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CAN BRITAIN DEVELOP A GLOBAL ADVANTAGE IN ULTRA-LOW-EMISSION VEHICLES?

REPORT

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All of the views contained in this report are those of the authors.

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EXECUTIVE SUMMARY

Around the world, different countries and jurisdictions are responding to both the threat of man-made climate change and exposure to the costs of imported oil and gas by tightening regulations on vehicle emissions. Britain, as part of the EU, has been at the forefront of this revolution. Regulations introduced in 2009 set new goals for manufacturers to reduce vehicle emissions over the following decade. Australia, Canada, China, Japan, Russia, South Korea and the US have all developed their own standards. As a result, manufacturers have already developed vehicles with 'cleaner' petrol and diesel engines, but in order to meet these targets they have also begun to introduce a range of new technologies such as hybrid and pure electric vehicles. Hydrogen vehicles are expected to be available for purchase in the near future.

This transformation presents a number of benefits and opportunities for Britain. First, there are significant opportunities for jobs and growth if Britain can capture a share of the expanding global market in ultra-low-emission vehicles (ULEVs) and create its own domestic market. Second, all other things being equal, ULEVs are likely to bring motoring costs down for consumers over time – costs which are of growing concern for millions of people facing squeezed living standards. Although the purchase costs are currently higher for ULEVs than for internal combustion engine vehicles (ICEVs), these are expected to fall over time as the technology matures, while the fuel costs are already far lower. Third, reducing carbon emissions from the automotive sector in tandem with electricity decarbonisation will help the UK to achieve its legally binding and ecologically essential carbon reduction targets. Fourth, combined with smart meters, ULEVs can help balance supply and demand on the UK's electricity grid and guarantee energy security.

Achieving all of these benefits will require both a vibrant domestic market and the domestic production of these vehicles on the supply side. Although 30 branded ULEVs are likely to be available to consumers by 2014, demand in the UK has fallen behind that of most other European countries and the US. As discussed below, Britain could potentially learn from countries like Norway and states like California which have a more concerted approach to boosting demand.

In recent years Nissan have invested £725 million in the production of their LEAF car model in the UK. Toyota are producing engines for the Auris hybrid here, and the British firm Axeon is Europe's largest independent lithium-ion battery system supplier. Ensuring that more ULEVs and their parts are produced in the UK will require an unprecedented collaboration between government and industry. Britain has an important base within the global automotive industry from which to build. Over the last decade, Britain's automotive industry has dramatically increased its production – which is set to return to levels last seen in the 1970s – and exports are at a record level. Britain now has the world's fifth most competitive automotive industry in the world. But this lead will not be maintained automatically. Britain needs to ensure that it remains at the technological frontier, which means that the industry needs to build a comparative advantage in ULEVs to complement that in ICEVs.

Achieving this goal will require concerted action in three areas of industrial policy.

- More must be done to ensure that firms in the automotive supply chain have access to the finance that they need. The number of domestic firms in the supply chain, and their value to the UK economy, have fallen in recent years – in part due to the effects of the recession. As in a number of other sectors, existing policies such as the 'Funding for Lending' scheme have so far failed to increase lending, and smaller firms are struggling. Possible solutions include greater collaboration across the industry, with large firms ramping up their lending to smaller firms in the supply chain if they have excess cash or access to credit. The government should also consider capitalising and giving borrowing powers to a British investment bank with the objective of increasing long-term financing to small and medium-sized businesses where the banking sector is currently failing.[1]

- Britain is a world leader in automotive innovation, with a number of companies already setting up their low-emission vehicle research in the UK. The Formula One industry is a particular strength. The Automotive Council has taken strategic ownership of the sector and has set out five priority areas for the industry. Nonetheless, as with other sectors, public money is skewed towards basic research, and not enough is done to apply and commercialise innovation. We believe that serious consideration should be given to creating a new advanced propulsion centre to support the government's automotive sector strategy. To help pay for this the government should improve the targeting of existing grants, fees and R&D tax credits to ensure that there is sufficient funding for the development and demonstration phases of the low-carbon vehicle innovation process. More consideration should also be given to facilitating access to EU R&D funding, which will increase under a new multi-annual financial framework.
- On the issue of skills, the supply of engineers is not keeping up with demand from the automotive industry. This requires changes to higher education, immigration and apprenticeship policy. Successive governments have emphasised the need for more engineering graduates with relatively little success. Industry should continue to provide incentives for students to take up these courses, including covering some or all of the costs of degrees. Given the high proportion of current engineering undergraduates who come from outside the EU, government immigration policy must make it easier for foreign students to remain in the UK and take up highly skilled posts upon graduation. Current policy is, perversely, making this harder. Finally, the quality of apprenticeships should be enhanced – firms should complement their graduate recruitment with apprenticeship programmes, and offer more schemes at higher levels.

Positive steps towards developing a comparative advantage for Britain in the global ULEV industry have been made by a number of organisations including the Automotive Council, which is jointly chaired by government and industry, the Office for Low Emission Vehicles (OLEV) which sits in the Department for Transport (DfT), the Smart Meters Forum which produces costing scenarios and plans for the uptake of low-carbon technologies, and UKH_2Mobility which develops a strategy for the development of hydrogen refuelling stations. However, there is a gap which could be filled by the creation of a low-emission vehicles forum to focus attention on the development of an ULEV market and related infrastructure. This should include representatives of government, the automotive and energy industries, and other stakeholders.

Industrial policies such as these are necessary but not sufficient for ensuring that Britain retains its comparative advantage in the automotive industry. A thriving domestic market in ULEVs is also necessary, since it is not cost effective for manufacturers to export all of their vehicles. Yet Britain appears to be slipping behind competitor countries in relation to the take-up of ULEVs, and it is also currently lagging behind most European countries and the US in terms of the proportion of plug-in electric vehicles being registered.

1 For a full account of IPPR's proposals for a British investment bank see Dolphin and Nash 2012

As well as the impact that this has on manufacturers' location decisions, it is also concerning because it means that Britain is less likely than other countries to benefit over time from lower lifetime costs for consumers, a decarbonised economy, and a better balanced electricity grid. Achieving these outcomes requires action in several areas.

- First, we need to ensure that as many people as possible are given the opportunity to experience driving ULEVs. While the government's current policy regime – including purchase grants, reduced vehicle excise duty, corporation tax allowances and lower rates of company car tax – does not significantly reduce the expensive purchase costs for individuals in their own right, it can present an attractive offer to businesses and public sector fleet managers (and therefore their employees). However relatively few applications for 'plug-in grants', which reduce the costs of buying a plug-in electric vehicle, have been made so far: just 5.6 per cent of the £300 million fund that was first made available in 2011 has been used. Nonetheless, government should persevere with the policy of providing financial support to purchasers, which has been effective in other countries such as Norway. Pulling the rug away at this stage would undermine the certainty which fleet managers and early adopters need to make the purchase of an ULEV cost-effective. A political consensus is needed to guarantee that this fund will continue to the end of the next parliament. Furthermore, policy amendments in the 2012 budget which removed the availability of enhanced capital allowances to leasing and rental companies should be reversed immediately.
- Second, while current usage incentives such as free parking spaces are welcome, more could be done to ensure that they are made more convenient for drivers. Other usage incentives such as the use of toll roads for ULEVs – need to be considered. Such initiatives tend to fall under the remit of local authorities, meaning that a range of different policy innovations have been introduced with a somewhat disjointed approach, with rules and rights differing across political boundaries. To remedy this, local authorities and local enterprise partnerships should work towards greater coordination of ULEV usage incentives. The DfT should also look to introduce a single 'green badge' scheme to make it easier to identify qualifying vehicles.
- Third, as the procurer of over £400 million worth of vehicles per year, government has an opportunity to drive demand for ULEVs and allow a large group of people who drive or share government vehicles to experience their usage. We recommend that the Government Buying Standard for transport should become more stringent than it is presently. By 2020, all new cars procured by central government should have emissions of 95g CO_2/km or less, and all vans should achieve 147g CO_2/km or less. Both targets should be phased in over time.
- Fourth, government must ensure that those buying ULEVs have access to 'fuelling' infrastructure. OLEV have found that the charging of plug-in vehicles takes place primarily in individuals' homes or businesses' depots. Yet current policy is targeted only at home and public infrastructure, with no provision for private business infrastructure. To address this, existing funds should also be offered to businesses, and more of the existing funding should be put towards home and depot-based fast charging, with a cap on the amount that can be spent on publicly available rapid charging points. As with purchase incentives, a political consensus is needed to ensure that funds currently put aside will not expire in 2015.
- Fifth, those rapid charging stations that are built should be placed at strategic locations identified by local authorities, local enterprise partnerships and devolved transport institutions. Meanwhile, more must be done to address safety concerns relating to charging at home using a domestic three-pin plug with a cable that

does not have a built in trip switch, and to charging at street level with trailing wires connecting to plug-in electric vehicles.

- Sixth, government must ensure that the increase in electricity demand caused by an expansion in the usage of ULEVs does not cause perverse effects. The government is undertaking an ambitious programme to decarbonise the economy by 2050, and a key milestone in this agenda is the decarbonisation of the electricity system by 2030. Failure to achieve this would mean that drivers were switching from dirty petrol-fuelled cars to dirty electricity-powered cars. Since this would be likely to undermine public support ULEVs, the government should ensure that a specific target for the decarbonisation of the power sector in the UK is set by April 2014, that new and ambitious EU-wide targets to cut carbon emissions by 2030 are agreed, and that further targets for 2025 relating to the carbon footprint of cars and vans are set for the whole of the EU.
- Finally, the uptake of plug-in electric vehicles will require upgrades to the electricity network over the coming decades. At present, the companies responsible for those upgrades do not have full knowledge of where the charging of plug-in electric vehicles takes place. This must be addressed, and made publicly available. On a related note, the Department for Energy and Climate Change (DECC) should clarify how all charging point infrastructure will interact with the smart meter programme. We recommend that DECC and OLEV work together to ensure that the roll-out of smart meters and charging infrastructure are coordinated to avoid unnecessary wastage of public money.

Taken together, this set of policy recommendations, which build on existing efforts by government and industry, would give Britain the best possible chance of increasing demand for ULEVs, and ensuring that UK manufacturers continue to excel in terms of innovation, production, and export. Failure to address these challenges effectively could result in Britain falling further behind other countries in relation to the purchase of ULEVs, and to lose our hard-fought comparative advantage in the automotive industry. Benefits to consumers, to the environment, and to industry would be lost as a result. Britain is on the starting grid. Now it’s time to get motoring.

GLOSSARY

For the purposes of this report, the terms set out below are defined as follows.

Abbreviation	Full description	Explanation
ULEV	Ultra-low-emission vehicle	Refers to any vehicle whose average carbon emissions are categorised as being under 75g CO_2/km. Currently likely to be a plug-in electric vehicle, but in future will include FCEVs and ICEVs (see below) as the fuel efficiency of those vehicles improves and biofuels penetrate the fuel mix.
PEV	Pure electric vehicle. Also known as a battery electric vehicle, an electric vehicle, a pure-electric car/vehicle, an all-electric vehicle or fully electric vehicle.	A vehicle powered solely by an electric motor, powered by a battery charged from mains electricity. Typical PEVs have a range of approximately 100 miles.
PHEV	Plug-in hybrid electric vehicle. Also known as a plug-in hybrid vehicle or parallel hybrid.	A vehicle driven by a plug-in battery-powered electric motor and an internal combustion engine (ICE). Typical PHEVs will have a pure-electric range of over 10 miles. After this range is utilised, the vehicle reverts to the benefits of full hybrid capability (utilising both battery power and ICE), thereby increasing the vehicle's range.
E-REV	Extended range electric vehicle. Also known as a range extended electric vehicle (RE-EV) or series hybrid.	A vehicle powered by a plug-in battery-powered electric motor. E-REVs have an electric-only range of around 40 miles. An on-board ICE-powered generator charges the battery when necessary to significantly extend the range of the vehicle.
FCEV	Fuel cell electric vehicle. Also known as a hydrogen vehicle.	Hydrogen fuel cell electric vehicles share a large proportion of the electric motor and drive train technology with other electric vehicles; it is the energy storage/conversion devices that are different. The fuel cell is an electrochemical device that can be refuelled quickly and will continue to generate power as long as it is fed with hydrogen fuel. They emit no emissions or pollutants from the tailpipe.
–	Plug-in electric vehicle	Refers to any ULEV powered by a battery that is charged from mains electricity: a PEV, PHEV or E-REV. This term does not encompass FCEVs or other hybrid electric vehicles.
–	Electric vehicle/car	Can refer to any vehicle/car that has a battery-powered motor: a hybrid, a plug-in electric vehicle or an FCEV.
Hybrid	Hybrid electric vehicle	A hybrid vehicle is powered by either/both a battery and an ICE. The power source is selected automatically by the vehicle depending on speed, engine load and battery charge level. This battery cannot be plugged in: charge is maintained by regenerative braking supplemented by ICE-generated power. Hybrids do not currently qualify as ULEVs, but may do in the future.
ICEV	Internal combustion engine vehicle	A vehicle powered by a petrol or diesel engine, including those adapted to operate on alternative liquid or gaseous fuels. These vehicles do not currently qualify as ULEVs, but may do in the future.

1. WHAT VEHICLES WILL THE BRITISH DRIVE IN THE FUTURE?

1.1 Why are manufacturers making ultra-low-emission vehicles?

A change is coming. Across the world, emissions standards are being tightened as countries tackle their carbon emissions and their dependence on imported oil and gas. In the EU, this is being driven by regulations giving each manufacturer a specific annual emissions target which is based on the average emissions of all its new cars sold in the EU in a given year, with harsh penalties imposed for failure to meet these targets.[2] This legislation means that the average emissions of all cars sold in the EU will be 130g CO_2/km by 2015 and 95g CO_2/km by 2020, provided that manufacturers meet their targets. Similar EU legislation applies to vans.

Other jurisdictions are also adopting new regulations to encourage manufacturers to develop ULEVs.[3] New regulations include corporate average fuel economy standards set by the US federal government, and more stringent zero emission vehicle regulations from the state government of California; the Top Runner programme combined with fuel efficiency standards in Japan; and the 12th five-year plan in China, which places particular emphasis on the production of electric vehicles (Beltramello 2012). Australia, Canada, Russia and South Korea have also introduced their own rules, which means that countries which account for two-thirds of world GDP have emissions standards in place.

This global regulatory environment is driving an innovation revolution in the production of ultra-low-emission vehicles. In the UK alone, during 2012 and so far in 2013, new models of hybrid vehicles, plug-in hybrid electric vehicles (PHEVs), pure electric vehicles (PEVs) and extended range electric vehicles (E-REVs) have come on to the market. In the near future, fuel cell electric vehicles (FCEVs) will also become available for purchase.

These new models are conventional vehicles that look and function in a very similar way to the internal combustion engine vehicle (ICEV) with which Britain is so familiar. Examples include the Vauxhall Ampera, Nissan LEAF, Renault Zoe, BMW i3, Porsche 918 Spyder and Toyota Plug-In Prius. The annex to this paper sets out a list of ULEVs currently available on the UK market, or scheduled to be made available in 2013 or 2014.

1.2 The benefits of ultra-low-emission vehicles

Unless there is a dramatic global retreat, ULEVs are here to stay. This is to be welcomed for several reasons. Firstly, Britain already has a strong automotive industry and is well placed to take full advantage of this transition. Effective government policy to create an attractive business environment for manufacturers (discussed in more detail in chapter 2) will help Britain develop a comparative advantage in ULEVs to match its existing strength in ICEVs. If this takes place, the transition has the potential to create jobs, rebalance the British economy towards manufacturing and exports, and promote sustainable economic growth in the UK.

