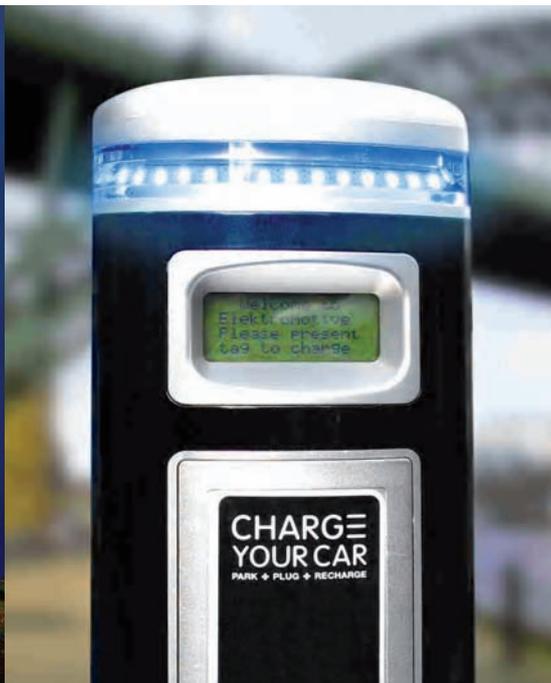




Making the Connection

The Plug-In Vehicle Infrastructure Strategy



June 2011



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This Strategy sets out the framework for the development of recharging infrastructure to support plug-in vehicles in the UK. Implementation of the Strategy will be taken forward in a way that recognises and respects the policy responsibilities and powers of the devolved administrations in Northern Ireland, Scotland and Wales respectively.

In Northern Ireland, planning policy and policy relating to the generation, transmission and supply of electricity are devolved matters.

In Scotland, the generation, transmission and supply of electricity is a reserved matter; while planning is devolved.

In Wales, town and country planning is a devolved matter.

Foreword



Low and ultra-low emission vehicles are a vital part of the Government's plans for a modern transport system that promotes economic growth while delivering on its climate change targets.

Road transport is responsible for over 90% of the UK's domestic transport emissions. But this Government believes it is the carbon that is the problem, not the car. The idea that the only way to achieve our environmental goals is to force people out of their cars is pessimistic, outdated dogma. Low and ultra-low emission technologies, such as plug-in vehicles, offer the potential to reduce emissions but still allow people the mobility that they want and need - assisting in the battle against carbon without persecuting motorists.

The automotive sector already accounts for 12% of the UK's manufacturing employment; low and ultra-low emission vehicles offer the potential to secure these jobs and build upon them, supporting the rebalancing of our economy that we require for a sustainable, profitable future.

The transition to ultra-low emission vehicles will not take place overnight. In the short-term emissions reductions from road transport will be driven largely by improvements in conventional technology, but in the longer term an increased penetration of ultra-low emission vehicles will be vital to meet our environmental goals. We are laying the foundations now with this Strategy to support the growth in the ultra-low emission market that we want to see in the future.

Plug-in vehicles are a viable technology now, but, for this market to grow, consumers need to be reassured that they are affordable and meet their needs. An effective recharging infrastructure, alongside improvements in vehicle range, is a fundamental part of this. However, it is important that this infrastructure operates in the most cost-effective way possible to maximise the environmental, economic and energy system benefits of plug-in vehicles.

This Strategy sets out our vision for recharging infrastructure in the UK and the steps that we, and other industry players, will need to take to make it a reality in the years ahead.

A handwritten signature in black ink, appearing to read 'Philip Hammond', with a horizontal line underneath.

The Rt Hon Philip Hammond MP
Secretary of State for Transport

Executive summary

The shift to ultra-low emission vehicles presents unique environmental and economic opportunities for the UK. It offers the potential to decarbonise road transport while still enabling mobility and stimulating the kind of green jobs and investment that we require to help rebalance our economy.

Reducing transport emissions will require a range of different technologies and solutions in the future. To help support this transition, the Government is committed to growing the market for plug-in vehicles in the UK. This is due to the contribution that they, and other low and ultra-low carbon technologies, can make across our economic and environmental priorities – climate change, green growth, energy security, decarbonising the electricity system and air quality.

The Government is taking an integrated and pragmatic approach to support market growth:

- The Spending Review made provision of **over £300m** over the life of this Parliament for the **Plug-In Car Grant** to reduce the upfront cost of eligible vehicles to consumers and businesses.
- Consumers and businesses also benefit from a **favourable tax regime**, with plug-in vehicles receiving Vehicle Excise Duty and Company Car Tax exemptions, as well as Enhanced Capital Allowances.
- The **Plugged-In Places programme** has made **£30m** available to match-fund eight pilot projects installing and trialling recharging infrastructure in the UK to support the Carbon Plan commitment to install up to 8,500 chargepoints.
- Recognising that continued growth in recharging infrastructure will be driven by private sector investment, which could be constrained by the ability to raise finance, there is the potential for the **Green Investment Bank** to provide targeted financial solutions for appropriate plug-in vehicle infrastructure projects.
- The Government is also supporting low and ultra-low carbon vehicle **Research, Development and Demonstration** focusing on priorities identified in conjunction with the UK Automotive Council.

This Strategy sets the framework for the development of recharging infrastructure to support plug-in vehicle owners and industry in the UK. By providing a clarity of approach and removing barriers for those wishing to invest in, provide or benefit from such infrastructure, this Strategy aims to stimulate and accommodate the expected growth in the plug-in vehicle market.

In the period up to 2015, we expect to see tens of thousands of plug-in vehicles on the roads in the UK, with manufacturers bringing increasing numbers of models to market. In the period from 2015 to 2020 we expect to see the number of plug-in vehicles accelerate as costs reduce and vehicle manufacturers bring forward a wider range of plug-in vehicle models in order to meet their stringent 2020 CO₂ targets under the European New Car CO₂ Regulation.

