategy (LCES)[iv,] published in November 2010, is a key component of the Scottish Government's approach to meeting Scotland's climate change targets and securing the transition to a low carbon economy in Scotland. In terms of the future of LCVs, the document is 'technology neutral', but identifies an opportunity for the Government to develop an 'early adopters market', where LCVs, including Electric Vehicles (EVs), become more prominent in public and private sector fleets and

stimulate both public demand and the provision of supporting infrastructure. The following section introduces the different types of LCV technologies.

1.3. Low Carbon Vehicles

Because of their wide range and various functions, there is not currently a simple definition of what constitutes an LCV. For the purposes of the Consultation, an LCV was defined as 'being powered by alternative fuels or technologies". The section below presents the different technologies that are available.

Efficiency improvements to Internal Combustion Engines (ICE)

Improvements relate to both the efficiency of the engine such as using direct injection technology and turbo-charging and also to non-propulsion elements such as regenerative braking and low rolling resistance tyres. The King Review[v] suggested that adopting a selection of the most cost-effective technologies could achieve a 30% fuel efficiency saving for the average new vehicle within the next 5-10 years.

Hybrid Vehicles (HV)

Hybrid vehicles combine an internal combustion engine that burns petrol, diesel or biofuels with an electric battery powertrain. There are several types of hybrid vehicles including:

- Stop / Start hybrids – where the engine shuts down when the vehicle is stationary;
- Mild hybrids – As above but including regenerative braking;
- Full hybrids – which can run on battery power alone for limited distances. The battery is recharged by the ICE during travel; and
- Plug-in hybrids – as per the full hybrid, but batteries can also be recharged through connection to mains power.

Electric Vehicles (EVs)

EVs run on battery power alone. Vehicles can currently be charged from the domestic power supply, or at an extremely limited number of current on-street charging points. Whilst having zero CO_2 tailpipe emissions, overall carbon emissions are dependent upon the energy mix at source. CO_2 emissions associated with an electric vehicle (EV) powered by electricity from today's grid are approximately 50% less than from the average ICE powered car. This figure should improve to approximately 80% less by 2030 as the power sector is progressively decarbonised[vi].

Hydrogen Powered Vehicles (HPV)

HPV are not yet available on the mass market, primarily due to the price of technology. Current prototypes burn hydrogen in an internal combustion engine or generate electricity in a hydrogen fuel cell. HPVs only produce water as a by-product, and hydrogen is one of the most common elements on the planet. However, storing hydrogen is problematic, and its production is

currently energy intensive.

Biofuels

The most commonly available transport fuels are currently bio-diesel and bio-ethanol (first generation biofuels) which can be blended with petrol or diesel and used in a conventional combustion engine.

2. THE SCOTTISH GOVERNMENT'S CONSULTATION ON LCVs

2.1. Purpose

In June 2009 the Scottish Government launched its Consultation on Low Carbon Vehicles to inform the development of their policy framework for the uptake of LCVs and alternative fuels. The consultation was complemented by a series of sectoral Focus Groups and one-to-one meetings with key stakeholders.

The results from this process were to feed into the SG's Report on Policies and Proposals, the Energy Efficiency Action Plan and the Low Carbon Economy Strategy.

2.2. Consultation Document

The Consultation document provided detailed information on all of the technology options, as well as setting the policy and legislative context for LCV development. The 23 consultation questions were split up into three broad sections:

i. Technology;

ii. Target Setting and the Public Sector Role; and

iii. The Role of Industry

2.3. Respondents

51 responses to the consultation were received in total. These consisted of:

- 18 public bodies (12 Local Authorities, five regional Transport Partnerships and COSLA);
- four vehicle/component manufacturers;
- three energy companies;
- 19 other organisations; and
- seven individuals.

2.4. Findings:

The key findings from the Consultation exercise are presented below:

Technology Options

There was no consensus as to which technologies would be early influencers, although hybrid vehicles emerged as slight favourites. Other responses were split between alternative fuels, EVs and improvements to internal combustion engines.

In the longer term, EVs and hydrogen technology were expected to provide the most substantial carbon reductions. Alternative fuels were seen principally as a transitional technology, focused on decarbonising conventional fuels in the short term.

There was little consensus on specific dates for the development and uptake of LCV technology. The rate of development of technologies was seen as being largely dependent upon external factors, the most important being market demand (largely based upon the price and reliability of technology) and the level of government support for manufacturers and consumers.