Secondly, ULEVs can help to bring down motoring costs. Although the upfront purchase costs of ULEVs are currently higher than those of an ICEV, the lifetime costs are comparable, and in some cases they are cheaper to own and operate (as discussed in chapter 3). With the anticipated fall in the purchase costs of ULEVs (as batteries become cheaper), this balance could tip even further. ULEVs therefore have the potential to help address the growing problem of transport poverty in the UK.[4]

2 Regulation (EC) No 443/2009

3 A glossary of all acronyms is available on page 6.

4 The potential for this reduction in motoring costs will depend on government policy, including what measures might be introduced in future to replace the losses in revenue from vehicle excise duty and fuel duty which

Thirdly, greater uptake of ULEVs will be integral to Britain's efforts to meet its legally binding and ecologically essential carbon emission reduction targets set under the Climate Change Act 2008. By 2050, Britain must have reduced its carbon emissions by 80 per cent against a 1990 baseline. In 2009, 24 per cent of UK domestic greenhouse gas emissions were attributable to domestic transport emissions (DECC 2011). Not only do the tailpipe emissions for the average new car need to fall to between 50 and 70g CO_2/km during the 2020s to meet this target (ibid), compared to an average of 133.1g CO_2/km in 2012 (SMMT 2013a), but by 2040 all new cars and vans sold in the UK will need to be near zero-emission in order for domestic transport to meet its contribution to the 2050 targets (DECC 2011). As chapter 5 sets out, this is contingent on the decarbonisation of the power sector by 2030.

Fourth and finally, these new vehicles could provide a new means of balancing supply and demand on the electricity network by storing energy to power our homes and workplaces, or resupplying the electricity network with energy. This is discussed further in chapter 5.

1.3 Methodology and report structure

The research methodology for this report has included an extensive literature review; one-to-one interviews with 20 stakeholders from government, industry, academia, and the third sector; and a roundtable discussion, held under the Chatham House rule, with key stakeholders.

The remainder of the report is structured as follows:

- Chapter 2 examines the need for an effective industrial policy for the ULEV industry in the UK. It will examine the current capacity in the UK to capture a large proportion of the expanding global market in ULEVs and propose policies focusing on access to finance, supporting innovation and workforce skills to achieve that aim.
- Chapter 3 looks at the current level of demand for ULEVs in the UK and the barriers to take-up, and suggests changes to purchase and usage incentives at all tiers of government, and to public procurement policies, based on international evidence.
- Chapter 4 examines the charging infrastructure required to facilitate a thriving domestic market. We make recommendations about how both local and central government policies can better stimulate, and keep pace with, demand in the context of continued fiscal austerity.
- Chapter 5 looks at the impact that ULEVs will have on the UK's efforts to decarbonise, and on the electricity transmission and distribution networks. It will assess how this can be managed with minimum detriment to the taxpayer and the consumer. It will propose short- and medium-term policies to prepare the grid and network as fully as possible for the steady and safe roll-out of ULEVs in the future.

would result from increased engine efficiency in ICEVs and the growth in ULEVs. This question is beyond the scope of this report.

2. BRITAIN'S OPPORTUNITY

Chapter 1 outlined how regulatory changes around the world are driving an increase in the supply of ULEVs. Britain has a serious opportunity to capture a significant proportion of the production of these vehicles.

Domestic growth in the production of plug-in electric vehicles to the levels predicted by the Smart Grid Forum[5] could create gross value added of £16.5 billion in the UK by 2030, and £52 billion by 2050 (Ernst & Young 2012). The same analysis suggests that employment in this sector could reach 130,000 in the 2020s, and 470,000 in the 2040s. This opportunity is too important to be left to chance. Recent collaboration between government and industry, including the creation of the Automotive Council, has begun the process of developing an industrial strategy and contributed to significant growth in the sector in recent years. However more effort is needed to maintain this.

This chapter turns first to the increased levels of production and emerging comparative advantage which Britain has developed in the automotive industry in recent years. Since this expansion in capability has taken place in collaboration with government, and given that there have been other, less productive phases in the history of the UK automotive industry, we examine which industrial policies have been effective and which have failed in order to draw lessons for the ULEV market. We examine the case for greater collaboration across government and between government and industry. Finally, we examine ways of enhancing policy in three specific areas which have been identified as critical to the prospects of developing a domestic ULEV industry: access to finance, support for innovation, and workforce skills.

2.1 Increased production and comparative advantage in the automotive industry

The UK's automotive sector has become an increasingly important part of the UK economy. In 2011 the UK produced 1,465,122 vehicles, an increase of 5.1 per cent on the 2010 figure (SMMT 2012a). It is estimated that the industry will continue to grow by 9 per cent per year to produce 2.2 million vehicles annually by 2016 (KPMG 2012). If this occurs, it would restore British automotive manufacturing back to levels not seen since the 1970s.

The UK automotive industry, including manufacturing, engineering, sales, maintenance and repair, employs over 720,000 people – around one in 40 of all jobs – with 19,000 created in the last two years alone. The total figure includes around 140,000 manufacturing jobs (SMMT 2013b). Vehicle production is spread throughout the United Kingdom, but the greatest concentration is found in the West Midlands, which is home to Aston Martin, BMW, Jaguar Land Rover, MG Motors and Toyota (SMMT 2012b).

In international terms, the UK was ranked 13th on the list of global automotive producers in 2011.[6] In export value terms, however, it performs rather better. This is partly because the average value of each car exported from a UK plant is £18,000, a third more than the average price of vehicles sold in the UK (Marsh 2013). The automotive industry is the country's largest sector in terms of exports and generated £20.3 billion of revenue in 2011.

In 2012, exports comprised 73 per cent of the UK's car production. This is higher than in France (62 per cent) Japan (52 per cent), and about the same as in Germany (Marsh 2013). The UK exports approximately 55 per cent of its production to non-EU countries,

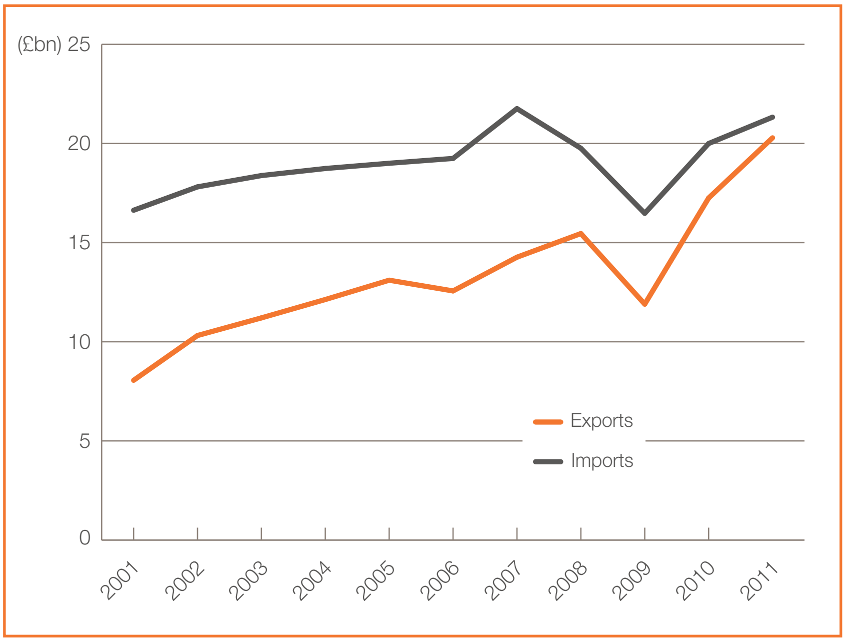
5 For more detail on the Smart Grid Forum, see page 13.

6 OICA 2011 production statistics, http://oica.net/category/production-statistics/2011-statistics/

the highest proportion of any European nation. By comparison, around 83 per cent of French, Italian and Spanish production is sold within the EU at an aggregate level (KPMG 2012). This diversity is a source of strength and makes the UK less vulnerable to fluctuations within the eurozone.

The contribution made to GDP by any sector is measured in terms of net trade (the difference between exports and imports). Over time our trade gap has narrowed because exports have grown much faster than imports. Indeed, while the trade in motor cars has been in deficit in each of the last 10 years (with that deficit peaking in 2001 at £8.6 billion), between 2007 and 2011 the deficit fell back to £1 billion as figure 2.1 below shows.

Figure 2.1
Auto trade, all motor cars, 2001–11 (£bn)



Source: ONS 2012

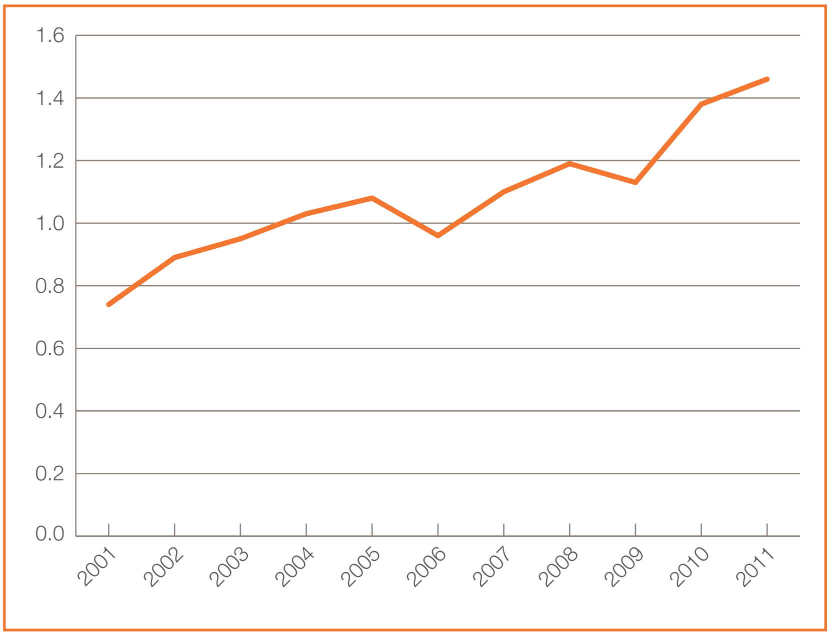
It is expected that the automotive industry's trade deficit in 2012 will have fallen to £150 million, its smallest deficit since 1975.[7] This compares with an overall UK trade deficit in 2012 of £37.7 billion in 2011 (ONS 2013a). The reason for this is that Britain has become increasingly competitive at exporting cars.

Economists can measure this through revealed comparative advantage (RCA).[8] The UK automotive industry had an RCA score of 1.46 in 2011. Figure 2.2 (over) shows how Britain's revealed comparative advantage in this sector has grown over the last decade from a score of 0.74 in 2001.

7 http://www.ft.com/cms/s/0/f598162a-671d-11e2-8b67-00144feab49a.html#axzz2Jvgd34q5

8 Revealed comparative advantage is an index which calculates the relative advantage or disadvantage of a given country in a particular class of goods or services based on trade volumes compared to a global average. A comparative advantage is 'revealed' if the RCA is greater than 1. If RCA is less than 1, the country is said to have a comparative disadvantage in the commodity or industry.

Figure 2.2
UK revealed comparative advantage score in automotive vehicles, 2001–11



Source: IPPR calculations using International Trade Centre data

Table 2.2 below shows RCA scores for the world's top 10 car producers by volume, plus the UK which ranks 13th. This analysis suggests that the UK is the fifth-strongest producer of cars for export in the world. Each of the BRIC countries produce more cars per year than the UK, but because they are low value and primarily for their domestic market they do not enjoy a comparative advantage. Neither does the US, which also manufactures primarily for its domestic market. Germany and Japan have the highest comparative advantages, with Spain and South Korea also faring well.

Table 2.2
Revealed comparative advantage, top 10 car producers (plus UK)

Rank		Car production (m)	Car exports ($bn)	Total exports ($bn)	RCA
1	China	14.5	3.7	2,081.5	0.06
2	Japan	7.2	87.3	968.6	3.14
3	Germany	5.9	154.3	1,748.4	3.08
4	South Korea	4.2	40.9	650.2	2.19
5	India	3.0	3.6	438.6	0.29
6	US	3.0	48.4	2,079.4	0.81
7	Brazil	2.5	4.4	294.5	0.52
8	France	1.9	23.2	806.4	1.00
9	Spain	1.8	30.5	451.3	2.36
10	Russia	1.7	0.5	532.0	0.03
⋮					
13	**UK**	**1.3**	**32.1**	**766.4**	**1.46**
	World	*59.9*	*634.2*	*22,115.6*	-

Source: OICA,[9] ITC[10]

9 http://oica.net/category/production-statistics/2011-statistics/
10 http://www.intracen.org/trade-support/trade-statistics/

2.2 An industrial strategy for the automotive sector

Despite a chequered history (discussed in more detail in the box below), the UK is now a major player in the global automotive industry. Given the growth and number of jobs associated with the sector, maintaining this status is critical if the government wants to continue to rebalance the UK economy towards manufacturing and exports.

Cluster theory suggests that, because the UK currently excels in the production of ICEVs, it is well placed to develop a comparative advantage in ULEVs (Porter 2000, Hausmann and Hidalgo 2011). That said, the car companies based in the UK, which are predominantly foreign-owned, have choices about where to invest and could choose to move their production to other countries. Therefore if we want them to stay we must ensure that Britain remains an attractive location in which to produce vehicles. Given the global changes discussed in chapter 1, and the higher value associated with cutting-edge technology, government policy must therefore focus on making Britain the premier home of ULEVs. Doing this effectively is essential to an active industrial policy.

A brief modern history of Britain's automotive industry

The modern history of the British automotive industry began in 1968 when British Motor Holdings (BMH) and Leyland Motor Corporation (LMC) merged to form British Leyland Motor Corporation (BLMC). The ostensible reason for the merger, which was strongly encouraged by the Labour government of the day, was to create one large company operating with the economies of scale needed to compete with the US giants General Motors, Chrysler and Ford. In fact, BMH was struggling to stay afloat and would probably have gone bust if the merger had not happened. The creation of BLMC was seen as necessary to preserve the UK's position as an automobile manufacturer: BLMC was to be the national champion.

The reprieve lasted merely eight years. Following the quadrupling of oil prices in 1973 and the subsequent recession, BLMC found itself in serious trouble. Consequently the Labour government formed a new holding company, British Leyland (BL), and effectively nationalised BLMC. Following the recommendation of Lord Ryder, then head of the National Enterprise Board, it planned to inject £1 billion of taxpayers' money into the company in an effort to turn it back into a profitable automotive manufacturer. However, the assumption that BL could return to profit was 'unsupported by evidence or analysis' (Owen 2012: 10) and it soon became clear that the government was pouring good money after bad. The company became better known for industrial disputes – most infamously at its Longbridge plant – than for the quality of its product. British Leyland became – and remains – a byword for how not to conduct industrial policy, and for the dangers of 'picking winners' (though in truth it was more an exercise in 'bailing out losers').

The Thatcher government's approach to these issues was the complete opposite of those of its predecessors in the 1960s and 1970s. It recognised that backing a British-owned automobile industry was likely to ultimately result in there being no British automotive industry at all (apart from a few niche producers). Therefore it allowed parts of BL to pass into foreign ownership, starting with the sale of Jaguar to Ford in 1984. More importantly, the Thatcher government developed a covert industrial policy to attract Japanese automotive manufacturers to the UK in the late 1980s.

BOXED TEXT CONTINUED

Nissan was courted with the offer of cheap land in Sunderland, which was sold at agricultural prices. It opened its car plant there in 1986, and it is now the most productive in Europe. Honda of the UK Manufacturing began production in Swindon in 1989; in 2000, Honda announced that cars made in the UK would be exported to Japan for the first time. Toyota Manufacturing UK was founded in 1989 and is headquartered at Burnaston in Derbyshire, with an engine manufacturing factory in Deeside, North Wales.

Adopting an approach of 'if it isn't broke, don't try to fix it', governments in the 1990s and much of the 2000s largely left the foreign owners of Britain's automotive industry to get on with transforming the industry. In contrast to the 1960s and 1970s, government interventions were on a small scale – one example being the regional development agency Advantage West Midlands' £72 million programme to increase collaboration between manufacturers and regional universities. Generally speaking this was not a bad approach. As a result of foreign ownership, Britain's automotive industry has enjoyed a significant resurgence, particularly in recent years.

A number of companies have already chosen to base their low-emission vehicle production in the UK. For example, giving evidence to parliament, Toyota Motor Europe's managing director Graham Smith said:

> **'We chose the UK to introduce our hybrid technology partly because of the positive overall total environment towards low-carbon and low-emission vehicles here in the UK. We could have made other choices … We have vehicle assembly plants in France and Turkey, as an example, but the UK was chosen.'**
> HC 2012

This demonstrates that companies are choosing the UK despite having operations in countries with lower employment costs.

Government policy in recent years has begun to recognise the need to produce ULEVs in the UK and to create a vibrant domestic market for them. Under the last Labour government the UK Automotive Council was established with the aim, among others, of creating 'a transformed business environment for the automotive industry in the UK'.[11] The Office for Low Emission Vehicles (OLEV) was established with a team drawn from the Department for Business Innovation and Skills, DECC and the DfT to provide strategic direction and support the early market for ULEVs. To date OLEV has published one strategic document, in 2011, which focuses on charging infrastructure.