The rate at which the plug-in vehicle market develops in the UK will be determined by a range of factors, such as consumer acceptance and oil prices, which are difficult to predict. Independent forecasts suggest that hundreds of thousands of plug-in vehicles could be on the road by 2020 and we need to be equipped to deal with this; but we also need to be ready to accommodate an even more rapid rate of growth should this occur.

The evidence base

The Plugged-In Places programme is the key mechanism for commencing the roll-out of recharging infrastructure in the UK and providing learning to inform the future development of a national network. In addition, the Energy Technologies Institute Plug-In Vehicle Economics and Infrastructure Programme and the Technology Strategy Board's Ultra-Low Carbon Vehicle Demonstrator Programme have informed this Strategy. We have also worked closely with the energy utilities, plug-in vehicle manufacturers, chargepost manufacturers and have sought insights from a range of global initiatives.

Our vision for recharging

Our approach is not to mandate 'a chargepoint on every corner' – this is not necessary to help the market grow and would be uneconomic. Rather, for plug-in vehicles to appeal to, and be a viable solution for, consumers, we want recharging infrastructure to be targeted, convenient and safe. We want to see the majority of recharging taking place at home, at night, after the peak in electricity demand. Home recharging should be supported by workplace recharging for commuters and fleets, with a targeted amount of public infrastructure where it will be most used, allowing people to make the journeys they want.

Recharging at home

Recharging at home, at night, off-peak, is not only most convenient for drivers, but also maximises the environmental and economic benefits of plug-in vehicles by using cheaper, lower carbon night-time electricity generation. It also makes the best use of available electricity network capacity.

To help people charge at home as easily as possible, the Government is:

- ensuring that **smart metering** in Great Britain includes the functionality to support smart charging of plug-in vehicles. This will allow recharging to react to price signals, ensuring that it can happen when it is cheapest for consumers and the energy system, subject to appropriate technology in the chargepoint or plug-in vehicle;
- through Ofgem's **Low Carbon Network Fund**, supporting smart grid projects linked to the Plugged-In Places projects in London and the North East which will look at how plug-in vehicles and domestic recharging can be best managed;
- facilitating the installation of domestic chargepoints through the **Plugged-In Places** projects;

- proposing the inclusion of policy on plug-in vehicle infrastructure in the **National Planning Policy Framework**, due for consultation in July 2011. This will encourage local authorities to consider adopting policies to include plug-in vehicle recharging infrastructure in new domestic developments; and
- exploring whether **voluntary standards**, such as the Code for Sustainable Homes, can be used to encourage the inclusion of plug-in vehicle recharging infrastructure in new domestic developments.

Recharging at work

After home recharging, we want to see workplaces providing recharging opportunities, both for fleet vehicles and employees for whom recharging at home is not practical or sufficient. We expect that plug-in vehicles will be particularly attractive to fleet purchasers. Given the current favourable taxation regime, running cost savings and the opportunity for businesses to differentiate themselves and demonstrate their leadership on sustainability, plug-in vehicles make commercial sense for many businesses.

To help businesses respond to these demands we are:

- establishing a **Permitted Development Right** that will allow landowners to install plug-in vehicle chargepoints in car-parking areas without the need to apply for planning permission, removing a barrier for those interested in installing chargepoints;
- enabling businesses whose emissions are caught under the **Carbon Reduction Commitment** to discount electricity used to charge plug-in vehicles from their total electricity consumption. This means businesses with workplace chargepoints will not face additional costs;
- proposing the inclusion of policy on plug-in vehicle infrastructure in the **National Planning Policy Framework**, due for consultation in July 2011. This will encourage local authorities to consider adopting policies to include plug-in vehicle recharging infrastructure in new workplace developments;
- looking at enabling provision of information to consumers about plug-in vehicles and workplace recharging as part of the **Green Deal** customer journey – evidence suggests people taking up core Green Deal measures for workplaces are also likely to be plug-in vehicle adopters; and
- supporting the **Plugged-In Places** projects to install chargepoints in workplaces.

Recharging in public places

The majority of recharging is likely to take place at home and at work, so an extensive public recharging infrastructure would be underutilised and uneconomic. We want public infrastructure to be targeted at key destinations, where consumers need it, such as supermarkets, retail centres and car parks, with a focused amount of on-street infrastructure, particularly for residents without off-street parking.

Although central and local government is currently playing a key role in establishing the early public infrastructure, in the longer term a commercial market needs to develop. Public infrastructure needs to be easy to locate and easy to access, to give the public the assurance that they need to utilise the full range of their vehicles and to support the commercial case for public charging.

To ensure appropriate targeting and ease of access we are:

- establishing a **National Chargepoint Registry** that will allow chargepoint manufacturers and operators to make information on their infrastructure, including location, available in one place;
- supporting a **common standard for plug-in vehicle smartcards** issued by the Plugged-In Places to access their infrastructure, making it easier for users to access more than one scheme;
- challenging industry to specify, by the end of the year, back-office requirements that **enable users to easily access chargepoints provided by different schemes**. As the essential first step we are developing a central system to allow the back-offices of the Plugged-In Places, and other infrastructure schemes, to communicate with each other (a central whitelist); and
- supporting the **Plugged-In Places** projects to install chargepoints in public places where they are most needed.

To make public infrastructure easier to install and to improve the commercial case for installing it we are:

- establishing a **Permitted Development Right** that removes the requirement from local authorities and owners of publicly accessible car parks to apply for planning permission to install chargepoints;
- **working with Ofgem to remove regulatory barriers**. Ofgem will consult this year on an exemption that makes it clear that chargepoint owners and operators can sell electricity via chargepoints at the market rate; and
- **making data freely available** on how public recharging infrastructure installed through the Plugged-In Places is used, to help inform commercially viable business models.

We want plug-in vehicle owners to be able to recharge quickly when they need to. Industry favours moving to a dedicated plug-in vehicle recharging connector (the IEC62196-2 Type 2) to allow faster recharging rates than are possible with a three-pin plug. Given this clear direction of travel, the Plugged-In Places will start to install public infrastructure with Type 2 connectors.