Financial barriers were seen as the dominant barriers to development and uptake of LCV technologies, followed by the provision of adequate support and infrastructure.

In terms of potential negative social impacts, most concern centred upon the production of biofuels, the requirement for a renewable energy mix and the potential for inequality in LCV take-up in rural and disadvantaged areas. However, as many opportunities as challenges were identified for rural and remote areas including the potential development of local renewable energy production and 'self-sufficient' transport on island communities.

Energy companies felt that large scale upgrades to the National Grid (as a result of increased demand for electricity) would be unlikely, and could be accommodated by initiatives such as smart metering and demand management.

Target Setting and the Public Sector Role

Within the Consultation[vii], the SG proposed the following targets as a starting point for discussion:

- 100% use of low carbon vehicles by public sector vehicles by 2020; and
- A national target of 30% for other road users.

Overall, government support in terms of funding assistance (tax regimes and further incentives), and enabling legislation were seen as the key drivers of change, setting the 'will' for change in the wider community. Respondents recognised that the SG would have to work closely with energy and fuel suppliers, as well as local authorities to develop the LCV market.

There was strong support for a twin approach to promoting LCV uptake through targets in both the public and private sector. The preferred form of fleet target was one based upon overall fleet emissions (as opposed to fleet composition), as this was seen as offering more flexibility, and allowed direct measurement against the ultimate aim – an overall reduction in emissions;

At what level these targets should be set at was more problematic. Only a limited number of respondents gave views on suitable targets to apply to LCV uptake in the public and private sector. The majority of respondents supported fairly ambitious targets approaching 100% of the public sector fleet in 2020. Suggested targets for the private sector were less ambitious. The most common response cited was a target of 50%-60% of new car sales in 2020. The need to set variable targets according to fleet characteristics and the differing geographies of council areas was also identified, with LCV uptake deemed to be more problematic in more rural areas due to current range limitations.

The cost implications of LCVs purchase featured heavily in the identification of potential barriers to public sector procurement, although investment in LCV purchase was seen by local authorities as representing an efficient use of public funds. A wide range of other potential barriers were identified and included a lack of knowledge of available alternatives, current procurement practices, the industry's potential capacity, and the lack of suitable LCV alternatives for some vehicles, such as emergency vehicles or gritters.

The Role of Industry

This part of the consultation revealed considerable enthusiasm for future LCV development in Scotland, but this was balanced by uncertainties surrounding how LCV technology may evolve. Across almost every area, leadership, funding and implementation roles were again identified for both central and local government. This was seen as crucial to almost every aspect of the development of a LCV industry and to the public's adoption of such new vehicles;

From a Scottish perspective, there was uncertainty surrounding what the shape of the LCV industry would be or how it would be developed. The absence of large scale vehicle manufacturing capability, the very small Scottish consumer market and the availability of skills were perceived as continuing to work against the development of a mass market orientated manufacturing sector.

Scotland was perceived to have very strong niche players in both core technologies and vehicle types, strength in academic research, skills in engineering and electronics and capability and capacity in training. All of these would be essential in a sector where technology is evolving, and would continue to do so rapidly, and, potentially, unpredictably.
Investment in more research and development, including academic and industry based research was seen as a vital contribution towards retaining Scottish leadership in all areas of LCV technology;

The Private Fleet

There are approximately 2.6m vehicles registered in Scotland, the vast majority of which are privately owned. Public take up of LCVs was therefore seen as being essential to significantly reduce emissions. The Consultation identified several areas where public uncertainties would potentially cause market resistance:

- cost;
- a proliferation of technologies;
- a lack of adequate fuelling / charging infrastructure;
- actual or perceived vehicle / infrastructure incompatibilities;
- unreliable and unverified claims for the performance of LCVs; and
- perceptions that adequate technical back up is missing in the motor trade*;*

The consultation revealed no clear focus on which vehicle types or technologies should be developed in Scotland, perhaps reflecting the 'technology neutral' tone of the consultation document itself. It was recognised that the development of specifications and infrastructure for LCVs which are to be adopted in Scotland cannot be undertaken independently of the European Union and UK Government, with some degree of standardisation required.

3. ELECTRIC VEHICLES

3.1. Current Status

At a UK level, the King Review identified electric vehicles as the lowest carbon emissions route to clean transportation, even taking into account various mixes of future electricity generation.