In addition to the Automotive Council and OLEV, there are two government and industry bodies that are providing strategic advice to increase the uptake of ULEVs:

- **The Smart Grid Forum** examines the impact of ULEVs (and other low-carbon technologies) on the electricity network, produces scenarios of costs, and makes recommendations to government and industry.

11 For more details see http://www.automotivecouncil.co.uk/what-we-do/mission-and-objectives/

- **UKH_2Mobility** is an industry and government consortium chaired by OLEV, the aim of which is to develop a rollout strategy for FCEVs and related hydrogen refuelling infrastructure. To date it has only published a synopsis of its initial findings[12] but will soon publish a full report. It has set out an outline plan for future work, but it focuses only on FCEVs to the exclusion of other types of ULEVs.

Nonetheless, despite these initiatives, the interviewees and attendees at IPPR's roundtable discussion expressed concerns about the level of coordination across government and industry. Representatives from the automotive industry expressed frustration at the rate of progress of the energy industry in preparing the UK for a transition towards ultra-low-emission vehicles, which has little commercial interest in the promotion of ULEVs. The perspective of the energy industry, by contrast, is that the uptake of ULEVs is just one of many challenges to be met in order to achieve the UK's 2050 decarbonisation targets. They also expressed frustration that ULEVs are not designed with the UK electricity network in mind.

While there was praise for the quality of the personnel at OLEV, many interviewees felt that it lacked clout within Whitehall. A key reason for this observation was that the announcements in the 2012 budget which weakened fiscal incentives for businesses using ULEVs (see chapter 3) were made without any consultation between HM Treasury and OLEV. In light of the need for action from a variety of levels of government, it is not surprising that interviewees expressed a desire for OLEV to become more closely linked with the Department for Environment, Food and Rural Affairs (Defra) in order to focus on air quality standards, and with the Department for Communities and Local Government (DCLG) in order to focus on policy areas within local government, as well as to strengthen its relationships with DECC and the DfT.

IPPR recommends that government and industry work together to create a low-emission vehicles forum to focus attention on the development of an ULEV market and related infrastructure. This would include representatives of government, the automotive and energy industries, and other stakeholders. OLEV should provide a secretariat for this body. It should regularly produce detailed and publicly available progress reports covering the range of responsibilities at all levels of government for establishing a strong domestic ULEV market. Secondments from industry into government should become normal practice, and vice versa. Defra and DCLG should also second personnel into OLEV.

2.3 Recommendations for three key areas of industrial policy

Current government policy leaves something to be desired in three areas of critical importance to the industry: access to finance, support for innovation, and workforce skills (NAIGT 2009, SMMT 2012c).

2.3.1 Access to finance

An inadequate supply of affordable, long-term finance for SMEs is a longstanding economic problem in the UK. The 1931 Macmillan report identified this as an issue, and found that the root cause was an 'information asymmetry' between lenders and borrowers. Given the high transaction costs of conducting due diligence on each and every individual SME, banks tend to be reliant on standard markers, such as a company having a good track record and high level of collateral. This 'tick-box' approach automatically shuts out many SMEs, particularly start-ups, because they enjoy neither (Dolphin and Nash 2012).

12 https://www.gov.uk/government/news/future-of-hydrogen-powered-cars-mapped-out

This problem has been exacerbated by the financial crisis and its aftermath. Figures from the Bank of England show that the growth in lending to all SMEs in the UK has been negative for the last four years (Bank of England 2013). Bond issuance has been the biggest net source of funds raised by British businesses since early 2011, while loans and equity have been falling in net terms. There appears to be a particular problem for companies looking for funding of between £500,000 and £2 million, which is too much to raise informally but too little to be of interest to institutional investors (Merlin-Jones 2012). Early to mid-stage firms seeking to raise £5–10 million are also struggling. Recent government schemes to support increased lending, such as the Funding for Lending scheme, have done far more to support mortgage holders than small businesses (Pratley 2013).

The automotive industry has been no exception. While over the last two years investments totalling almost £6 billion have been announced in the UK,[13] most of these have been made by major manufacturers, with far less investment taking place down the supply chain. Indeed, smaller companies have struggled to access finance, and most banks do not offer specific tooling finance (Rumfitt 2012) (although there may be some progress on this issue following joint industry roundtables between the Automotive Council and the British Bankers' Association).

The number of UK companies that regard themselves as part of the 'automotive' supply chain has fallen from a peak of over 3,500 firms in 2005 to around 3,000 in 2009. Only one third of the value of components needed to support UK-based vehicle production are currently purchased in the UK, while two-thirds are imported. Through the trough of the recession in 2009, the UK automotive supply chain generated around £3.1 billion of the value of sales worth £12 billion in total. This compares with the 10-year period preceding the global financial crisis, when this 'value added' was significantly higher at approximately £4.5 to £5 billion annually (Holweg et al 2011).

A recent survey of 82 automotive firms, which together employed 18,500 people, found a series of systematic problems relating to both a lack of understanding of the automotive sector by Britain's banks and reluctance on the part of many SMEs – particularly the 37 per cent which are family run – to seek external equity (Rumfitt 2012). Indeed, credit conditions and terms of borrowing have worsened for more than a quarter of automotive firms, with many now forced to fund growth from their internal cash flow. The author of the report concluded that, 'Despite the market opportunities and the desire to grow (half of the firms surveyed want to raise extra funds to expand their businesses), the UK's automotive suppliers, especially firms with less than 500 staff, are being starved of the finance they desperately need' (ibid).

There is a clear need for banks, especially at the regional level, to increase their understanding of the different sectors of the local economy. More could also be done by government to 'bring together the ever expanding list of financial initiatives' (ibid), but the historic nature of the UK's problems with the supply of credit to SMEs suggests that a more radical approach is needed.

To address the chronic problem of lending to small firms, **IPPR advocates the creation of a British investment bank with responsibility for increasing long-term financing for small and medium-sized businesses** (Dolphin and Nash 2012). Given the future importance of the ULEV sector to the UK economy, it would be a key beneficiary of this policy.

13 For more details see http://www.smmt.co.uk/investment/

In the interim, large firms with excess cash or access to credit should do more to investigate lending to smaller firms in their supply chain in order to circumnavigate Britain's dysfunctional banking sector.

2.3.2 Support for innovation

In recent years the government has developed a plethora of initiatives to encourage innovation in the UK. Since 2007, both the Technology Strategy Board (TSB) and Energy Technology Institute (ETI) have been created. The government's £4.6 billion science budget was preserved during the spending review in 2010, and an additional £600 million for research council infrastructure was announced in the 2012 autumn statement.

These initiatives have contributed to an increase in R&D activity, but Britain is still behind its competitors. In 2011, the UK's gross domestic expenditure on research and development was £27.4 billion – an increase of 2 per cent in real terms compared with 2010. Total R&D expenditure in the UK in 2011 represented 1.79 per cent of GDP, which was below the EU average of 2.03 per cent of GDP (ONS 2013b).

A second problem is that the UK often fails to follow up its well established excellence in basic research with world class applied science and the commercialisation of new technologies (Sainsbury 2007). Indeed, universities in other countries outperform the UK in applied research and its commercial exploitation (Dyson 2010). Related to the issues outlined in the previous section on finance, there is a 'valley of death' in the UK that prevents the progress of science from the laboratory bench to the point at which it provides the basis of a commercially successful business or product (STC 2013).

Despite this, Britain is a world leader in automotive innovation. The Automotive Council was established in 2009 under the last government, and has set out a technology roadmap and identified five priority R&D areas for the industry (Jackson 2010).

In recent years Nissan has invested £725 million for the production of their LEAF model in the UK, Toyota are producing engines for their Auris Hybrid here, and the Tata European Technical Centre was expanded. The Motor Industry Research Association is also investing £250 million to expand its facility in Nuneaton, while UK-based Axeon is Europe's largest independent lithium-ion battery system supplier.

Meanwhile, the Formula One industry continues to be concentrated here – eight of the 12 teams that competed in the 2012 season are based in the UK. More broadly, approximately 4,500 companies are involved in the UK motorsport and performance engineering industry, which has an annual turnover of around £6 billion – of which £3.6 billion comes from exports.[14]

Nonetheless, there are a number of improvements that could be made to government policy.

A series of seven new 'catapult centres' are in the process of being established, two of which have direct relevance for the ULEV sector. The High Value Manufacturing Catapult, which was opened in October 2011, includes a focus on lightweight product system optimisation and energy storage and management. The Transport Systems Catapult, which appointed its chairman in February 2013, is tasked with improving the efficiency and cost-effectiveness of moving people and goods. Nonetheless, the automotive industry remains concerned that neither body addresses the need for new technology to support vehicle propulsion.

14 For more details see http://www.the-mia.com/The-Industry

Serious consideration should be given to creating a new advanced propulsion centre to support the government's automotive sector strategy.

There are concerns that all catapult centres are being pushed to become self-financing too quickly (STC 2013), while an effective advanced propulsion centre is likely to require £1 billion of joint funding from government and industry over a 10-year period. Finding additional resources for applied research in the current fiscal climate will prove difficult, so better use of existing funds must be explored. As Green Alliance have outlined, around 70 per cent of the current £1 billion R&D tax credit goes to large companies. In their view there is a 'suspicion … that much of it is paying for research by multinational companies which would happen anyway' (Spencer and Arwas 2013).

To address this, a recent select committee report has called for the government to distinguish between small and medium-sized enterprises, since it regards a single SME category as too broad (STC 2013). EEF and the Society of Motor Manufacturers and Traders (SMMT) have urged the government to introduce a cash benefit or redeemable credit at the point that R&D costs arise, rather than providing a 'relatively opaque offset' against corporation tax payments (SMMT 2011). Meanwhile, small pots of cash, such as the £125 million Advanced Manufacturing Supply Chain Initiative, can be important sources of money, but would work better if they were consolidated and made permanent.

The government should improve how existing grants, fees and R&D tax credits are targeted in order to ensure that sufficient funding is available for the development and demonstration phases of the low-emission vehicle innovation process. More consideration should also be given to facilitating access to EU R&D funding, which will increase under the new multi-annual financial framework.

2.3.3 Workforce skills

The automotive industry needs to attract well qualified employees at every skills level. This means attracting school leavers, apprentices undertaking high-level training, recent graduates, and those already in work. The Automotive Council is currently attempting to take strategic ownership of this issue. Its approach includes examining the case for an Employer Ownership of Skills pilot to create a clear framework and infrastructure for skills in the automotive sector for those with basic skills, on apprenticeships, graduates and people in work. Nonetheless, the challenge remains significant.

It has been estimated that 30,000 vacated positions in the automotive industry need to be filled as a result of retirements which either have taken place or are expected to take place between 2010 and 2016 (Semta 2010). While this total is offset by the loss of 2,800 jobs over the same period, it does still mean that 27,000 vacancies will need to be filled over this period, at a rate of 4,500 jobs per year. As well as managerial occupations and professionals, this includes process, plant and machinery operatives.

The supply of engineers is far from keeping up with this demand. Only around one fifth of employees in the automotive sector have a higher education degree or equivalent qualification, yet new and growing areas of demand in the sector require high-level skills (McNeil 2012). Therefore it is alarming that, of the 2,895 mechanical engineering graduates in the UK in 2010, just 76 became automobile engineers (HECSU/AGCAS 2011). Last year, a report by the Royal Academy of Engineering (RAE) (Harrison 2012) found evidence that 'the demand for graduate engineers exceeds supply and the demand is pervasive across all sectors of the economy'. The RAE estimates that the number of science, technology, engineering and maths graduates needs to increase by at least 50 per cent. At odds with the Semta research, they concluded that premium vehicle manufacturing was a sector in which demand for labour is driven by expansion as well as by people leaving the labour market.

The UK government should continue to prioritise the expansion of engineering degree courses at British universities, but more must be done to ensure that those who complete the courses use their skills professionally. There is an important role for the automotive industry in sponsoring students taking engineering degrees, since rising tuition fees mean that there can be no guarantee that new places will be taken. This could include covering some or all of the cost of their degrees in exchange for a time-limited commitment to the firm after graduation.

Since 17 per cent of engineering undergraduates and 47 per cent of graduates are from outside the EU, the problem of skills shortages will be exacerbated by the government's immigration policies (HESA 2012). The growth in international students coming to study in UK higher education institutions has halted, and the number of students at universities who are applying to extend their stay in the UK (for example, to move on to a more advanced degree) is now falling. The closing of the post-study work scheme, and the consequent uncertainty about international students' ability to stay in in the UK after they graduate, risks both damaging recruitment of international students and depriving the British economy of the benefit of UK-trained foreign engineering and technology graduates.

Beyond the issue of students, there is also a risk that the cap on skilled migration to the UK for work will limit the future ability of firms to recruit sufficient skilled staff from overseas. The government should be actively seeking to attract students and workers with engineering and technology skills to come to the UK, but its current policies and political rhetoric are sending the opposite message.

The government should reverse these policies and encourage international engineering and technology students to remain in the UK and use their skills professionally. Engineering and technology graduates should also be encouraged to come to the UK to work.

Of course not all jobs are suitable for recent graduates, and it is vital that there are vocational routes into the automotive industry. Across the economy, the number of apprenticeships nearly doubled in two years, from 279,700 in 2009/10 to 520,600 in 2011/12. Much of this has been due to a rapid increase in the number of people aged 25 and over starting apprenticeships, primarily as a result of the relabeling of the Train to Gain programme. Indeed, the number of apprenticeships taken up by this age cohort more than quadrupled in just those two years (Evans 2013).

In the automotive sector only 14 per cent of establishments offered apprenticeships in 2009, which was below the average of 18 per cent for manufacturing as a whole (UKCES 2011). Although there are no specific data for apprenticeships in the automotive sector, apprenticeships in the engineering sector fell by 28 per cent in 2011/12, and are at their lowest level for five years. That said, advanced and higher apprenticeships rose from 8,650 in 2010/11 to 9,830 in 2011/12 (Data Service 2013).

The Automotive Council should work with the Data Service to collect figures on the number of apprenticeships in the automotive sector. They should outline targets to rapidly increase the number of automotive firms offering apprenticeships, as part of an effort to double the number of advanced and higher apprenticeships over the next five years. These opportunities should be better communicated by industry to young people, parents and careers advisors.

3. CREATING A DOMESTIC MARKET FOR ULEVS

A revolution is taking place in the motoring industry, with new regulations around the world driving ever lower emissions standards. As one of the world's largest car producers, and a leading exporter, Britain has a significant opportunity to capture a large portion of this new market. Chapter 2 outlined some of the industrial policies relating to innovation, access to finance and skills which could ensure that the UK remains a world-class car producer. However it is also essential that the domestic ULEV market is developed so that Britain becomes as attractive an environment as possible for automotive manufacturers.

3.1 The global and UK ULEV markets

All around the world, consumers are beginning to purchase these new vehicles. Table 3.1 shows how within Europe, in volume terms, France led the way in 2011 and 2012, while in terms of a percentage of total car registrations over the same period, Norway is the leader. By the end of January 2013, 10,591 plug-in electric vehicles (primarily PEVs) had been bought (including those bought before 2011) and were being driven on Norwegian roads (GB 2013).