Enabling longer journeys

We want plug-in vehicles to become a viable, mass-market alternative to conventional cars. We recognise that, while 95% of trips in Great Britain are less than 25 miles, well within the range of battery electric vehicles, consumers' purchasing decisions are influenced by the potential to travel further.

Plug-in hybrids and extended-range electric vehicles, rapid chargers, battery swap and flexible ownership models all have the potential to help plug-in vehicle owners undertake longer journeys. We are supporting a range of approaches for extending journeys through the Plugged-In Places, including plans to install around 50 rapid chargers at key locations. We have also included plug-in hybrids and extended-range electric vehicles within the scope of the Plug-In Car Grant.

Taking the Strategy forward

We have set out much in this Strategy that we need to deliver. However, success will require the combined efforts of many.

Local leaders and local initiatives will have an important role in driving activity to ensure infrastructure fits with community needs and priorities. Electricity distributors need to factor in additional demand from plug-in vehicles as they plan to reinforce the grid and consider how to introduce smart grid capabilities. Electricity suppliers have a valuable opportunity to develop new tariffs for plug-in vehicle owners and commercial models for the provision of recharging infrastructure. Businesses and investors need to act on the new commercial opportunities that recharging infrastructure presents, including provision of auxiliary services such as media, communications and mobility services.

Given this wide range of different parties that need to be brought together to make this market a success we are asking the Society of Motor Manufacturers and Traders' Electric Vehicle Group, the Energy Retail Association and the Energy Networks Association to, by the end of the year:

- specify how the back office functions for recharging infrastructure will operate; and
- develop recommendations on the most cost-effective way to ensure that recharging occurs off-peak.

We will not stop here. This is a fast-moving market and, for this reason, we will provide an update to this document at the start of 2013.