2011 has been cited as a being a potential breakthrough year for EVs, with numerous major manufacturers launching EV models. These include the:

- Nissan Leaf;
- Chevrolet Volt;
- Renault Fluence; and
- Mitsubishi iMiEV.

These EVs retail for around £29,000 and have top speeds of over 80mph. The stated range is typically 80-100 miles. with recharging times of between 6hrs

and 8hr. ‘Fast charges’ are in development which are expected to deliver an 80% charge in around 30 minutes;

As a result, electric cars are currently most suited for use as second private cars for urban use, in commercial fleets (for small loads), and as company 'pool' cars.

Within Scotland, the WWF’s Watt Car Report[viii] estimates that there needs to be 290,000 EVs on the road if the 2020 CO_2 target is to be met, representing 11% of the Scottish fleet. At a UK level, the Committee on Climate Change forecasts that 1.7 million plug-in electric vehicles will be needed by 2020 to meet these CO2 commitments.

Clearly these figures are extremely ambitious, and require decisive policies to be implemented as soon as possible. To put these targets in context, in 2009 there were just under 2,000 electric vehicles registered in the UK[ix]. In order to achieve the step change in EV and LCV take-up that the Scottish Government envisages, a number of significant issues must first be addressed.

3.2. Issues and Opportunities

Technical

Batteries are the most expensive component of EVs, and the area in which most research is being progressed. The payoff between battery range, power and cost is currently the biggest constraint on EV development.

As an example, a medium sized family car powered by an ICE can travel over 370 miles in mixed driving conditions whilst maintaining a speed of 70mph, even when fully loaded. Using current technology, for an electric car to achieve this, its lithium-ion batteries would need to weigh over 1.5 tonnes and would be similar in size to the car itself, which would cost around £100,000[x].

Due to their high cost, batteries are often not included within the purchase price of an EV, but are leased on a monthly basis. If the battery is purchased outright, it must generally be replaced within 3-5 years.

There is also the concern that the materials required in EV batteries necessitate swapping one scarce source of energy (oil) for others. Present-day batteries are typically lithium-ion, but batteries containing rare-earth elements (REE) are becoming increasingly common. Lithium is typically sourced from Bolivia, China, Chile and Argentina, but demand is already driving prices up. Similarly REE, whilst not necessarily being as scarce as their name suggests, are rarely found in concentrated deposits, and most of the world’s supply comes from just a few sites.

The limitations of current batteries manifest themselves in the price of an EV and also in the current limited range of most models, typically achieving between 80 and 100 miles between charges. Analysis of Scotland’s National Transport Survey shows however that EVs are likely to be suitable for most journeys. Approximately 72% of journeys undertaken by car are under 5 miles[xi] and 64% of commuters who drive to work complete round trip

commutes of less than 32km. This suggests that for the majority of trips, concerns over range are more likely to perceived than actual.

Range concerns notwithstanding, one of the key challenges in EV take-up is the provision of sufficient charging infrastructure. The scale and complexity of the challenge is large. WWF Scotland estimates that 1.7m domestic charge points and 500,000 workplace charge points will be required by 2030 (Stretch scenario).

Strategic decisions on the density and location of charging points need to be taken. Should the focus be upon creating a dense network of charging points in urban areas (concentrating on workplaces / shopping centres / on-street points), or could battery replacement stations (with a similar distribution to petrol stations) be more effective? This raises the issue of an urban / rural disparity in the take-up of EVs, and the social and economic implications of this.

The cost of charging infrastructure is also a factor. A conventional charging on-street charging point costs in the region of £1500, but provision of a 'fast charge' point could cost ten times this amount. Perhaps the simplest option would be to place an emphasis on recharging at home, but WWF Scotland's Watt Car report identifies that a significant proportion of households in Edinburgh, Glasgow, and to a lesser extent, Dundee do not have access to off-street parking, largely in areas characterised by tenements. In comparison, throughout the UK around 80% of car owning households have access to a garage or off road parking space.

The increased electricity demand resulting from a new fleet of EVs is expected to be relatively modest at just a 1% increase from today by 2020 and 5% by 2030. If backed up by smart grid technology, only a fraction of this new demand would actually be additional. This technology would help to balance supply and demand for electricity and ensure that recharging takes place outside peak demand periods. EV owners would be able to set their vehicles to recharge during off-peak hours, and also have the option of allowing the National Grid to 'buy-back' electricity from plugged in cars to cater for peaks in demand.