Table 3.1
Plug-in electric vehicle (PHEV, E-REV and PEV) registrations total, 2011 and 2012

Country	Total plug-in electric vehicle registrations	Total vehicle registrations	Plug-in electric vehicles per thousand vehicles
Norway	6,287	276,312	22.75
Estonia	562	32,617	17.23
Portugal	2,250	248,713	9.05
Austria	4,924	692,155	7.11
Netherlands	6,030	1,058,390	5.70
Poland	1,640	551,016	2.98
Denmark	987	340,799	2.90
Switzerland	1,472	647,097	2.27
France	8,989	4,102,989	2.19
Sweden	1,128	584,883	1.93
Czech Republic	507	347,291	1.46
Slovakia	156	142,099	1.10
Belgium	1,148	1,058,948	1.08
Germany	6,553	6,256,138	1.05
United Kingdom	**3,342**	**3,985,862**	**0.84**
Spain	863	1,507,640	0.57
Latvia	13	25,636	0.51
Bulgaria	14	38,541	0.36
Hungary	34	98,162	0.35
Greece	2	156,164	0.01

Source: ACEA (2012)

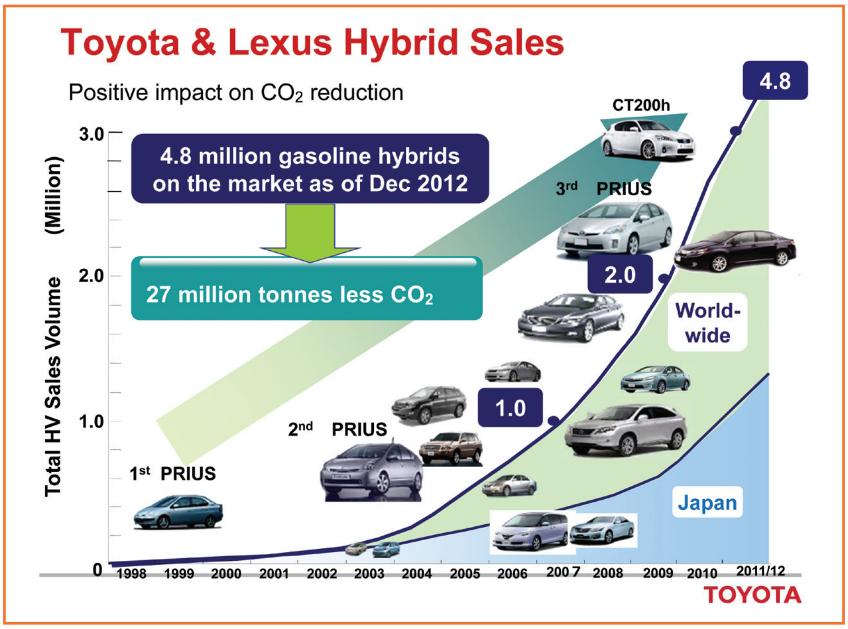
Globally, the largest sales of ULEVs by volume are in the USA. Though total sales figures for 2012 are not yet available for the US, early indications show that sales of plug-in electric vehicles in the US almost trebled in 2012 relative to sales in 2011, to around 53,000 (Voelkcer 2013).

Pike Research forecasts that the global plug-in electric vehicle market is likely to grow at an annual rate of 39 per cent between 2012 and 2020, resulting in 7.8 million plug-in electric vehicles on the world's roads. Their research also indicates that global sales of charging point equipment are likely to surpass $3.8 billion by 2020 (Pike Research 2013a and 2013b).

Although total registrations of hybrid cars (like the Toyota Prius) and other electric vehicles in the UK had risen to 104,900 by the end of 2011 (DfT 2012a), Britain has not enjoyed the same initial take-up of ULEVs as has been seen in the countries listed above. As a result the UK is sixth out of 20 in terms of total registrations of plug-in electric vehicles, and 15th in terms of registrations of these vehicles expressed as a percentage of all cars registered in 2011 and 2012.

Since many ULEVs have yet to come on to the market in the UK (see the annex), it is too early to say whether there has been a market failure. Interviewees generally expected the uptake of ULEVs to follow a similar trajectory to that of the Toyota Prius, originally launched in 1998 (see figure 3.1 below). It took six years from the launch date for global sales of the Prius to begin to take off. This is because consumers are initially sceptical about new technologies in the automotive sector, and the expense of new automobiles means that potential purchasers are naturally cautious when choosing what type of product to buy.

Figure 3.1
Growth of Toyota Hybrid by volume



Source: Toyota

Nonetheless, the UK is already lagging behind other countries. The main barrier to the growth of the ULEV market in the UK lies in the lack of demand for ULEVs amongst UK drivers and fleet managers. The potential reasons for this can be narrowed down into two key factors; the perception that ULEVs are always more expensive than other vehicles, and the lack of public knowledge about what it is like to drive ULEVs and about their technological operation (including charging patterns). While Britons continue to default to familiar technologies, there is a growing risk that the UK will lose the hard-won comparative advantage it has built up in recent years.

The government has a range of incentives in place to stimulate demand for ULEVs. In this chapter we will focus on three types: purchase incentives to reduce the costs of ULEVs; usage incentives designed to make owning and driving an ULEV a more attractive prospect than other vehicles; and public procurement. Support for the development of charging infrastructure for electric vehicles, including hydrogen infrastructure for FCEVs, will be dealt with in chapter 4.

3.1 Purchase incentives

This section will set out the UK's purchase incentives for ULEVs, give some examples of purchase incentives from other countries, and make recommendations for the future.

3.1.1 UK purchase incentives

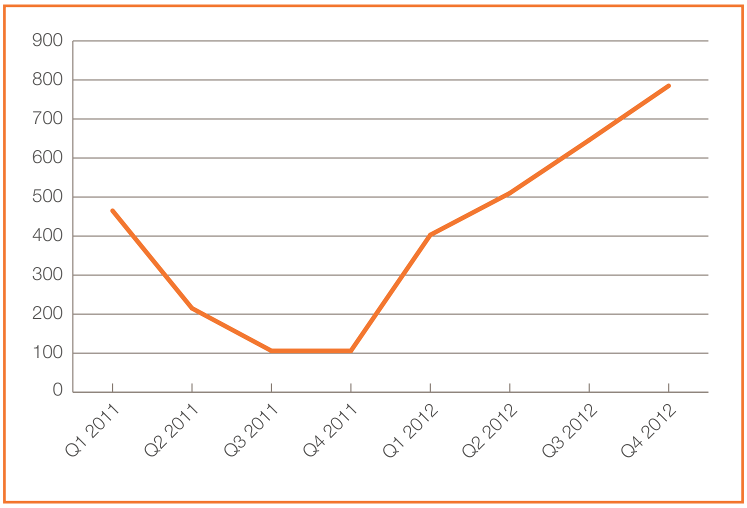
The government's flagship policies to stimulate the domestic market for ULEVs are the plug-in grants. These grants will be available until 2015, and cover:

- 25 per cent of the cost of a car, up to a maximum of £5,000
- 20 per cent of the cost of a van, up to a maximum of £8,000.

In order for a vehicle to be eligible for the grant it must fulfil a number of criteria – including safety, battery range and speed – and must emit less than 75g CO_2/km.[15] The ULEVs that are approved for eligibility for the plug-in grants are highlighted in the annex.

The government set aside £300 million for the funding of the plug-in grants, which remains available until 2015. Figure 3.2 below illustrates the number of annual applications for the plug-in grants since they were first made available in January 2011. As of the end of 2012, 3,236 applications had been made to OLEV for funding to support the purchase of ULEVs, with the majority of these (93 per cent) going towards the purchase of cars. Of this total, 75 per cent of the cars and 95 per cent of the vans were purchased by businesses (HC 2013).[16] By the end of 2012 just 5.6 per cent of the fund had been used, leaving over £283 million of available funds. The dip in applications in 2011 followed the publication of OLEV's infrastructure strategy and the criticisms made of it by the Labour party.[17] Some interviewees stated that this lack of cross-party support for the industry generated a negative media cycle for the ULEV market which set it back by several months.

Figure 3.2
Annual applications for plug-in grants, 2011–12



Source: OLEV

15 Not all electric vehicles are eligible for this grant, for a variety of reasons. For example the Renault Twizzy is not eligible as it technically constitutes a quadricycle and not a car or van. However FCEVs will be eligible if they meet the qualifying criteria. For details of the eligibility criteria for ultra-low-emission cars see https://www.gov.uk/government/publications/plug-in-car-grant, and for ultra-low-emission vans see https://www.gov.uk/government/publications/plug-in-van-grant

16 https://www.gov.uk/government/publications/plug-in-car-grant and https://www.gov.uk/government/publications/plug-in-van-grant

17 http://www.labour.org.uk/ministers-must-come-clean-bury-bad-news

In addition to the plug-in grants, government offers a range of fiscal incentives for ULEV uptake that can be utilised by the public sector and businesses. These incentives,[18] which are also available until 2015, are:

- cars that have emissions of 0g CO_2/km attract a company car tax (CCT)[19] rate of 0 per cent of the car list price
- cars that have emissions of between 1–75g CO_2/km attract a CCT rate of 5 per cent of the car list price
- vans that have emissions of 0g CO_2/km are exempt from the van benefit charge[20]
- ULEVs and other low-emission vehicles emitting less than 95g CO_2/km attract 100 per cent first year capital allowances
- cars with emissions of less than 100g CO_2/km and vans with emissions of 0g CO_2/km will attract no vehicle excise duty.

However, changes to these policies were introduced in the 2012 and 2013 budgets (see box below).

The potential of these polices to reduce the costs of owning and operating an ULEV to businesses and the public sector is best illustrated by work being done by the Energy Saving Trust (EST) under the government-funded Plugged-in Fleet Initiative (PIFI)[21].

An analysis prepared for IPPR by the EST demonstrates this potential (while taking account of the changes brought in by the 2012 and 2013 budgets; see below). The EST found that, by purchasing and operating a Nissan LEAF rather than a Ford Focus Zetec S, a business or public sector owner could potentially save £3,755 over a four-year period, with an assumed mileage of 10,000 miles for business use and 5,000 miles for personal use. The employee driving the vehicle would benefit from savings of £5,197 over the same period.

Budget changes in 2012 and 2013

In the 2012 budget the government introduced changes to the preferential CCT rates applicable to ULEVs which will make them less favourable after 2015. This meant that the tax incentives for buying ULEVs would have become equal to those for hybrid electric vehicles, which have a much better-established market. Furthermore, it was announced that, from 2013/14, the 100 per cent first-year capital allowances available to purchasers of ULEVs and other vehicles emitting less than 95g CO_2/km would no longer be available to companies purchasing vehicles for the purpose of leasing or renting them to other persons.

18 In addition to these incentives, owners of ULEVs are also likely to pay much less fuel tax, including fuel duty and fuel benefit tax (a ‘benefit in kind’ tax similar to company car tax). In the case of PEVs, no fuel tax is payable at all.

19 Company car tax is the term given to the ‘benefit in kind’ taxes (the employer’s class 1A national insurance contributions, employee’s national insurance contributions and the employee’s income tax) payable in respect of the provision to the employee of a company car. The total amount of tax payable is based on a percentage of the car’s list price (published by the manufacturer, importer or distributor) which is then graduated according to the car’s g CO_2/km emissions.

20 The van benefit charge is the CCT equivalent for vans, but is set at a fixed rate of £3,000.

21 http://www.energysavingtrust.org.uk/Organisations/Transport/Products-and-services/Fleet-consultancy/Plugged-in-Fleets-Initiative

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In the 2013 budget, the chancellor announced that, from 2015/16, ULEVs with emissions of between 0–50g CO_2/km would attract a CCT rate of 5 per cent of the car list price, and that from 2016/17 this would rise to 7 per cent. A new second band was also introduced for ULEVs with emissions of between 51–75g CO_2/km: these will attract a CCT rate of 9 per cent in 2015/16, rising to 11 per cent in 2016/17. Furthermore, the government set out a descending scale for changes to the differences between these two bands, and the third band above them, for the remainder of the next parliament. The government also committed to publishing future CCT changes three years in advance of their implementation.

It was confirmed that the enhanced capital allowances for ULEVs would be extended until March 2018. The 2013 budget also included the announcement that vehicle excise duty for ULEVs would remain fixed, and there would be no reform of vehicle excise duty during the current parliament.

3.1.2 International examples

In Norway, the country that has been most successful in encouraging ULEV uptake, purchase incentives include exemptions from car purchase taxes (which can be in excess of €10,000) and from the 25 per cent VAT rate on the purchase of the car (NE 2013). As a result, they are significantly cheaper than in the UK.

Estonia, which has the second-highest rate of uptake of ULEVs in Europe, provides a grant for PEVs of 50 per cent of the vehicle price, capped at €18,000 (Beltramello 2012).

France, on the other hand, has operated a 'feebate' tax scheme for all new vehicles purchased: if cars emit less than 125g CO_2/km, a tax credit is payable to the purchaser of up to €7,000, and over that threshold a purchase tax is paid by the buyer of up to €3,600 (AP 2012, IEA 2012, Beltramello 2012). However, as the OECD has demonstrated, this scheme led to an increase in French carbon emissions, and accumulated a deficit of €1.25 billion between 2008 and 2010; a further deficit of €245 million was expected for 2011 (Beltramello 2012).

In the US, the ULEV market benefits from support at both federal and state level. The federal government provides between US$2,500–7,500 in tax credits, depending on the size of the car battery, and the White House is encouraging congress to increase this support and change it to cash credit akin to the plug in grants in the UK (Beltramello 2012). Furthermore, 40 state governments and the District of Columbia offer additional tax incentives or cash rebates as incentives to buy ULEVs. For example, California offers rebates of up to US$2,500 on top of the federal tax credits.

3.1.3 Support for Leasing and Rental Companies

Many interviewees argued that the key to promoting ULEV uptake lay in supporting leasing and rental companies, partly as a means of allowing the public to gain experience of ULEVs.

Most cars and vans are bought through some form of leasing or rental company. In 2011 58 per cent of new vehicle registrations were made by businesses, and of these registrations over 90 per cent were part of a fleet of 25 vehicles or more (SMMT 2012a).

In the fourth quarter of 2011, 74 per cent of fleets had vehicles financed on a contract hire basis, 22 per cent had vehicles financed on an ad hoc hire basis, and 19 per cent of fleets had vehicles financed on a finance lease basis (Experteye 2012). Furthermore, 66.5 per cent of consumers used either hire purchase arrangements or personal lease arrangements.[22]

Therefore the changes made in the 2012 budget, which removed the availability of enhanced capital allowances for ULEVs to leasing and rental companies, have had a serious impact on the fiscal incentives available to support ULEV uptake, particularly by public sector bodies.[23] IPPR has been told that the removal of the availability of 100 per cent first year capital allowances to leasing and rental companies could add 3 to 5 per cent to the cost of a car lease, or up to £15 per month on a £300 per month lease. For a fleet of 25 ULEVs financed over a four-year period, this adds a total of £18,000 to the cost of that fleet of ULEVs.

We recommend that the government immediately reinstate the 100 per cent first year capital allowance availability for leasing and rental companies.

3.1.4 Policy recommendations: medium-term certainty of policy

Examples from abroad, Norway in particular, show that making the cost of an ULEV comparable to, or better than, the cost of an ICEV can have a positive effect on ULEV uptake. Indeed, many interviewees commented that making the cost of ULEVs comparable to that of ICEVs would help encourage their purchase.

PIFI research shows that, for business and the public sector, current government purchase incentives can be very effective in reducing the whole-life costs of an ULEV to a level comparable to, or lower than, those of an ICEV. This is reflected by the fact that 75 per cent of applications for plug-in grants for cars and 95 per cent of applications for plug-in grants for vans in 2011 and 2012 had been made by businesses (HC 2013). With the majority of vehicles being bought as part of large fleets, the government's current purchase incentives have the potential to encourage the uptake of ULEVs by those currently purchasing the majority of ICEVs; however, more needs to be done to make fleet managers aware of this potential. Therefore, given both the large underspend of the funding available for the plug-in grants and the fiscal constraints facing the government, we do not believe that it is practicable for extra funding to be made available at this stage of market development.

Without exception, all participants in our research agreed that the changes introduced by the government's 2012 budget to the fiscal incentives available to business and the public sector to support the uptake of ULEVs had a negative impact on the market, as did the negative news cycle mentioned above. A study commissioned by the Institution of Engineering and Technology (IET) on the future of low-carbon vehicles in the UK showed that 'the lack of political will to promote the use of low-carbon vehicles is by far the most important issue according to experts. Without that will, we are unlikely to see substantial increase in ULEV use in the next 15 years' (IET, no date).

22 Data provided to IPPR by the Finance & Leasing Association.

23 Public sector bodies generally can't take advantage of capital allowances in their own right because they don't pay corporation tax (the notable exception being certain NHS Foundation Trusts that carry on significant commercial activity). Therefore the only way they can benefit from this policy is if a leasing company buys an ULEV and then leases it to the public sector body, with the leasing company passing on the benefit received from the capital allowances by reducing the amount of rent that it charges the public sector body.