1. Introduction



Introduction

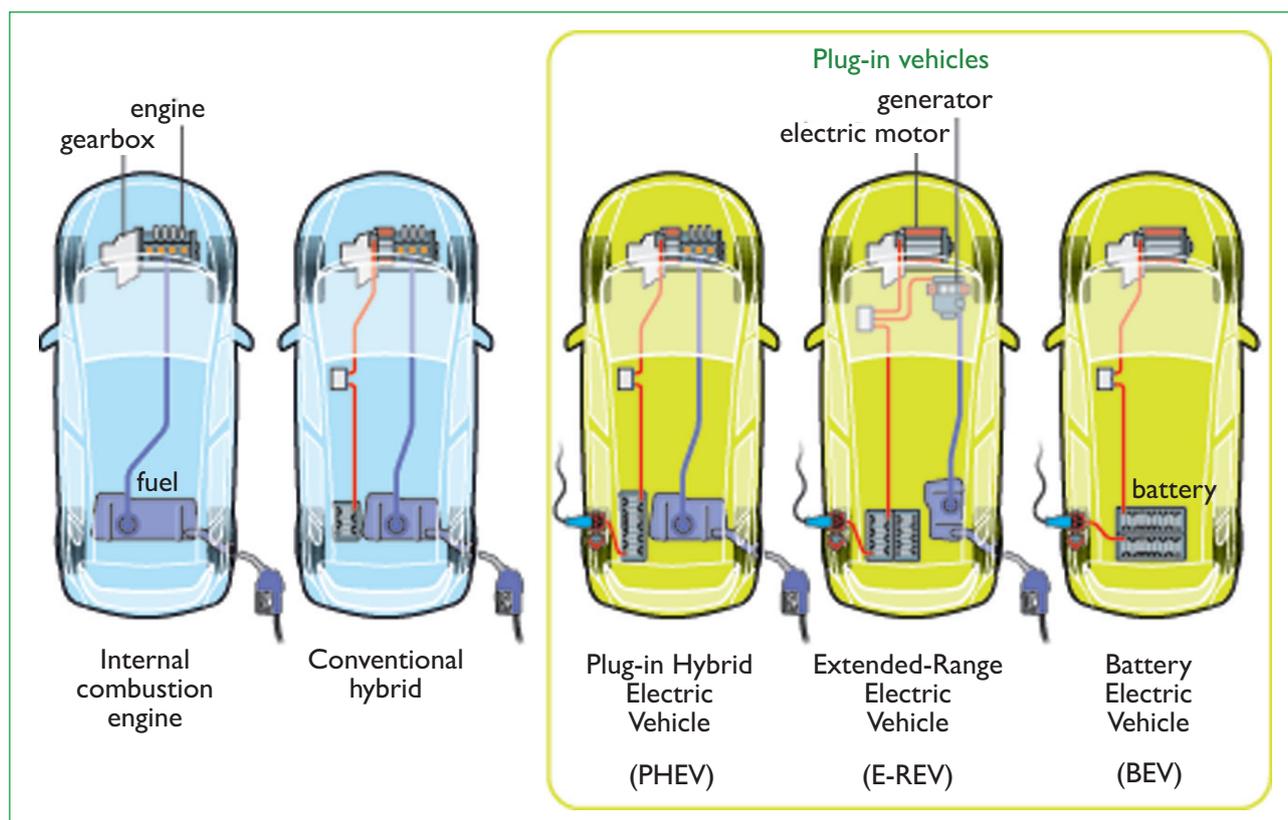
Our vision for plug-in vehicles

- 1.1 The shift to ultra-low emission vehicles presents unique environmental and economic opportunities for the UK. It offers the potential to decarbonise road transport while still enabling mobility and stimulating the kind of green jobs and investment that we require to help rebalance our economy.
- 1.2 The UK's Climate Change Act and commitment to Carbon Budgets has set a strong environmental framework that requires an ambitious shift in transport technology towards ultra-low carbon alternatives. As set out in the UK Automotive Council's technology roadmap,¹ we recognise that in the future there will be a portfolio of low emission technologies for different transport applications – including plug-in vehicles, hydrogen fuel cells, sustainable biofuels and ultra-efficient internal combustion engines.
- 1.3 But the emergence of plug-in vehicles as a real option for consumers and businesses, and as an opportunity for the associated supply chain, has begun, and we are taking practical steps to put the UK at the forefront of this global market.
- 1.4 We are taking an integrated and pragmatic approach to lay robust foundations now that will support continuing market growth in the years ahead:
 - The Spending Review made provision of **over £300m** for the **Plug-In Car Grant** to reduce the upfront cost of eligible vehicles to consumers and businesses.
 - Consumers and businesses also benefit from a **favourable tax regime**, with plug-in vehicles receiving Vehicle Excise Duty and Company Car Tax exemptions, as well as Enhanced Capital Allowances.
 - The **Plugged-In Places programme** has made **£30m** available to match-fund eight pilot projects installing and trialling recharging infrastructure in the UK.
 - Recognising that continued growth in recharging infrastructure will be driven by private sector investment, which could be constrained by the ability to raise finance, there is the potential for the **Green Investment Bank** to provide targeted financial solutions for appropriate plug-in vehicle infrastructure projects.
 - The Government is supporting low and ultra-low carbon vehicle **Research, Development and Demonstration**, focusing on priorities identified in conjunction with the UK Automotive Council.
- 1.5 This has placed the UK at the global forefront of this market, as demonstrated by Nissan's decision to locate production of the LEAF and electric vehicle batteries in Sunderland; Toyota's production of the hybrid Auris in Burnaston; the development of Tata Motors' European Technical Centre in the Midlands; and cutting-edge research such as the Technology Strategy Board's Ultra-Low Carbon Vehicle Demonstrator programme. As a result of this, the UK is regularly recognised as one of the most attractive international plug-in vehicle markets.² The UK is well positioned to benefit from the growth in the plug-in vehicle market, but we need to build on this position of strength to secure the potential advantages.

1 Automotive Council, Technology Roadmap, www.automotivecouncil.co.uk/technology-group/reports

2 Frost & Sullivan, *EV Charging Infrastructure Market: Country Level Analysis of Charging Types (Europe)*, 2010 and 2017, www.frost.com

Figure 1.1 What is a plug-in vehicle?



The term 'plug-in vehicle' is used to describe a wide variety of different technologies that use electric drive to power, or assist in the powering of, a vehicle. For the purpose of this Strategy, the term plug-in vehicle is used as a generic term to describe Battery Electric Vehicles (BEV), Plug-in Hybrid Electric Vehicles (PHEV) and Extended-Range Electric Vehicles (E-REV). Figure 1.1 illustrates these technologies for a passenger car but they are equally applicable to vans, heavy goods vehicles and powered two-wheelers.

- In a BEV a battery pack and electric motor replace the petrol tank and internal combustion engine of a conventional vehicle. BEVs rely entirely on electricity for fuel.
- A PHEV combines both a battery pack and electric motor with an internal combustion engine. Both the electric motor and the internal combustion engine can drive the wheels. The battery pack is much smaller than in a BEV, tending to only drive the wheels at low speeds or for limited range, with the internal combustion engine driving the wheels when the battery is depleted or when extra power is required.
- An E-REV also has both a battery pack and electric motor, as well as an internal combustion engine. The battery pack tends to be larger than in a PHEV but smaller than in a BEV. The electric motor always drives the wheels, with the internal combustion engine acting as a generator to recharge the battery when it is depleted.

E-REVs and PHEVs can use a number of low carbon technologies to provide their additional range and power, such as highly efficient internal combustion engines, sustainable biofuels or hydrogen.

All these vehicles are capable of being plugged into mains electricity. This differentiates them from a conventional hybrid, which also uses electricity to help drive the wheels but cannot be plugged into the mains, generating electricity only through regenerative braking.

This Strategy

- 1.6** In addition to making plug-in vehicles more affordable and stimulating technological innovation, having the right infrastructure in place to support plug-in vehicle owners is the other critical component in maintaining the UK's favourable market position. By providing a clarity of approach and removing barriers for those wishing to invest in, provide or benefit from such infrastructure, this Strategy aims to stimulate and accommodate the growth in the plug-in vehicle market that we expect to see up to 2020.

The developing market

Government's policy framework aims to both stimulate and accommodate the expected substantial growth in plug-in vehicles in the UK.

In the period up to 2015...

...we expect to see tens of thousands of plug-in vehicles on the roads in the UK, with manufacturers bringing increasing numbers of models to market. Early purchasers are likely to be fleet or business users and consumers in urban and suburban locations. It is these segments of the market that are most likely to reap the full environmental and cost of ownership benefits of plug-in vehicles. The market will expand its reach as consumer and business acceptance continues to grow.

The majority of recharging will happen at home or 'back at base', with further recharging opportunities provided at key destinations. The majority of public recharging infrastructure will be provided through the Plugged-In Places programme (see Chapter 3), generating key information, such as how consumers use infrastructure and the impact of plug-in vehicles on the grid. This, and initiatives like the Low Carbon Network Fund (see Chapter 4), will help inform Distribution Network Operators (DNOs) about the best ways to manage their networks to accommodate the increased penetration of plug-in vehicles that we expect to see. A number of commercial organisations, such as supermarkets, are already installing public chargepoints, but further commercial business models will emerge, supported by forward-thinking enterprise and local initiatives.

In the period from 2015 to 2020...