Finally, the development of a consistent set of standards for vehicle and battery design and infrastructure is essential. This will provide consumers with the confidence that they will not be investing in technology that will quickly become obsolete, or that will not work outside of Scotland. An example of this might be in ensuring that car designs will be able to incorporate new batteries, rather than rendering the whole car obsolete.

3.2.2 – Non-Technical

At present EVs are more expensive than conventional alternatives, in the region of 80% for a new car or small van[xii]. The UK and Scottish Governments have attempted to make them more economically attractive through subsidies and other incentives such as a reduction in road tax or an exemption from London's congestion charge. More substantially, in July 2010 the DfT announced that UK motorists purchasing a qualifying ultra-low emission car[xiii]

will receive a Plug-in Car Grant of 25% towards the cost of the vehicle, up to a maximum of £5,000[xiv]. At some point in the future these subsidies are likely to be reduced or removed, and consumers will then have to make a direct choice between EVs and conventional vehicles.

At present, only early adapters are prepared to purchase an EV that requires a significantly higher initial investment even though running costs are lower. Current estimates place the overall fuel cost per mile of the average ICE car at around 10p. In comparison, the average cost per mile of an electric car is around 2-2.5p, depending upon electricity tariff. In the future, rising petrol costs could increase this margin, although it is important to note that EV running costs could also change in the future with electricity providers charging for electricity used for transport.

Although the image of EVs is changing they are generally perceived as niche vehicles, with concerns over their range and power. To reach the mass market, the average car buyer will need to be convinced that the EV models on offer are affordable, reliable and desirable – at present EVs are competing with conventional cars which are backed by multi-million pound advertising campaigns.

A comprehensive support network for conventional ICE vehicles exists, including dealerships, garages for services and repairs and producers and distributors of spare parts. A similar support network would need to develop to provide potential EV purchasers with the confidence to invest.

A final point to note is that the introduction of EVs does not address existing issues relating to motorised transport such as safety, congestion and severance. There is the possibility that by promoting (potentially) cheaper, 'guilt free' motoring, traffic levels might rise. This so called 'rebound' effect' could exacerbate the issues mentioned above.

4. THE ROLE OF THE SCOTTISH GOVERNMENT

Current policy governing the development of EVs is implemented at three levels:

4.1. European Union policy

Directives such as the Promotion of Clean and Energy Efficient Road Transport Vehicles, the Renewable Energy Directive and the Fuel Quality Directive, guide high level policy development within Scotland. Other European regulations such as long-term target for average new car 'tailpipe' CO2 emissions of 95g/km by 2020[xv] will also influence the take up of EVs.

Whilst the Scottish Government will have some role in the standardisation of EV technology and infrastructure, this will have to be coordinated at an EU or UK level.

4.2. UK Government Policy

Issues reserved to the UK Parliament include taxation[xvi], defence and foreign affairs, macro-economic management and social security. Current policies

focus on price reductions in EVs at the point of sale, reductions in Vehicle Excise Duty and relief from congestion charges. The DfT is also investing in pilot schemes throughout the UK. Examples of UK wide policies include:

- £250m worth of subsidies from the Department for Transport (DfT) towards Ultra Low Carbon Vehicles. £2,000-£5,000 per vehicle is available for the purchase of electric and plug-in hybrid cars;
- £20m 'Plugged in Places' funding from the Office of Low Emission vehicles (OLEV). The first round of the initiative will see 9,000 EV charging points installed in London, the North East and Milton Keynes. Consortia based in the Midlands; Greater Manchester; East of England, Scotland and Northern Ireland;
- The DfT's £20m LCV procurement programme; and
- Vehicle Excise Duty exemption for LCVs – vehicles emitting less than 100g/km CO2 qualify;

4.3. Scottish Government Policy

The Scottish Parliament has wide legislative powers and can create laws in any areas that are not reserved to the UK government

The following section discussed potential **policy areas** for the Scottish Government and Local Authorities to consider.

Transport infrastructure and local speed limits

The provision of EV infrastructure requires decisions to be taken (primarily at a national level) on the strategic development of the charging network, as well as financial and planning support at the national and local levels. This is seen as critical especially in rural areas where the market may have no incentives to invest.