All interviewees argued that increased political support and medium-term certainty about current government policy was more important than increases in purchase support for business, the public sector or individuals. This political support and policy certainty is needed due to the slow expected take up of ULEVs by consumers (see chapter 1). In short, current government policy was seen as good for encouraging take-up, but only provided that it would last beyond 2015. **We recommend that all political parties confirm that the money currently available for the plug-in grants will not expire in 2015, and that any underspend will be rolled over until it is exhausted.**

As the PIFI research demonstrates, from the perspective of a fleet purchaser these policies only make sense over a period of several years, over the lifetime of a vehicle (that is, beyond the end of the current parliament). Therefore there needs to be certainty about the continuance of these fiscal measures extending beyond the availability of the plug-in grants. We welcome the announcements the government made in the 2013 budget (see boxed text on page 23), and recommend that all political parties confirm that the vehicle excise duty rates, CCT rates and the availability of first year capital allowances for ULEVs set out in the 2013 budget will remain in place until the end of the next parliament.

Naturally this would result in losses to government revenues beyond 2015 which need to be calculated (to the extent that they have not been costed in the 2013 budget). However these would represent only a fraction of the decline in vehicle excise duty and fuel duty revenue which will result from increased fuel efficiency in ICEVs and the future take-up of electric vehicles. The solution to both problems lies in reform of fuel duty and vehicle excise duty, which fall outside the scope of this report.

Nevertheless, we recommend that the following principles should underpin the implementation of such reforms:

- **Any increase of vehicle excise duty on more polluting vehicles which is designed to subsidise the lack of revenue from ULEVs during the next parliament should focus on vehicles with median emission levels.** Global emissions standards are pushing manufacturers to produce ULEVs and ICEVs with increased fuel efficiency and lower carbon emissions – there is no need to tax the most polluting vehicles to discourage demand for them, as their supply is already diminishing. Since revenue from the most polluting vehicles will therefore always be in decline, a policy of continuing to tax the most polluting vehicles would only produce uncertainty. Targeting the median bracket of emissions, on the other hand, would give medium-term certainty of policy.
- **Any increase in vehicle excise duty should continue to target new cars over older cars in order to be as progressive as possible. There is currently a higher rate of vehicle excise duty for vehicles in their first year of registration, and we suggest that the Treasury consider extending this term.**
- **The government should also look at the possibility of taxing sales of hydrogen and electricity for ULEVs to mitigate any losses of fuel duty and ULEVs in the medium to long-term future.**
- Any changes should be made on the basis of long-term planning, gradual introduction and consistency of approach.

3.2 Promoting the use of ULEVs

IPPR's interviewees stated that not only is it important to reduce the *cost* of an ULEV in comparison to an ICEV, it is also important to prioritise the *use* of an ULEV over that of an ICEV. This was deemed to be particularly important for the consumer market, where the level of purchase support is not as high as for businesses and the public sector. However usage incentives would benefit all types of purchasers.

Examples of ULEV usage incentives include:

- free parking of ULEVs in public car parks and on streets where a payment or permit is required
- in areas of intense competition for parking, priority being given to permit applications from ULEV drivers over drivers of other vehicles
- permission to park ULEVs in restricted areas – such as double red or yellow lines
- fines for more polluting vehicles parked in areas reserved for ULEVs – for example, in front of a charging point (akin to the blue badge scheme for disabled drivers)
- exemption from any city congestion charges – in London and Durham, for example
- free use of toll roads, bridges, tunnels and ferries – such as the M6 toll road, the Clifton Suspension Bridge and the Severn Bridge
- permission for ULEVs to use bus lanes or other restricted road lanes – such as high occupancy lanes.[24]

3.2.1 Usage incentives in the UK

In the UK, usage incentives tend to fall within the remit of local authorities and other devolved administrations. Some authorities already have such policies place.

Congestion charge exemptions

Durham does not currently offer any exemptions to its congestion charge for ULEV drivers. However, Transport for London (TfL) operates two full discounts, for which all ULEVs are eligible, to the London congestion charge. The PIFI research prepared by EST for IPPR shows that, on the basis of three trips per week over four years, this could save a business £5,400 on top of the purchase incentives offered by government. In some circumstances, this incentive could tip the balance between whether or not the overall cost of an ULEV outweighs that of another type of vehicle. While TfL is considering reform of its congestion charge exemptions, these reforms will not impact ULEVs.

Parking incentives

Local authorities around the country have different policies that give priority parking rights to ULEVs. Examples include the following:

- Islington council[25] gives free residential parking permits to plug-in electric vehicle owners.
- Milton Keynes council[26] allows plug-in electric vehicles to be parked free of charge at a charging point, regardless of whether or not the vehicle is plugged in.
- Brighton and Hove council[27] allows plug-in electric vehicles to benefit from free parking provided that the owner has a permit.

24 High occupancy lanes are road lanes reserved for vehicles with multiple occupants only.
25 http://www.islington.gov.uk/services/parking-roads/electric-vehicles/Pages/default.aspx
26 http://www.milton-keynes.gov.uk/mkparking/displayarticle.asp?ID=73757
27 http://www.brighton-hove.gov.uk/index.cfm?request=c1245919

- Newcastle council fines drivers of any vehicle who park in front of a charging point without being connected[28], offers free residential parking permits to owners of PEVs, and offers owners of any other ULEV a discount on their residential parking permit.[29]
- Sunderland council offered free parking to drivers of plug-in vehicles connected to charging points, but only until March 2013.[30]
- Wandsworth council[31] offers a reduced residential parking rate for plug-in electric vehicle owners, but does not offer any benefits to plug-in electric vehicle drivers visiting Wandsworth.
- Westminster council[32] requires plug-in electric vehicle owners to pay a £75 annual fee, over and above the fees payable for use of charging point, for permission to park at a charging point for free.

ULEVs in London bus lanes?

The only city in Europe which currently allows ULEV drivers to use bus lanes is Oslo in Norway – the country which has the highest proportion of ULEV sales relative to sales of other vehicles. TfL has already examined the possibility of allowing ULEVs free use of bus lanes in London, and decided against such a policy (TfL 2010).

TfL's reasons for not permitting ULEVs on London's bus lanes include the following:

- London is a much larger and more dense city than Oslo, where the bus lanes on which ULEVs are permitted to travel are all on major roads between neighbouring conurbations rather than minor roads.
- The fact that ULEVs are becoming increasingly indistinguishable from other vehicles would make it difficult to enforce such a policy.
- The friction caused by ULEVs changing lanes could slow down all traffic, resulting in a potential cost to London of up to £15 million per km per annum, amounting to £4.656 billion per year (ibid).

The primary purpose of bus lanes in London is to improve the bus network and therefore the road network as a whole, and this – rather than the promotion of ULEV uptake – should remain the priority. However, TfL's decision should not discourage other local authorities from considering whether they could benefit ULEV drivers in other UK cities by implementing such a policy.

3.2.2 International examples of usage incentives

ULEV usage incentives in Norway include freedom from charges on toll roads, congestion charge exemption, free municipal parking, and the ability to drive zero emission vehicles on bus lanes in Oslo (see box above). In the Netherlands – where there are no direct purchase subsidies for ULEVs – free parking is available in Amsterdam, where public parking otherwise costs €5 per hour.[33] PEV owners are also given priority when applying for a

28 http://www.newcastle.gov.uk/parking-roads-and-transport/parking/electric-vehicle-charging-points
29 http://www.newcastle.gov.uk/parking-roads-and-transport/parking/resident-permit-holders
30 http://www.sunderland.gov.uk/index.aspx?articleid=5014
31 http://www.wandsworth.gov.uk/info/474/street_parking-permits/1074/permit_and_parking_charges
32 http://www.westminster.gov.uk/services/transportandstreets/parking/wheretopark/vehicletype/electric/
33 http://www.amsterdam.info/travel/driving/

residential parking permit, the waiting list for which is currently five years long[34]. In Canada, Washington DC and in 14 US states such as New York, California and Florida, electric vehicles are allowed to use high occupancy lanes regardless of the number of occupants (IEA 2013, Beltramello 2012). In California, which has a culture of promoting environmentally friendly policies, a one-stop advisory service is provided by the Center for Sustainable Energy which gives potential purchasers of ULEVs an independent source of information on matters such as installing domestic charging point equipment.[35]

3.2.3 Policy recommendations: usage incentives

The countries that have had the most successful take-up of ULEVs so far tend to be those that offer not just strong purchase incentives but also comprehensive usage incentives. This strongly indicates that, at this stage of global market development, both incentives are required.

A major concern for local authorities is that the introduction of new schemes to promote ULEVs will lead to a loss of revenue, particularly the provision of free parking for either residents or visitors. In 2010/11, local authorities' receipts from parking totalled £1.27 billion[36], while the net income from both on and off-street parking service revenues for that year was £511.6 million. That net income rose to £565.4 million in 2011/12, a 10.5 per cent increase (DCLG 2012). In the current fiscal climate, councils are naturally defensive of this income as a means of offsetting cuts in receipts from central government.

Since data is not yet available on the use of charging point infrastructure, it is not yet possible to carry out any analysis of which councils would be most affected by the cost of providing parking exemptions. The evidence submitted by the DVLA to the parliamentary transport committee certainly shows that the registration addresses of ULEVs are clustering, but this gives only limited information about where these ULEVs are likely to be parked and none as to the destinations to which they travel (HC 2012). Nonetheless, since only 3,236 applications for plug-in grants had been received by OLEV at the end of 2012, the total fiscal impact on any particular local authority of providing free parking or other usage incentives for ULEVs is likely to be small.

Furthermore the implementation of usage incentives could also offer opportunities for local authorities to access new revenue streams. For example, parking fees charged to drivers of vehicles other than ULEVs could be increased to subsidise free parking to ULEV drivers, and fines could be levied on other vehicle drivers for parking in areas reserved for ULEVs.

As the examples above demonstrate, usage incentives for ULEVs vary in the UK from local authority to local authority. It is therefore impossible for an ULEV driver to be sure of the benefits offered to him or her without careful planning. Given the current differences in the approaches taken by local authorities, particularly those local authorities with dense populations such as London, greater uniformity of local authority policy is needed.

DCLG, the Local Government Association and OLEV should work together to encourage local authorities to offer incentives which are compatible across borders. This could be facilitated by secondments from DCLG into OLEV.

34 http://www.businessgreen.com/bg/news/1806110/amsterdam-launches-electric-vehicle-grant-scheme
35 http://energycenter.org/index.php/outreach-a-education/plug-in-a-get-ready
36 https://www.gov.uk/government/news/town-hall-transparency-to-expose-car-parking-charges

We encourage all local authorities to work together, and with local enterprise partnerships, to examine the potential for creating new usage incentives in their jurisdictions and to ensure uniformity across their boundaries, particularly in urban areas. We encourage them to be as innovative as possible in raising and distributing revenue from fines to offset any decline in revenue from other sources. The government should also work with operators of toll roads, bridges and ferries to encourage them to offer exemptions for ULEV drivers.

Concern has been expressed at how similar ULEVs now coming on to the market look to other vehicles – this does present a potential barrier to local authorities providing usage incentives (TfL 2010). The difficulty of differentiating between ULEVs and other vehicles is likely only to increase: as the emissions of new models of ICEV continue to fall, they may reach a point at which local authorities consider them worth promoting as well. To overcome this barrier, **a simple first step would be for the DfT to set up a 'green badge scheme' to allow ULEVs to be easily identified**. This could be similar in operation to the blue badge scheme[37] that facilitates parking for disabled people. The terms for obtaining a blue badge and the benefits it entails are ultimately set by local authorities, although its physical appearance is uniform across the EU.

3.3 Public procurement

The UK government currently spends over £400 million on the procurement of vehicles every year (OGC 2009). As a significant purchaser, government at all levels can send a positive signal to the automotive industry by committing to the purchase of ULEVs. Furthermore, greater public procurement would ensure that a wider group of people gained experience of driving ULEVs. In 2011, Defra published a new government buying standard[38] (GBS) for transport which mandates that fleet average CO_2 emissions of all new cars procured must be at or below 130g CO_2/km. However this standard does nothing to promote greater acquisition of ULEVs by government, because the average emissions of all new cars in the UK in 2012 were only marginally higher than this target (SMMT 2013a).

Calling for a quantitative procurement target (for example, requiring NHS trusts to replace all small vehicles used by district nurses with ULEVs) is not practicable. The PIFI analysis shows that each public sector organisation needs to examine procurement on a case by case basis. However, with careful planning and consideration, it is possible for the public procurement of ULEVS to be more cost-effective than buying other vehicles. Furthermore, the OECD points out that 'using public procurement to support [market] development of green cars runs the risk of inefficient policies' if they are targeted towards particular kinds of vehicles or particular types of public sector body (Beltramello 2012). A learning process about the procurement of ULEVs across all government departments is therefore required.

On 19 February 2013, OLEV announced its commitment to reviewing the fleet average emissions standard in the transport GBS. We welcome this commitment. As well as tightening the target, the GBS for transport should set out a series of milestones – our suggestions for which are outlined below. These would send a clear signal to the global automotive industry that the UK government is serious about building public demand for

37 There are 2.62 million blue badge holders in the UK (DfT 2012c). These drivers are entitled to various benefits including the ability to park on double yellow lines, stop on red line routes, free parking in meter and pay-and-display areas and also reserved parking spaces (DfT 2012d).

38 Government buying standards are mandatory for all central government departments, their executive agencies, non-departmental public bodies and non-ministerial departments. They are aligned to the European Commission's Green Public Procurement (GPP) initiative, and so meet EU-wide minimum criteria. See http://sd.defra.gov.uk/advice/public/buying/products/transport/standards/

ULEVs in the UK. They would also give central government fleet managers sufficient time to learn about the operation of ULEVs and how to maximise the benefits they provide, as well as retaining flexibility for central government fleet managers to procure ICEVs in addition to ULEVs right up to 2020, which would ensure that the transition is made at a steady and achievable pace.

Our recommendations for these milestones are as follows:

- **The GBS for transport should become more stringent over time. By 2020 the fleet average for all new cars procured by central government should not exceed 95g CO_2/km. This would mirror the emissions target set for manufacturers by the EU.**
- **The new 2020 target should be phased in so that, in 2017, an average of 65 per cent of all new cars procured by central government must have emissions of 95g CO_2/km or less. This should rise to 75 per cent in 2018, 85 per cent in 2019, and 100 per cent from 2020 onwards.**
- **A 2020 emissions target for all vans procured by central government should be introduced. It should be set at 147g CO_2/km (again mirroring the EU target for van manufacturers) and phased in as above.**

4. 'FUELLING' INFRASTRUCTURE FOR PLUG-IN ELECTRIC AND HYDROGEN VEHICLES

As chapter 1 of this report set out, new emissions standards around the world are driving an increased supply of ULEVs. We argued in chapter 2 that Britain's automotive industry can establish a comparative advantage in ULEVs, as it has done in ICEVs, provided that the right industrial policies are put in place and a thriving domestic market is developed. However, if this is to occur, the UK will need to formulate a strategic approach to installing charging point infrastructure to connect plug-in electric vehicles to the UK's electricity system. Furthermore, when FCEVs come to market in around 2015 an initial network of hydrogen refuelling stations will need to be in place to support them, and a long-term plan established for further roll-out. This chapter will look at the policies required to achieve this.

Plug-in electric vehicle charging – the technical bit
There are three types of charging.[39]

Standard charging (2.3 to 3.7kW) – This type of connection can be made using the standard three-point plug available throughout the UK, although it can also be made with a different type of plug and, in some cases, with trip switches built into the wiring. Standard charging will typically take six to 10 hours. The first public charging points to be installed using PiP funding (see section 4.1 below) were all standard charging connections. There were 1,539 public standard charging connections in the country as of 20 March 2013.[40]

Fast charging (7.4 to 20kW) – Fast charging requires a different plug and connection to the standard three-point plug, and therefore cannot be carried out at home without installing new technology. Fast recharging will typically take one to three hours. The government favoured a plug-in electric vehicle connector known as 'Type 2' (OLEV 2011), and in January 2013 the European Commission announced it was mandating this connector for the whole of Europe.[41] There were 1,631 public fast charging connections in the UK as of 20 March 2013.[42] ULEVs coming on to the market are increasingly fast-charging compatible. Energy companies are beginning to offer fast charging technology for home use, but the varying condition of wiring in homes means that not all homes are suitable.

Rapid charging (20 to 100kW) – This type of charging converts the alternating current delivered by the electricity system into a direct current that can be used to charge a plug-in electric vehicle's battery at a much faster rate. This requires larger, more expensive charging points with thicker wiring due to the higher wattage of the charge, and is therefore deemed unsuitable for domestic charging. Rapid charging will typically take between 15 minutes and one hour. There were 27 public rapid charging connections in the UK as of 20 March 2013.[43] Internationally there are two different types of rapid charging connection, CHAdeMO and Combo II.