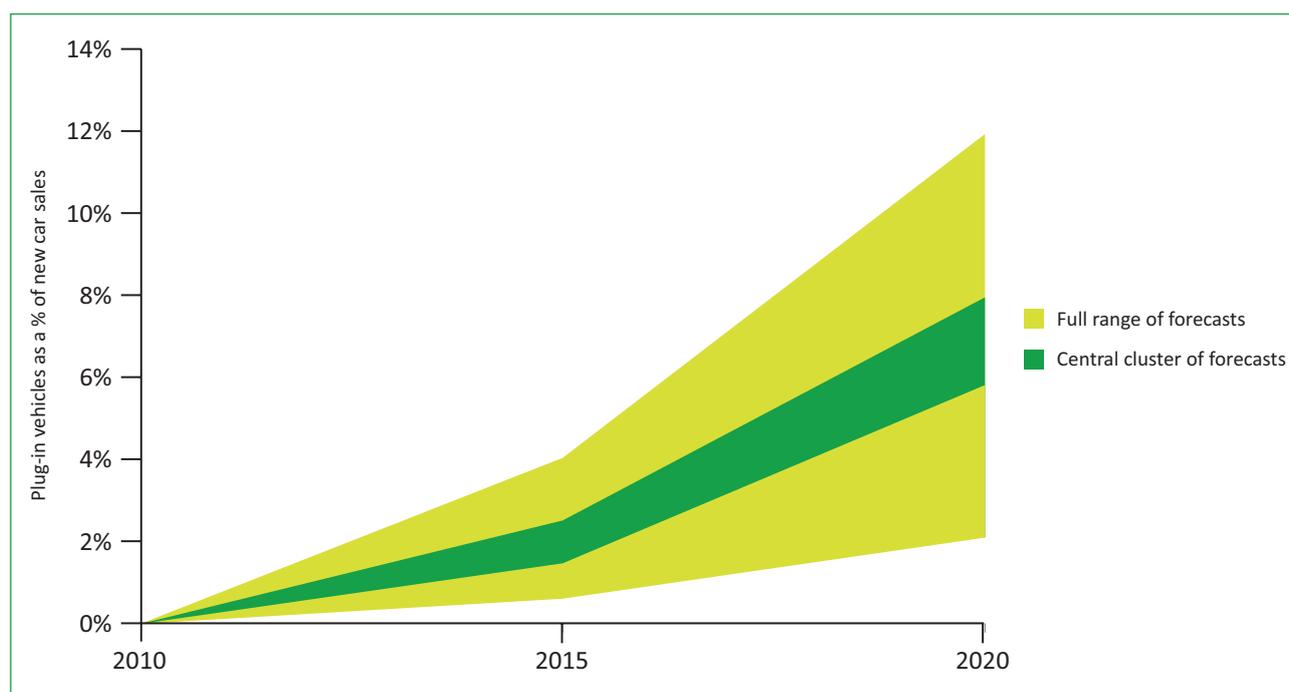
...we expect to see the plug-in vehicle market start to accelerate. A range of forecasts is set out in Figure 1.2 about how the market could develop. We recognise that how the market actually develops will be determined by a range of factors, such as consumer acceptance and oil prices, which are difficult to predict. Independent forecasts suggest that hundreds of thousands of plug-in vehicles could be on the road by 2020 and we need to be equipped to deal with this, but we also need to be ready to accommodate an even more rapid rate of growth should this occur.

As the European New Car CO₂ targets³ come fully into force, vehicle manufacturers will bring forward products in order to meet their stringent 2020 CO₂ targets. And as vehicle costs reduce, so we expect to see the number of plug-in vehicles sold increase more rapidly. Business models will emerge that support the commercial deployment of recharging infrastructure in homes, workplaces and in public. The Government will monitor and facilitate this market, but direct interventions will phase out.

As demand for plug-in vehicles grows, so recharging infrastructure will start to be included as standard in increasing numbers of domestic, workplace and retail developments. Recharging solutions to enable longer distance journeys (such as rapid chargers at key locations, or potentially other technologies like battery swap) will appear in greater numbers.

This will put the UK on a sound footing for the increased penetration of ultra-low emission vehicles that we expect to see in the 2020s, supporting the Government's ambition to reduce the UK's greenhouse gas emissions across the economy by 50% by 2027, plans for which are due to be set out in autumn 2011.

Figure 1.2 Plug-in vehicle uptake forecasts for 2015 and 2020



Source: Graph based on selected plug-in vehicle uptake forecasts by Arup-Cenex, BCG, Berger, Cheuvreux, Deutsche Bank, Frost & Sullivan and McKinsey

1.7 The role of Government is not to mandate a chargepoint on every corner, nor to set aspirational targets for chargepoint numbers for some distant future date – this is such a fast moving technological field that any such prediction produced now will be wrong. Rather, infrastructure should be targeted where it will be most used, to allow people to make the journeys they want and to foster a commercial market in plug-in vehicle infrastructure provision.

³ Regulation (EC) No 443/2009

Our vision for recharging

- 1.8** For plug-in vehicles to appeal to, and be a viable solution for, consumers, recharging needs to be convenient and safe. Plug-in vehicles allow a different approach from refuelling a car, as it is no longer just a case of vehicles having to go to infrastructure – infrastructure can be located where vehicles are parked for the longest periods, which many consumers may find more convenient.
- 1.9** We want to see the majority of recharging taking place at home,⁴ at night, after the evening peak in electricity demand. This is not only most convenient for drivers, but maximises the environmental and economic benefits of plug-in vehicles by using cheaper, lower carbon night-time electricity generation. Off-peak recharging will also enable best use of available electricity network capacity.
- 1.10** After home recharging, we want to see workplaces providing recharging opportunities, both for fleet vehicles and employees for whom recharging at home is not practical or sufficient.
- 1.11** Although chargepoints in public places and destination recharging will be the most visible type of recharging, we want this to be targeted at key destinations, where consumers need them, such as supermarkets, retail centres and car parks, supplemented by a focused amount of on-street infrastructure. This infrastructure will generally be used for top-up recharging or to extend journeys, although there is likely to be a role for public infrastructure in supporting those plug-in vehicle owners who do not have access to off-street parking.
- 1.12** Above all we want recharging to be simple for consumers, with trouble-free, safe, recharging at home or work, supported by public infrastructure that is easy to access, backed up by effective information on where it is located.