Smarter Measures including marketing and promotion of EVs

This will be important in changing the public perception of EVs from niche vehicles to mainstream acceptability. The RAC Foundation conclude that the current level of public awareness and knowledge of EVs is low, so improvements in technology are not being communicated effectively.

Demand management measures

Measures such as dedicated EV lanes and prioritised parking spaces could help to stimulate uptake. The provision of a range of direct financial incentives (grants and/or tax breaks) will assist in three key areas, namely to:

- provide direct assistance to manufacturers of EVs and components such as batteries, to attract capital and share risks associated with new technologies;

- incentivise uptake of EVs by consumers and reduce perceived risks of purchase or leasing EVs; and

- contribute towards financing academic and other research, and industry training and offer incentives through competitions.

Transport investment prioritisation

Clear direction and support from the Scottish Government, with long term commitments, can provide consumers and manufacturers with the confidence to develop and invest in EV technology.

Local Government also has a direct role in procuring its own low carbon vehicles and influencing the bus and goods vehicle fleets, helping to play a role in testing and raising the profile of EV technology.

Planning policy

The SG can influence the location of infrastructure and the provision of other supporting facilities through the application of measures such as minimum parking standards for EVs at new developments, which would set a precedent in local authority areas.

4.4. Current initiatives

Current Scottish Government initiatives include:

- The Scottish Government's £3.6m Low Carbon Vehicle Procurement Support Scheme and £3.4 million green bus scheme;

- The Environmental and Clean Technology Partnership (ECT), led by Scottish Enterprise is currently developing an Action Plan that will seek to create demand at home and abroad for Scottish expertise in low carbon transport technologies; and

- Scotland (led by Transport Scotland) has successfully bid for the second round of funding as part of the 'Plugged in Places' scheme. Scotland was awarded £1.45m towards the provision of 375 charging spaces in the Central Belt.

4.5. Future Powers

The Commission on Scottish Devolution was established by the Scottish Parliament in 2008 to examine the impact of devolution, and to recommend changes to the present constitutional arrangements. The most relevant recommendation of the Calman Report[xvii] in relation to the take-up of EVs is in the area of taxation. As well as recommending that the current Scottish

Variable Rate (SVR) should be replaced by a new Scottish rate of income tax, the report also recommends that the SG should be given the power to legislate with to introduce specific new taxes. These reforms could potentially open the way for the SG to fund EV schemes through new revenue raising powers or to incentivise take up by taxing “high carbon” vehicles more.

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5. Next Steps

Transport Scotland will publish the Low Carbon Vehicle Action Plan in 2011 which sets out the activity required to deliver the emissions reductions set out in the Report on Policies and Proposals.

NOTES

[i] International aviation and shipping are included in the Act. If these sectors are required to be removed from the Act, an explanation must be put before Parliament before 31st December 2012.
[ii] http://www.scotland.gov.uk/Publications/2009/06/18103720/6
[iii] As identified by the Committee on Climate Change
[iv] A Low Carbon Economic Strategy for Scotland', Scottish Government (2010)
[v] 'The King Review of Low Carbon cars', The King Review (2008).
[vi] Watt Car: the Role of Electric Vehicles in Scotland's Low Carbon Future, WWF Scotland (2010)
[vii] 'Consultation on Low Carbon Vehicles', Scottish Government (2009). The consultation's definition of an LCV includes low emission traditional combustion, hybrid, plug-in hybrid, electric and hydrogen vehicles.
[viii] 'Watt Car', Element Energy for WWF (2010)
[ix] 'The fourth carbon budget – reducing emissions through the 2020s', CCC (2010)
[x] http://www.guardian.co.uk/environment/cif-green/2010/jun/21/batteries-electric-cars (Engineering and Technology magazine)
[xi] http://www.greenchoices.org/index.php/greenchoices/transport-2/car-use
[xii] http://www.nextgreencar.com/electriccars.php
[xiii] Nine vehicles have so far been confirmed as being eligible for the grant including the Mitsubishi i-MiEV, Nissan Leaf and Chevrolet Volt.
[xiv] http://www.dft.gov.uk/pgr/sustainable/olev/grant1/
[xv] Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO 2 emissions from light-duty vehicles.
[xvi] With the exception of the Scottish Variable Rate of Income Tax.
[xvii] Serving Scotland Better: Scotland and the United Kingdom in the 21st Century, Commission for Scottish Devolution (2009)