39 These descriptions of charging time are indicative only, and based on a typical battery installed in a PEV charging from empty to full. Charging times will vary depending on a number of factors including the technological constraints of the battery, the wiring to the connection and also how drained the battery is.
40 Data obtained from the POD Point national charge point registry.
41 http://europa.eu/rapid/press-release_IP-13-40_en.htm
42 Data obtained from the POD Point national charge point registry.
43 Data obtained from the POD Point national charge point registry.

BOXED TEXT CONTINUES

The key difference between the two from a consumer perspective is that a Combo II plug is capable of delivering both fast and rapid charging, while a CHAdeMO plug can deliver only rapid charging, necessitating a separate plug for fast charging. Interviewees described the development of these two different types of connection as an 'own goal' by the global automotive industry, and the debate simply creates confusion for consumers and local authorities.

4.1 Government policy

Government analysis has indicated that the majority of plug-in electric vehicle charging would take place at home,[44] generally overnight, followed by the workplace and with the balance done at public charging points (OLEV 2011). IPPR's research showed strong concurrence with this expectation. The government's policy to support this was to provide match funding to a consortia of businesses and public sector partners who were willing to install and pilot charging point infrastructure (whether domestic, in the workplace or in public places) in eight designated regions[45] known as the 'plugged-in places', or PiPs. The aim of encouraging a variety of approaches was to learn from the successes and failures of each PiP.

The government originally allocated £33 million of funding for the support of charging point infrastructure to be used by plug-in electric vehicles. By September 2012, £6.2 million had been spent providing over 2,500 PiP-funded charging points. 1,853 of these are available for the general public (HC 2013). In addition, OLEV estimate that about 5,000 charging points have been installed by non-PiP organisations nationwide without central government support (OLEV 2013a). There are therefore more charging points than ULEVs in the UK.

No data is yet available on the reliability of the charging points or how they are used. Interviewees stated that because the government's policy was, until February 2013, only a pilot, public charging point infrastructure has not necessarily been installed in appropriate locations.

OLEV is expected to issue an update to the government's infrastructure strategy in mid-2013, based on the lessons learned from the PiPs and from infrastructure installed by the private and public sector outside of the PiP regions. However on 19 February 2013 OLEV announced a new funding provision of £37 million to support the installation of charging points until April 2015. This expenditure is additional to the £6.2 million spent up to that date.[46]

This announcement by OLEV also gave details of four new policies for charging point installation. The funding will now be available as follows:

- *To homeowners with off-street parking (such as a driveway or private garage)*
  OLEV has allocated up to £13.5 million for a 75 per cent grant (capped at £1,000 including VAT) to UK homeowners who wish to have either a standard or a fast domestic charging point[47] installed in their home (OLEV 2013b).

44 'Home' was defined by OLEV in 2011 as including a depot in the context of fleet vehicles owned by a business.

45 London, Northern Ireland, Scotland, Milton Keynes, Greater Manchester, the Midlands, the East of England and the North East of England.

46 Email communication with OLEV.

47 This does not include the cost of a dedicated charging circuit, just of the charging point.

- *To local authorities*
  OLEV has allocated up to £11 million for a 75 per cent grant towards the cost of installing publicly available charging point infrastructure:
  - to local authorities in England to provide charging point infrastructure to homeowners without off-street parking upon their request. This funding is capped at £7,500, and each charging point must be Type 2, publicly accessible with 'pay as you go' functionality ('PAYG', meaning that the driver pays for the electricity at the charging point), and have an associated dedicated parking bay for plug-in electric vehicles
  - to local authorities in the UK towards the cost of installing rapid charging points in their jurisdiction around the strategic road network. This funding is capped at £37,500, and each rapid charging point must have PAYG functionality. OLEV have not specified whether these charging points should be Combo II or CHAdeMO, but are encouraging collective bids from neighbouring authorities (OLEV 2013c).
- *To train operating companies*
  OLEV has allocated up to £9 million for a 75 per cent grant (capped at £7,500) available to train operating companies towards the cost of installing charging points at railway stations in England. The conditions of these grants are that the charging points must have some form of PAYG functionality, that 50 per cent of them must have a dedicated parking bay for plug-in electric vehicles, and that 50 per cent of them are available for use by the general public (with the remainder for use by private fleets such as taxis) (OLEV 2013d).
- *To public sector bodies*
  OLEV has allocated up to £3 million for a 75 per cent grant (capped at £7,500) to public sector bodies in the United Kingdom towards the installation of publicly available charging point infrastructure on the UK government and wider public sector estate. There is no stipulation that these must have a dedicated plug-in electric vehicle parking bay, or that such charging points to have PAYG provision (OLEV 2013e).

Scottish government policy

In February 2013 the Scottish government announced a new policy for charging point infrastructure. It has established a £2.6 million scheme to offer free installation of home charging points in Scotland. It also intends to place charging points on all trunk roads at intervals of 50 miles or fewer, and provide funding for charging points at public transport locations, local authority car parks, leisure facilities, workplaces, ferry terminals and a network especially for the 2014 Commonwealth Games in Glasgow. A website has been set up to provide a map of charging point locations, information on costs, and to provide more general information to Scottish drivers of ULEVs.[48]

48 http://www.scotland.gov.uk/News/Releases/2013/02/electric-vehicles06022013

4.2 Getting charging infrastructure right

The recent announcement by OLEV is to be welcomed as, before it was made, government support for charging point infrastructure was due to end in March 2013. IPPR's qualitative research found that the decision to allow this support to expire had caused considerable uncertainty in the ULEV market, since it threatened the growth of the market for domestic charging infrastructure which had only just emerged. Given that OLEV's recently announced funding has now been allocated, it makes little sense for it to be time limited.

We recommend that all political parties confirm that the money currently available for the installation of charging point infrastructure will not expire in April 2015, and that any underspend by that point will be carried over until it is exhausted.

Even with this money in place, a series of issues relating to domestic, workplace and public infrastructure remain. The rest of this chapter will look at these issues in turn.

4.2.1 Domestic charging

Charging safety at home and the accuracy of the government's advice

The government's current policy on safe charging is to advise prospective purchasers to have their home checked by a qualified electrician in order to assess whether or not it is safe to charge a plug-in electric vehicle at home (OLEV 2011). It is therefore possible to buy a plug-in electric vehicle without any additional technology being installed at home, and for charging to take place using a conventional domestic three-pin plug connected with a standard cable which does not have a trip switch installed (that is, without a dedicated charging circuit and point being installed).

IPPR's interviewees expressed concern that charging in this way does not guarantee safe charging. The voluntary *Code of Practice for Electric Vehicle Charging Equipment Installation*,[49] published by the IET (the IET safety code) and approved by the energy and automotive industries, requires the installation of a dedicated charging circuit in a person's home, but this applies only if he or she has elected to have a charging point installed. Some of our interviewees went further than this, stating that anyone purchasing a plug-in electric vehicle should have a charging point and dedicated charging circuit[50] for the vehicle installed in their home.

Since the automotive industry is concerned that any regulation that makes it harder to charge vehicles at home would be a barrier to ULEV market development, it is pushing for the adoption of Type 2 connectors for all types of charging, and encouraging drivers to use three-pin plugs with standard cables only as a last resort. The availability of government funding for domestic charging points is therefore a very welcome development. However IPPR believes that public safety is paramount, though we do not possess the technical expertise to make a specific safety recommendation. That said, we believe that there is a strong body of expert opinion that feels the public is at risk of charging in a manner that is not the 'safest', casting doubts over whether the government's current advice is sufficient.

The government must re-examine its guidance to consumers regarding the safety of charging a plug-in electric vehicle using a domestic three-pin plug with a cable that does not have a built-in trip switch. If it concludes that, at the minimum, specialised

49 http://www.theiet.org/resources/standards/ev-charging-cop.cfm

50 From the consumer's perspective, this means a separate fuse in their home fuse box that would 'blow' if there was a charging issue.

charging equipment should be installed to guarantee safe charging then it must legislate to underpin minimum safety requirements.

On-street residential charging – funding and public safety issues
As set out above, the government has always believed that the majority of charging would take place at home. In 2010, 66.8 per cent of households in England had the ability to park their car off-street (DCLG 2010). The remaining 33.2 per cent of households would need some form of charging point installed on the street at or near their home if the householder were to purchase a plug-in electric vehicle. Two issues arise from this.

First, observers have noted instances of plug-in electric vehicles parked on the street with charging cables trailing across pavements, through windows and into domestic buildings. This presents a potential safety hazard to the general public, particularly the elderly and mobility impaired. It is too early in the development of the ULEV market to predict whether this will become a serious problem. The automotive manufacturing industry hopes that the move towards Type 2 standardisation of charging points, and the funding made available by government to local authorities, will mitigate this risk. However so long as (a) plug-in electric vehicles can be charged using a standard domestic three-pin plug, and (b) there is not a comprehensive public charging point infrastructure, a safety risk could exist.

We recommend that the Health and Safety Executive investigate the potential safety hazard posed by trailing charging cables from on-street charging of plug-in electric vehicles.

A second problem is that the same funding pot is allocated to both cheaper charging points for on-street domestic parking, and to more expensive rapid charging points on the strategic road network. The funding set aside by OLEV would only cover the installation of up to 1,466 standard or fast charging points (assuming that none of the more expensive rapid charging points are built). Given that over 3,200 applications for plug-in grants have been received by OLEV in just two years, it is likely that this funding will be used quickly. IPPR's research also showed that at least one manufacturer was intending to use PiP funding to install scores of rapid chargers nationwide. The allocated funding would only cover up to 293 rapid charging points – assuming that none of it was used for on street domestic charging points.

The government's failure to allocate separate funding for different types of charging point runs contrary to its stated strategic approach of ensuring that most charging is done 'at home'.

OLEV should separate the £11 million pot of money available to local authorities for the installation of charging points. We suggest that, from this pot, £3 million should be allocated to the installation of at least 80 rapid charging points; the remaining £8 million should be used to install at least 1,000 on-street charging points.

4.2.2 Workplace and business charging

Central government funding is no longer available to private businesses for the installation of charging point infrastructure at depots, for their employees' use.[51] There is no published government rationale for this change in strategy – indeed, data on the uptake and usage of this infrastructure by business while funding was in place, which might have

51 It does remain possible for a private business to receive funding for a rapid charging point if the relevant local authority agrees to it, and if its land is on the strategic road network. However that charging point would also have to be available to the general public, making it difficult of a business to plan the charging patterns of its fleet.

informed policy in this area, had not yet been released by OLEV. We note that Scotland is continuing to provide support for workplaces.

Given that 75 per cent of cars and 95 per cent of vans eligible for plug-in grants sold to date have been bought by private businesses, this withdrawal of support to business seems to directly conflict with the objective of promoting uptake of plug-in electric vehicles in England.

OLEV should make the £13.5 million pot of infrastructure funding available to private businesses, as well as to homeowners, for the installation of charging points at their depots.

4.2.3 Public charging

Although the majority of charging is expected to take place at home, there is still a need for public charging infrastructure to be put in place to allow consumers to charge their vehicles when they make long distance journeys. In the future, hydrogen refuelling stations will also be required for FCEVs.

Plug-in vehicle public charging point infrastructure

The Scottish government has chosen a centralised, top-down strategy for its public network, whereas OLEV has elected to devolve responsibility for this to local authorities in England. There is therefore a concern that unless local authorities work together, rapid charging points may not be installed in the most strategic locations for facilitating long-distance journeys. There are no policies in place in Wales or Northern Ireland as yet.

In chapter 3 we recommended that local authorities work together, and with local enterprise partnerships, passenger transport executives and integrated transport authorities, to encourage, develop and coordinate local usage incentives. **Similarly, as the government devolves transport policy, we encourage local authorities to work together through the new devolved transport institutions as they are created to ensure that rapid charging points are placed in the most strategic locations. Costs and revenue streams will need to be shared as a result. IPPR North has advocated the establishment of a 'supra-passenger transport executive', 'Transport for the North', to take a strategic view of transport planning in the north of England (IPPR North and NEFC 2012). We recommend that this body be established, and that funding for charging points be devolved to it.**

Barriers to long-term planning of public charging infrastructure

In addition to the planning of charging point infrastructure, there are five potential barriers to long-term planning of public charging points:

- the debate within the automotive industry between CHAdeMO and Combo II rapid charging
- poor information on charging provision
- incompatible payment systems
- the risk that owners of land on which strategically important charging points are located go bust
- the impact of regulation regarding the cost of electricity.

We will explore these issues below, and will also address the need to develop a network of hydrogen refuelling stations for FCEVs.

First, OLEV's policy on providing funding to local authorities for the installation of rapid charging points states that 'local authorities should carefully consider which connectors their rapid chargers will have, and provide a rationale for your choices in your bid' (OLEV 2013c). OLEV have essentially delegated responsibility for decisions over whether CHAdeMO or Combo II rapid chargers should be installed to local authorities.

It is conceivable that without international agreement on this issue the global automotive market could evolve so that just one of these standards, or perhaps both (in the same way that ICEVs can be fuelled by either petrol or diesel), becomes the norm. However the challenge for the UK is to remain technologically neutral in order to create as attractive an investment environment as possible for the automotive industry.

The UK government must continue to work with strategic international partners such as Germany and France to achieve European, and ideally global, agreement on which standard or standards should become prevalent. In the interim, OLEV should require as a condition of its funding that all rapid charging points installed by local authorities are capable of charging vehicles that are both CHAdeMO and Combo II compliant.

Second, information about the location and functionality of public charging is unreliable. OLEV maintain a database of publicly available charging points known as the National Charge Point Registry,[52] which is converted into an online map[53] of charging points to enable the public to plan their journeys. The National Charge Point Registry is not automated, and OLEV does not vouch for the accuracy of the map;[54] rather, it depends on charging point operators manually sending data to OLEV. As a result the map is unreliable and does not give real-time information about the functionality of a charging point. The map is incapable of enabling a driver to plan a lengthy journey.

Interviewees strongly advocated the automation of this information by OLEV, and stated that this is technologically simple and would be inexpensive to achieve.

OLEV should work with BSI Group and its relevant sub-committees for the introduction of a British standard so that this technology can be incorporated into public charging points.

Third, there are problems with the payment systems for public charging. In general, plug-in electric vehicle drivers pay to access publicly available infrastructure either by using PAYG or by subscribing to a membership scheme that allows a driver to use certain charging points, usually within a particular geographical area, for free. This variation is due to different back-office functions developed by the PiP providers, and it constitutes a barrier to a driver being easily able to use public infrastructure on a national scale as well as a disincentive to investment by private financiers. Industry has not been able to agree upon the back-office requirements for a national system, despite OLEV's encouragement (BEAMA et al 2012, OLEV 2011). Following OLEV's February 2013 announcement, all publicly available charging point infrastructure installed in future (except installations on land owned by the public sector) must have PAYG functionality in order to receive funding.

While we welcome this intervention, OLEV should explain why this exception was made for charging points installed by the public sector. The DfT should ensure that all public charging infrastructure has PAYG functionality, regardless of whether it is

52 http://data.gov.uk/dataset/national-charge-point-registry
53 http://nationalchargepointregistry.com/
54 Email communication with OLEV.

publicly funded. OLEV should also work to ensure that charging points are made compatible with other travel smartcard technologies, such as the Oyster card in London or the 'key' currently being piloted by Southern Rail.

Fourth, upon installation, charging points become legally indistinguishable from the land on which they sit, and are therefore the property of the landowner. There is therefore a risk that public charging points in important locations such as motorway service stations could become unavailable to plug-in electric vehicle drivers if the landowners become insolvent. This risk is regularly mitigated in relation to other strategically important infrastructure (such as railways), and is an important consideration when trying to make investment in infrastructure attractive to private financiers. Indeed, OLEV have already covered this risk in relation to charging points installed by train operating companies at railway stations by requiring that this infrastructure is designated as a primary franchise asset[55] (OLEV 2013d).

We recommend that the DfT ensures that any strategically important charging point infrastructure is protected from being taken out of public use in the event that the landowner becomes insolvent.

Finally, the regulations set by Ofgem to govern the pricing of electricity sold at charging points by the businesses or local authorities that operate them are ambiguous.