Implementing the Strategy

- 1.13** This Strategy sets out this vision for recharging in more detail and the initial steps that Government is taking to make this vision a reality. It sets out how we are:
- using the **Plugged-In Places** trials as a central mechanism to inform the development of commercial models for plug-in vehicle infrastructure;
 - **removing barriers to the market**, such as the requirement for planning permission for public recharging infrastructure, and working to enable chargepoint operators to charge the market rate for electricity;
 - **producing a conducive environment for private investment**, by encouraging infrastructure through planning policies, supporting the move to standardisation and, if raising finance proves a barrier, the potential for targeted financial solutions through the Green Investment Bank; and
 - **helping the consumer** by enabling all public infrastructure to be interoperable and improving the provision of information about public chargepoints.

⁴ Evidence from consultations with industry and data from Element Energy's analysis for the Committee on Climate Change suggests that as much as 90% of recharging (and possibly more) is likely to take place at home or at work. The exact proportions will depend upon the relative uptake of BEVs, PHEVs and E-REVs.

1.14 The development of this emerging market is characterised by the innovation of, and collaboration between, businesses. This is why the Government is also challenging the private sector through the Society of Motor Manufacturers and Traders' Electric Vehicle Group, the Energy Retail Association and the Energy Networks Association, to, by the end of the year:

- specify how the back-office functions for recharging infrastructure will operate in the UK; and
- develop recommendations on the most cost-effective way to ensure that recharging occurs off-peak.

Regulated Asset Base

1.15 Working with Ofgem we have concluded that a commercial market in public infrastructure is the favoured route to ensure its provision. The alternative would be to provide infrastructure through a Regulated Asset Base (RAB), such as the local electricity distribution network. In Great Britain there are 14 Distribution Network Operators (DNOs), responsible for the distribution of electricity from the high-voltage electricity transmission system to homes and businesses. Because they are local monopolies, their operation of local distribution networks is regulated by Ofgem and they are permitted to fund their operations by charging energy suppliers for the use of their network assets.

1.16 We do not believe that providing infrastructure through the DNOs' asset base is the right approach. Including public recharging infrastructure within a RAB could:

- rule out the commercial provision of infrastructure in the future;
- require a centralised approach to set infrastructure quotas for DNOs, rather than being responsive to what consumers want; and
- spread the cost of chargeposts across all electricity consumers, raising equity issues that would need to be considered.

1.17 Therefore, we are not pursuing the use of a RAB at this time, although we recognise that there may be some discrete sectors of the infrastructure market, such as on-street infrastructure for those without off-street domestic parking, where a RAB approach could be more applicable. We will monitor the development of the commercial market in plug-in vehicle infrastructure and if, in the longer term, a commercial market is unable to support the level of public infrastructure required for the growth in plug-in vehicle numbers that we would like to see, we will revisit this decision.

2. The case for plug-in vehicles



The case for plug-in vehicles

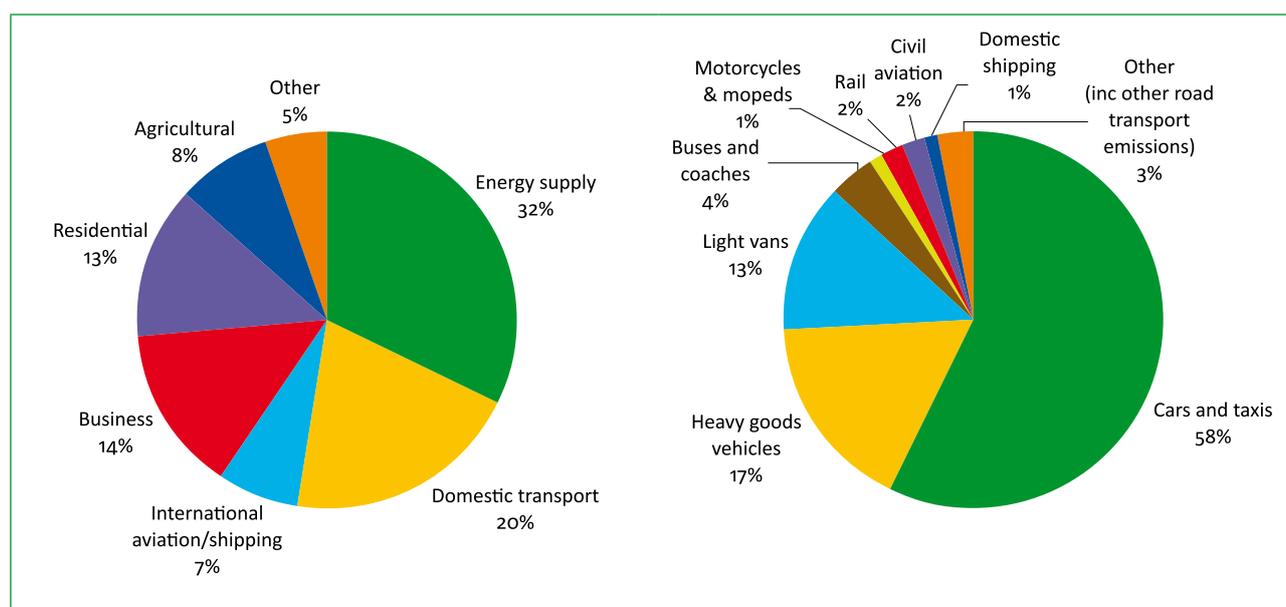
2.1 The Government is committed to growing the market in plug-in vehicles in the UK because of the contribution that they, and other low and ultra-low emission technologies, can make across our economic and environmental priorities:

- climate change;
- green growth;
- energy security;
- decarbonising the electricity system; and
- air quality.

Climate change

2.2 Transport represents one of the largest sources of CO₂ emissions in the UK, with road transport making up over 90% of this, the largest share of which comes from cars (Figure 2.1). As a result, ultra-low emission vehicles will have a key role to play in meeting our binding targets to reduce the UK's greenhouse gas emissions by 50% by 2027, as the Government has recently committed to achieve,⁵ and by 80% by 2050. Plug-in vehicles will make a substantial contribution to meeting these targets, although in the near term the majority of emissions reductions from transport will come from improved efficiency in internal combustion engines, changes that are driven by European regulation. The existing regulatory framework means that by 2020 new cars will emit 40% less CO₂ than they did in 2007.

Figure 2.1 UK greenhouse gas emissions and domestic transport greenhouse gas emissions 2009



Source: National Atmospheric Emissions Inventory, 2009, figures rounded to the nearest per cent

⁵ Secretary of State for Energy and Climate Change, Fourth Carbon Budget Statement, www.decc.gov.uk/en/content/cms/news/cb_oms/cb_oms.aspx

2.3 To realise reductions in greenhouse gases of 80% by 2050 across the UK economy, certain sectors, including road transport, are likely to need to reduce their emissions by even more. As a result, ultra-low and zero-emission vehicles will need to become commonplace. A portfolio of technologies will be used to drive down emissions, and the role for Government is to provide an environment that encourages these new low emission technologies to emerge at a sufficient pace to meet our environmental goals.

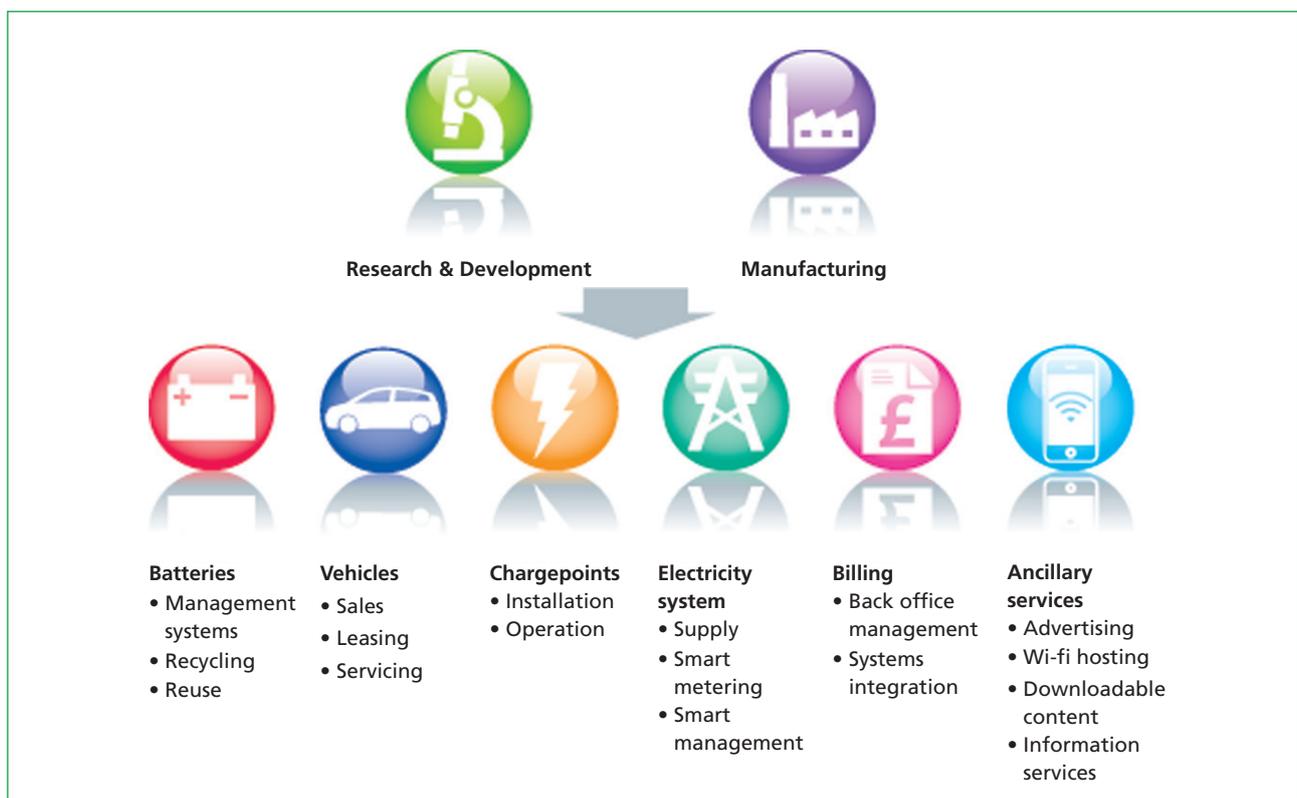
Green growth

2.4 The emergence of low and ultra-low emission vehicles offers significant potential for sustainable economic growth in the UK. The Automotive Council has already identified the shift to low carbon as a strategic imperative for the UK, with opportunities available across a new value chain for the development, deployment and integration of plug-in vehicles (Figure 2.2).

2.5 This will build on existing strengths in the automotive sector, which accounts for 12% of the UK's manufacturing employment, including research and development, design and engineering excellence.⁶ The UK's comparative advantage extends from our world-leading foundations in electrochemical research, through technology specialisms in batteries, motors and power electronics, to niche and volume vehicle manufacturing.

2.6 Further along the value chain, UK-based infrastructure companies including Chargemaster, Elektromotive and POD Point are early movers in the market, with ancillary service providers and systems integrators seeing opportunities in intelligent communication, links to the smart grid and billing systems.