Energy companies who sell electricity must be designated as authorised suppliers by Ofgem. However it is possible for people who buy electricity from these suppliers to resell it to other people: the classic example is that of a landlord buying electricity and selling it to their tenant. The same possibility would arise if a public charging point operator bought electricity from an authorised supplier and sold it to a plug-in electric vehicle driver.

Ofgem have issued the maximum retail price provisions, which require any resale of electricity by an unauthorised supplier to be priced at cost plus VAT; but this regulation is limited to the resale of electricity in a domestic setting (for example, by a landlord to a tenant). Therefore the current regulation would cover the charging of a plug-in electric vehicle at a tenant's home, but not at a public charging point. This creates ambiguity about the scope of the regulation, and therefore uncertainty for the market.

Ofgem has recently closed a consultation aimed at ending this ambiguity. They have proposed that the maximum retail price provisions should not apply to the charging of plug-in electric vehicles under any circumstances.[56] IPPR is concerned that, as drafted, this amendment would mean that homeowners would continue to benefit from the maximum retail price provisions, but that tenants and persons without off-street parking would not.

Ofgem should amend the maximum retail price regulations to allow a free market in the sale of electricity by business and local authorities, but revisit this issue regularly as the market develops. Furthermore, it should ensure that any amendment to these regulations does not disadvantage tenants or those without off-street parking who charge their vehicles in a domestic context.

55 Designation as a primary franchise assets means that the charging point will transfer from the old railway franchisee to the new franchisee upon termination of a franchise (in the same manner as the trains will), including upon the insolvency of the relevant train operating company.

56 http://www.ofgem.gov.uk/domestic-consumers/Documents1/electricvehicle_MRP_consultation.pdf

Hydrogen refuelling stations
$UKH_2Mobility$ projects that 10,000 FCEVs will be sold annually in the UK by 2020, increasing to 300,000 per year by 2030 – by which time a total of 1.6 million FCEVs will be on the roads. In order to support this uptake, 1,150 hydrogen refuelling stations (HRSs) will be required across the UK by 2030. Early research showed positive responses from consumers regarding the refuelling time of an FCEV, which is comparable to that of an ICEV ($UKH_2Mobility$ 2013).

The total cost of this network is projected to be £418 million, of which £62 million would be required before 2020. No indications have yet been made as to whether this might be funded by private businesses or the public purse. The next stage of the $UKH_2Mobility$ project is to develop the business case for the initial network of stations. It is projected that by 2030 an initial concentration of HRSs will be needed, and the initial results show that these HRSs would be concentrated in London and the south east of England. Our understanding is that this analysis has been based on where new vehicles are currently purchased, and not upon the potential for this new infrastructure to stimulate economic growth.

The $UKH_2Mobility$ project should include an analysis of the potential of this new infrastructure to stimulate economic growth and regeneration in less affluent areas of the country.

5. GETTING CONNECTED

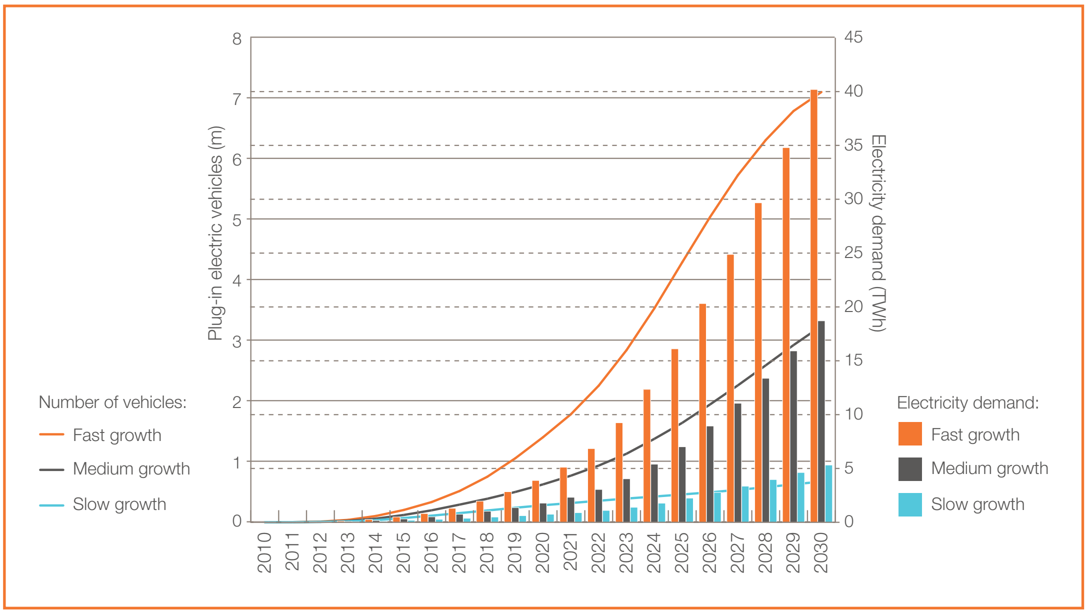
PLUG-IN ELECTRIC VEHICLES AND BRITAIN'S ELECTRICITY NETWORK

The previous chapter outlined the importance of developing a 'fuelling' infrastructure to underpin a vibrant domestic market in ULEVs. This chapter will examine two issues relating to the provision of electricity to plug-in electric vehicles: first, the need to ensure that an adequate supply of decarbonised electricity is generated to supply a mass market of plug-in electric vehicles; and second, the pressure that plug-in electric vehicles will place on the electricity network.

5.1 Generating clean electricity for plug-in electric vehicles

In time, plug-in electric vehicles will become a large source of demand for electricity in the UK, which means that it is essential for the UK to have a long-term strategy for the continued production and distribution of electricity. Figure 5.1 below illustrates this new demand. It sets out three scenarios, based on the UK making fast, medium and slow progress towards meeting the transportation aspects of its 2050 decarbonisation targets (set out in chapter 1).[57] It demonstrates that even in the slow progression scenario the annual electricity demand from plug-in electric vehicles will increase from almost 0TWh to 5.3TWh by 2030, and up to 40.2TWh under the fast progression scenario.

Figure 5.1
Impact of plug-in electric vehicles on electricity demand



Source: NG 2012

Given that the electricity network is still largely polluting, plug-in electric vehicles can be less environmentally friendly, in terms of carbon emissions, than ICEVs at present. The RAC has carried out road testing of 63 of the 'greenest vehicles on the road' to measure their carbon footprint, taking into account not just carbon emissions at the tailpipe but also the footprint from carbon emissions generated by power stations for electricity, the production of hydrogen, and/or the production of petrol and diesel. During these tests

57 'In the Slow Progression [slow] scenario developments in renewable and low carbon energy are comparatively slow, and the renewable energy target for 2020 is not met until some time between 2020 and 2025. The carbon reduction target for 2020 is achieved but not the indicative target for 2030. In the Gone Green [medium] scenario the renewable target for 2020 and the emissions targets for 2020, 2030 and 2050 are all reached. The Accelerated Growth [fast] scenario has more low carbon generation, including renewables, nuclear and Carbon Capture and Storage (CCS), coupled with greater energy efficiency measures and electrification of heat and transport. Renewable and carbon reduction targets are all met ahead of schedule.' (NG 2012: 4)

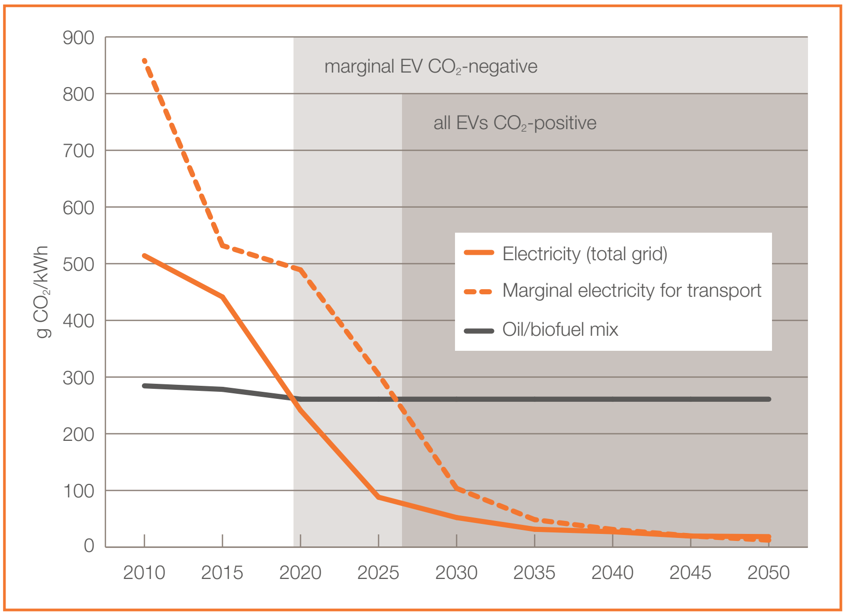
they found that the average 'well-to-wheel emissions' of a PEV were 105g CO_2/km, whereas those of an FCEV were 112g CO_2/km. Neither of these categories of vehicle have any emissions at the tailpipe. By contrast, the hybrid electric vehicles, PHEVs and E-REVs tested had lower average well-to-wheel emissions of 103g CO_2/km, and petrol ICEVs tested emitted on average 81g CO_2/km from well to wheel.[58] The diesel ICEVs were higher with, on average, 147g CO_2/km well-to-wheel emissions (RAC 2011).

These figures must be taken on a case-by-case basis, and only look at carbon emissions related to road transport vehicles. The purchase today of a plug-in electric vehicle remains environmentally friendly due to the lack of emissions at the tailpipe of other noxious substances such as particulate matters, unburnt hydrocarbons and nitrogen oxide which harm air quality, particularly in cities. Nonetheless, the UK's current energy mix means that an individual plug-in electric vehicle does not contribute by default to the overall lowering of the UK's carbon emissions.

This presents a paradox in terms of how the development of the UK's comparative advantage in the automotive industry relates to the reduction of the UK's carbon emissions. If plug-in electric vehicles are sold in bulk too soon, it could lead to more carbon emissions since the electricity will be from dirty sources. On the other hand, if bulk sales begin too late, efforts to decarbonise electricity generation will prove fruitless in terms of the country meeting its 2050 carbon targets.

Figure 5.2 below shows how, under current projections, emissions from electricity will fall below those of an oil and biofuel mix in around 2020. However the incremental (or marginal) power necessary to power plug-in electric vehicles will be the dirtiest and, therefore, more polluting until around 2027. Any slippage in Britain's plans to decarbonise its power sector would push back the date at which plug-in electric vehicles become less polluting than a car powered by an oil and biofuel mix (that is, an ICEV).

Figure 5.2: Emissions intensity pre-appliance (g CO_2/kWh)



Source: Provided to IPPR by National Grid in 2012

58 All ICEVs tested by the RAC had advertised low tailpipe emissions of no more than 110g CO_2/km. If all ICEVs on the market had been included, this figure would have been considerably higher.

National Grid has based its estimates on an emissions intensity for the electricity sector of around 50g CO_2/kWh in 2030. This is the level that the Committee on Climate Change believes is consistent with Britain staying on course to meet its climate objectives at the lowest cost to consumers (CCC 2012, McNeil and Hutchinson 2013). The Energy Bill, currently before parliament, includes provisions to introduce a target of this nature after 2016, but the CCC believes that this delay will create 'a high degree of uncertainty about sector development beyond 2020 … [which] will adversely impact on supply chain investment decisions and project development, therefore undermining implementation of the Bill and raising costs for consumers' (CCC 2013).

This creates uncertainty for the ULEV market, as potential consumers need to know that their purchase is contributing to the decarbonisation of the economy. Indeed, 38 per cent of drivers surveyed by the DfT considered the environment-friendliness of any car or van to be an important factor in deciding which vehicle to purchase (DfT 2012b), and IPPR's own interviewees stated that this issue was of particular concern to the early adopters of ULEVs. To promote uptake of ULEVs and maximise the UK's comparative advantage in the automotive industry, it is essential that consumers have confidence that their purchase contributes to a national effort to meet the UK's 2050 targets. If that confidence is lacking, those who are sceptical about the transition to ULEVs will make valid arguments against their uptake.

We recommend that the government accepts the cross-party amendment to the Energy Bill proposed by Tim Yeo and Barry Gardiner, which would ensure that a target for the decarbonisation of the power sector be set by April 2014. Britain should lead efforts at the EU level to agree targets, by the end of 2014, to cut carbon emissions by 2030 against 1990 baselines.

As chapter 1 sets out, the transition towards decarbonisation of vehicles at the tailpipe has been underway for over a decade, primarily as a result of EU emissions standards. These standards began as a voluntary agreement in 1998 among automotive industry associations and the European Commission to reach a reduced average carbon target for new cars of 140g CO_2/km by 2008. In 2006, when it became clear that this target was not going to be met, the European Commission decided to legislate, and in 2009 it introduced the current EU-wide average new car targets of 130g CO_2/km for 2015 and 95g CO_2/km for 2020.[59]

This process has encouraged the UK average CO_2 emissions of new cars to fall since 2000, from 181g CO_2/km in that year to 133g CO_2/km in 2012. A number of factors contributed to this achievement, including the increase of diesel in the fuel mix of new cars (55 per cent in 2012), the downsizing of new models for certain categories of vehicle such as dual-purpose 4x4s, and a market shift towards 'small cars',[60] sales of which increased by 201.5 per cent between 2007 and 2012 (SMMT 2013a). The UK market is certainly on course to meet the EU's 2015 target.

The technology roadmap published by the Automotive Council sets out the industry's strategic direction for meeting the EU's 2020 target and the UK's legally binding 2050 decarbonisation target outlined above. This is predicated on continuing enhancements to engine efficiency in ICEVs, complemented by mass market uptake of hybrid electric vehicles during this decade, and PHEVs, E-REVs and PEVs all reaching mass market penetration in the 2020s and 2030s. Interviewees confirmed this expectation, and

59 http://www.dft.gov.uk/vca/fcb/cars-and-carbon-dioxide.asp

60 Equivalent to the SMMT vehicle segment category of 'mini'.

reaffirmed that in order for the UK to meet the requirement to have zero carbon emissions from all new cars in 2040 (see chapter 1), new fuel technologies such as PEVs and FCEVs were essential. There are, however, no post-2020 vehicle emissions targets to continue to drive this transition.

Complete decarbonisation of cars and vans is technologically achievable (PEVs and FCEVs have zero emissions). With the hybrid electric market approaching maturity and PEVs, PHEVs and E-REVS coming on to the market (see the annex), the UK automotive industry is on course to supply the products needed to reach their targets if the demand materialises.

In order to set realistic post-2020 carbon emission standards for vehicles, the automotive industry is working towards global agreement on how vehicles are tested to ensure that the results more accurately reflect the emissions. However there is a need to continue to provide certainty to the automotive industry about the direction of policy on emissions standards, without picking technological winners.

As part of the EU process outlined above, the government should lead efforts to agree an average carbon emissions target for new cars and vans registered in the EU in 2025. New targets should take consideration of the well to wheel emissions of a vehicle.

5.2 The impact of plug-in electric vehicles on the electricity network

Having discussed how plug-in electric vehicles will impact upon the generation of electricity, it is now necessary to examine their impact on the network that carries that electricity from where it is generated to the ultimate consumer – and also whether the right steps are being taken now, at the earliest stages of development of the plug-in electric vehicle market, to ensure that any changes to the network are being carried out in a cost efficient manner. Before doing so, it is necessary to give a brief outline of how the network functions.

Power is generated in power stations and then carried by transmission networks[61] (each of which can be referred to as 'the grid'[62]) at high voltages over long distances using large pylons. The transmission networks feed into 14 regional and largely passive distribution networks, run by seven distribution network operators (DNOs). These carry the voltage to the eventual consumer through a series of transformers that reduce it to a level that is safe for consumption.

The practical challenge for the industry is balancing the supply and demand of electricity over the network within extremely tight limits. Imbalances of only one per cent can lead to power outages. However, electricity demand varies across different distribution networks, and different localities have historically dealt with these strains in various ways with differing capacities for changes in demand. Indeed, in some areas these differences could be very localised, such as between one side of a street and the other.

The increase in electricity consumption in the UK, and the corresponding change in supply and demand, has historically been driven by the rate of housing growth and economic activity. However, in order to meet the 2050 carbon targets, this is expected to change substantially in the coming decades with the electrification of transport and heating (that is, the installation

61 In England and Wales, there is one transmission network which is owned and operated by National Grid. In Scotland there are two transmission systems that are owned and operated by Scottish Power and Scottish Hydro Electric Limited respectively.

62 Note that some energy industry representatives refer to both the transmission networks and the distribution networks taken together as the 'grid'.

of electric heat pumps to replace boilers). This, in combination with the introduction of new and smaller generation technologies such as solar photovoltaics (solar power cells) and wind power, will make it much harder to keep the network functioning. The network will need to become 'smart' in order to handle these new technologies in a safe and efficient manner. This is the biggest challenge the electricity network has faced for 50 years (SGF 2012).

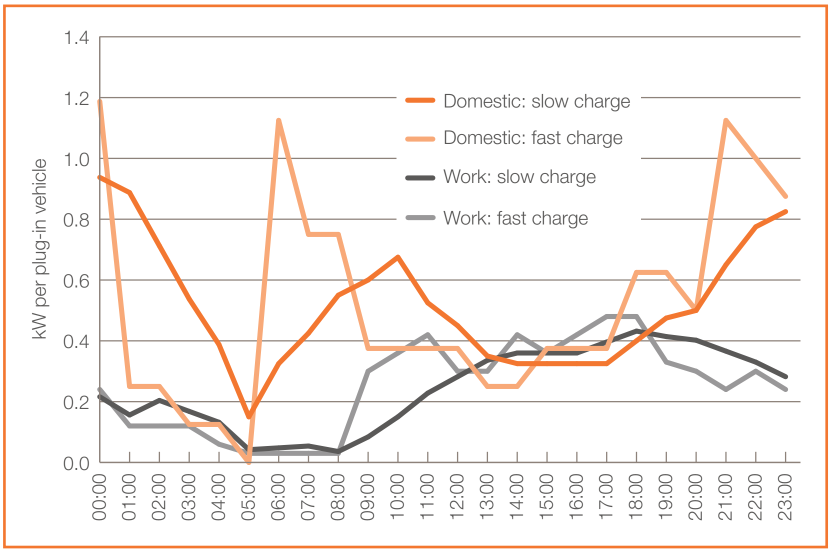
5.2.1 Changes to the daily pattern of demand, and network upgrades

Plug-in electric vehicles will impact the electricity networks in two ways. Firstly, the demand for electricity currently peaks at different times of the day (such as early evening on a weekday, when people tend to get home from work), but as plug-in electric vehicle uptake grows they will change the pattern of daily demand for electricity, making the balancing of the networks more difficult. Secondly, the increase in electricity demand that plug-in electric vehicles will put on local infrastructure will require upgrades to be carried out.

Increase in daily peak demand of electricity

The uptake of plug-in electric vehicles and heat pumps is expected not just to alter the times at which peak demand for electricity might occur, but also to potentially increase the size of such peak demand. Figure 5.3 below sets out one possible example of the demand profile of plug-in electric vehicles over the course of a day, based on trial data from the ultra-low-carbon vehicles demonstrator programme run by the Technology Strategy Board and sponsored by the government. It shows three large peaks from domestic fast charging at midnight, 6am and again at 9pm. Industry participants told IPPR that they had expected peak times to be early evenings rather than between 9pm and midnight. Indeed, the Smart Grid Forum described these findings as 'counterintuitive' (SGF 2012).

Figure 5.3
Example daily charging profile of plug-in electric vehicles (kW per plug-in vehicle)



Source: SGF 2012

This 'spiking' of electricity demand from plug-in electric vehicles is a major concern for the energy industry, especially when considered alongside similar expected demand patterns for heat pumps. One interviewee described to IPPR a 'nightmare scenario' in terms of pressure on the electricity network in which millions of people drove home from work, plugged their vehicles into a fast charging point at home or on the street, and turned on their household heat pumps at the same time.

Since this fear may come true, it is important that the DNOs in particular are given transparent information about the uptake of plug-in electric vehicles and related charging infrastructure so that they can plan ahead. This has been made all the more pressing by recent government policy targeting infrastructure spending towards charging points for homeowners, including on fast charging points (OLEV 2013b and OLEV 2013c).

The need for upgrades

Changes to the pattern of demand are not a concern until plug-in electric vehicle uptake reaches large numbers. However, a pressing issue in the short term is the possibility that clusters of small numbers of plug-in electric vehicles in a local area might be charging at the same time (as might be the case with a community car club or a small business fleet). Representatives of the energy industry told IPPR there was a possibility that a small number of plug-in electric vehicles charging simultaneously could overload a distribution network at a local level, although in the worst case this would manifest itself with mild warning signs (house lights flickering on one side of a street, for instance) which would allow DNOs to promptly carry out remedial work to local infrastructure. Therefore they were not worried that the uptake of plug-in electric vehicles in the short to medium-term future would present a threat to the continuing supply of energy to consumers in the UK. Given the scale of the challenge that the transition to various low-carbon technologies poses to the energy industry, there is a public interest in transparency about where the 'weak spots' are in the distribution networks, the locations of low-carbon technologies that are being connected to the distribution networks, and what measures DNOs are taking ensure that upgrades are made to prevent any interruptions.

There is currently no evidence indicating where such local pockets of charging are likely to develop in the next few years. IPPR's interviewees agreed that if the warning signs mentioned above did occur they could be unnecessarily detrimental to the uptake of plug-in electric vehicles in Britain – that is, they may lead the public to conclude, wrongly, that plug-in electric vehicles pose an immediate threat to the continuing stability of the UK's electricity network. Interviewees were therefore concerned about a lack of transparency regarding where plug-in electric vehicles were being charged, and where in the country the distribution networks were close to capacity.

In practice, the IET safety code is likely to ensure that the relevant DNO is normally informed about the installation of a public charging point, although we note that the code does not recommend DNO notification of charging point installation in all circumstances.[63] Yet unfortunately it is currently still possible for a consumer to buy a plug-in electric vehicle and simply take it home and plug it in with a standard three-point plug. In these cases, DNOs receive no information about the uptake of domestic charging.

We recommend that OLEV and DECC create a public information exchange between DNOs, organisations such as local authorities and energy companies responsible for the installation of charging points, and dealers that sell ULEVs.

This information should be published online in a consumer-friendly format, with a searchable map which would allow the public (such as a purchaser of a plug-in electric vehicle and its dealer) to calculate the likely impact that they or anyone else using any low-carbon technology would have on their local network.

63 Currently the IET safety code only requires the DNO to be informed either if current records of the capacity of the existing power supply to the location of the charging point are unavailable, or if, in practice, if there is a desire to increase the incoming power supply (which might be necessary to install a fast charging point, for example).

The positive contribution that plug-in electric vehicles can make towards making the network smart

Plug-in electric vehicles have the potential to bring benefits to the network in two ways. Firstly they have the potential to bring in balancing services, such as those already in operation in large industry today. If a large number of plug-in electric vehicles are plugged in at the same time for a lengthy period (overnight, for instance), the supply of power to them could be turned on or off according to the need to balance the network and then charging can recommence or stop later on: this moves the demand for electricity from plug-in electric vehicles to a better time for the network. This concept is known as demand-side response (DSR).

Secondly, the battery of a plug-in electric vehicle could be used to store energy so that in the event of a shortfall in the supply of energy to the network, the network could draw energy from large numbers of plug-in electric vehicles simultaneously (known as vehicle-to-grid or V2G), or alternatively an individual vehicle's stored energy could be used to supply power to a home or other building (known as vehicle-to-home or V2H).

Debate over and understanding of the potential value of both of these two mechanisms are still in the early stages – particularly in the case of the potential of energy storage by plug-in electric vehicles, where there is concern over the impact of excessive charging for energy storage on the economic life of what is the most valuable part of the ULEV. There was consensus among our interviewees that any potential benefit of V2G or V2H is only likely to materialise in the long-term future, if at all. DSR using plug-in electric vehicles is considered more likely to be of benefit in the medium-term future, along with DSR from other technologies generally, including heat pumps and domestic appliances. Interviewees stated that DNOs would be the first part of the industry likely to have a demand for consumer DSR services, with the transmission system operators and the energy suppliers following. However, because of current expectations that the value of such a market would be very low, there is a question as to how much the DNOs would currently be prepared to invest in infrastructure now to prepare for such markets.

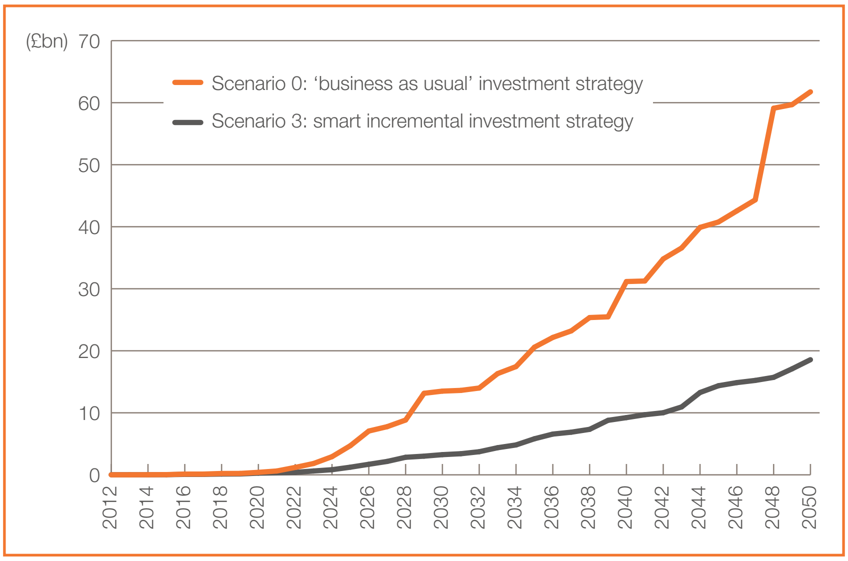
In terms of how these markets should be facilitated, research by Frontier Economics and Sustainability First carried out for DECC proved that installing technology to permit these interventions to happen automatically would deliver the greatest and most sustained household shifts in demand, especially for technologies such as plug-in electric vehicles where consumers' needs for power were flexible (Frontier 2012). IPPR's interviewees also expressed this view.

5.3.2 The cost of making the network 'smart'

The energy industry's calculations of the potential cost of upgrading the network and making it smart have only just begun. Various factors, such as the rate of low-carbon technology uptake, the actual volume of uptake, and the location and geographical concentration of low-carbon technology uptake, will affect the level of investment required. At this stage, the Smart Grid Forum is therefore developing various scenarios for investment as opposed to producing costed projections (SGF 2012).

The initial assessment is that the more that DNOs and transmission operators are able to make investment decisions in anticipation of the take up of new technologies (as opposed to reacting to their take up which is currently how upgrading occurs) the cheaper these investments will be for industry and, therefore, for all energy consumers. The Smart Grid Forum has produced scenarios which envisage possible costs that range from £18.6 billion to £61.8 billion, set out in figure 5.4 below, depending on whether industry continues to upgrade the grid in response to or in anticipation of the rollout of low-carbon technologies.

Figure 5.4
Spread of GB network related investment (£bn)



Source: SGF 2012

If the necessary upgrades to the network would be much cheaper if they were planned and carried out in advance of the uptake of plug-in electric vehicles, then the question arises as to whether or not the work that is being carried out today is being done in a 'future proof' manner, and anticipates the potential markets discussed in the box above.

The Smart Grid Forum anticipates that, even with advance planning for the uptake of plug-in electric vehicles, only about £3.4 million of investment in the distribution networks is required between now and 2022. Therefore the only significant changes being made to our electricity network at the moment that would have a role to play in connecting plug-in electric vehicles to a smarter grid in the future are the installations of specialised charging point infrastructure, and the roll-out of smart meters[64] into every UK home. We therefore wanted to know if the communication abilities of these two types of technology, and the planning of their installation today, would automatically provide the energy companies with the necessary information about the charging patterns of, and increases in demand made by, plug-in electric vehicles. We also wanted to know if the communication capabilities of these technologies were capable of automating DSR, and either V2G or V2H, should such markets arise to help balance the networks in future.

64 Smart meters are the next generation of gas and electricity meters, designed to inform consumers about how much energy they are using through a display in the home. They can also communicate directly with an energy supplier, making physical meter inspections unnecessary. Government policy is for every home to be fitted with a smart meter by 2019. For further information see https://www.gov.uk/smart-meters-how-they-work

IPPR's research revealed a mixed picture. Energy industry interviewees gave mixed statements as to whether or not the smart meters being installed by the government have the ability to facilitate communication about charging patterns between a plug-in electric vehicle and the network or the home. Some energy industry interviewees recommended that a British standard be introduced for charging point technology so that its design facilitates communication between a plug-in electric vehicle and the network, and the frequency at which a plug-in electric vehicle is charged can be ramped up and down (as opposed to switched off) remotely. Conversely, other interviewees expressed concern that there was a potential doubling of costs to the consumer, as both the smart meter and charging points currently being installed in some properties have the ability to communicate between a plug-in electric vehicle and the network.

DECC should clarify how all charging point infrastructure will interact with the smart meter programme. We recommend that DECC and OLEV work together so that the roll-out of smart meters and charging infrastructure are co-ordinated.

OLEV and DECC should work with BSI Group to ensure the introduction of British standards to ensure that technology being rolled out today is able to facilitate communication between the network and plug-in electric vehicles both now and in the future.

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ANNEX

Tables A1 and A2 list some of the ultra-low-emission cars and vans that are either currently available for sale in the UK or are expected to be available for sale in the UK in the near future.[65] Those in bold have been approved by the Office of Low Emission Vehicles (OLEV) as eligible for a plug-in grant.

Table A1
List of ultra-low-emission cars available or soon to be available in the UK

Manufacturer	Model	Release date	ULEV category
Citroën	**C-Zero**	**Available**	**PEV**
Mitsubishi	**i-MiEV**	**Available**	**PEV**
Nissan	**LEAF**	**Available**	**PEV**
Peugeot	**iOn**	**Available**	**PEV**
mia electric	**mia**	**Available**	**PEV**
smart	**fourtwo ed**	**Available**	**PEV**
Renault	**Fluence Z.E.**	**Available**	**PEV**
Toyota	**Prius Plug-In Hybrid**	**Available**	**PHEV**
Chevrolet	**Volt**	**Available**	**E-REV**
Vauxhall	**Ampera**	**Available**	**E-REV**
Renault	**ZOE**	**2013**	**PEV**
Volvo	**V60 PHEV**	**2013**	**PHEV**
Mercedes-Benz	SLS AMG E-Cell	2013	PEV
Tesla	Model S	2013	PEV
Ford	Focus Electric	2013	PEV
BMW	i3	2013	PEV
Volkswagen	e-Golf	2013	PEV
Volkswagen	e-Up	2013	PEV
Mitsubishi	Outlander PHEV	2013	PHEV
Porsche	918	2013	PHEV
Ford	C-Max Energi	2013	PHEV
Volkswagen	Golf blue-e-motion	2013	PHEV
BMW	i3 EREV	2013	E-REV
Fisker	Karma	2013	E-REV
BMW	i8	2013/14	PHEV
Land Rover	Range Rover PHEV	2014	PHEV
Honda	Accord PHEV	2014	PHEV
Porsche	Cayenne E-hybrid	2014	PHEV
Fisker	Surf	2014	E-REV
Ford	Mondeo Energi	2014/15	PHEV
Lightning	GT	TBC	PEV
Westfield	Sport-E	TBC	PEV
Ginetta	G50 electric	TBC	PEV

65 This list should not be treated as exhaustive or indicative.

Table A2
List of ultra-low-emission vans available or soon to be available in the UK

Manufacturer	Model	Release date
Renault	**Kangoo ZE**	**Available**
Allied electric	e-Expert Tepee	Available
Daimler Mercedes-Benz	**Vito E-Cell**	**Available**
Allied Electric	e-Boxer	Available
Smith Electric	**Edison**	**Available**
Smith Electric	Newton	Available
BD Otomotive Viecolo	**eTrafic Van**	**Available**
Faam	**ECOMILE**	**Available**
Faam	**JOLLY 2000**	**Available**
Mia electric	**Mia U**	**Available**
Citroen	Berlingo	2013
Peugeot	Partner	2013
Nissan	E-NV200	2014

In addition to the above, it is anticipated by industry and government that hydrogen powered FCEVs will begin to come on to the UK market from around 2015 onwards. Major manufacturers like Toyota, Nissan, Hyundai, Daimler and Renault are all in the process of developing FCEV models to bring to market in the near future.