Figure 2.2 Value chain for the development, deployment and integration of plug-in vehicles



⁶ www.bis.gov.uk/news/topstories/2011/Jun/uk-car-industry



Energy security

2.7 Decarbonising the transport sector will not only reduce the UK's carbon emissions, but it will also reduce security risks associated with our use of fossil fuels and help to ease our demand for oil. Global oil demand is projected to increase by around 18% by 2035 compared to 2009 levels,⁷ driven by the emerging economies of China and India. Against a backdrop of constraints on global supply, the risk of significant rises in oil prices and volatility is real. Domestically, North Sea oil production peaked in 1999, and the UK is increasingly dependent on imported oil, having been a net importer since 2005. Our reliance on oil imports and the potential for higher prices and increased volatility mean that oil price shocks can have significant impacts on the UK economy. A shift away from vehicles run on oil-based fuels to plug-in vehicles will improve our energy security and reduce the impact of high oil prices on the economy.

Decarbonising the electricity system

2.8 As part of our legally binding commitment to reduce greenhouse gas emissions we are committed to substantially reduce CO₂ emissions from electricity generation. By 2020 renewables will provide 30% of our electricity,⁸ with greenhouse gas impacts reduced yet further by other low carbon generation and the emergence of Carbon Capture and Storage. As we decarbonise the electricity system, the environmental benefits of plug-in vehicles will increase and they could provide a use for lower carbon night-time electricity generation. In the longer term, as we see increasing amounts of intermittent generation, such as wind, it may be possible through smart management to shift plug-in vehicle recharging according to when it is best for the energy system as a whole.

Air quality

2.9 While air quality has improved significantly over recent decades, current levels of air pollution remain harmful to health in some locations; experts estimate that human-made fine particulate

⁷ IEA WEO 2010 analysis – New Policies Scenario, www.iea.org/press/pressdetail.asp?PRESS_REL_ID=402

⁸ UK National Renewable Energy Action Plan, July 2010, www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/renewable%20energy/ored/25-nat-ren-energy-action-plan.pdf

matter (PM_{2.5}) in 2008 reduced life expectancy by six months averaged across the UK population.⁹ Action to manage and improve air quality is also driven by European legislation.¹⁰

2.10 Road transport is a significant contributor to poor air quality and is the main source of air pollution in 92% of areas identified by local authorities as having problematic pollution levels.¹¹ Battery electric vehicles produce no pollutant emissions at the tailpipe, and most use regenerative braking technology, which has the benefit of reducing particle emissions from brake wear. A significant penetration of zero-emission vehicles will help move the UK towards compliance with its legal obligations – in many urban areas road transport contributes to nitrogen dioxide emissions exceeding the EU limit values for this pollutant – and help reduce the impact of poor air quality on health, particularly in the worst affected urban centres.

Wider impacts

2.11 It is important to acknowledge that, although they have a significant environmental and economic role to play in transport, plug-in vehicles will not address all the implications of road transport, such as congestion. For some journeys, such as those in rural areas, the car is the only viable mode and we want to see an increasing number of these journeys undertaken by ultra-low emission vehicles. However, for other journeys, particularly those within towns and cities, public transport, walking and cycling can be the more sustainable and efficient modes. This is why the Government recently launched the £560m Local Sustainable Transport Fund and set out our strategy for local transport in *Creating Growth, Cutting Carbon: Making Sustainable Local Transport Happen*.¹²

9 *The mortality effects of long-term exposure to particulate air pollution in the United Kingdom*, www.comeap.org.uk/membership/128-the-mortality-effects-of-long-term-exposure-to-particulate-air-pollution-in-the-uk.html

10 European Union Ambient Air Quality Directive (2008/50/EC) sets legally binding limits for concentrations in outdoor air of major air pollutants that impact public health.

11 In House Policy Consultancy, Review of Local Air Quality Management, 2010, www.archive.defra.gov.uk/environment/quality/air/airquality/local/documents/laqm-report.pdf

12 www2.dft.gov.uk/pgr/regional/sustainabletransport/

3. The role for Government



The role for Government

What we are doing to support plug-in vehicles

3.1 The Government has established a policy framework designed to foster a successful market for ultra-low emission vehicles in the UK. This Strategy sets out how we are tackling infrastructure to complement the work to tackle vehicle cost and encourage the development of new technology.

The Plug-In Car Grant

3.2 The Plug-In Car Grant (PICG) was launched in January 2011 and reduces the cost of plug-in vehicles for consumers by cutting the cost of eligible vehicles by 25% up to £5,000. Combined with tax benefits (such as VED and Company Car Tax exemptions) and selected local benefits, these measures aim to make ultra-low emission vehicles a more attractive proposition to consumers in terms of cost – one of the key barriers to the uptake of new technology. Ten vehicles are currently eligible for the grant, meeting the Government’s requirements on performance, safety and warranty.

Vehicles eligible for the Plug-In Car Grant¹³



Research and development programme

3.3 Through the Technology Strategy Board’s Low Carbon Vehicle Innovation Platform the Government is supporting a wide range of research, development and demonstration projects for low and ultra-low carbon vehicles. For example, the Ultra-Low Carbon Vehicle Demonstrator programme has seen over 320 electric, plug-in and hydrogen vehicles trialled across the country, providing key learning to industry and to Government (some of which has been used as evidence in the development of this document). In addition, September

¹³ Top row, from left to right: Mitsubishi i-MiEV, Vauxhall Ampera, Peugeot iOn; middle row, from left to right: Citroen C-Zero, Tata Indica, Nissan LEAF, Renault Fluence; bottom row, from left to right: Chevrolet Volt, Smart fourtwo ED, Toyota Prius Plug-In

2010 saw £24m awarded to vehicle manufacturers, suppliers and universities in collaborative projects developing innovative technologies such as hybrids, lightweight materials, engine optimisation and catalyst efficiency.

Why does the Government need to support recharging infrastructure?

- 3.4** The provision of recharging infrastructure will be a significant factor in addressing ‘range anxiety’ (the concern about ‘running out of juice’), which is one of the key barriers to the uptake of plug-in vehicles. It is important to note that plug-in hybrid and extended-range electric vehicles do not have such range constraints. In addition, evidence from real-world trials¹⁴ suggests that this concern appears to reduce appreciably once people use plug-in vehicles regularly. However, we must make sure that the barrier itself does not stop people gaining that experience in the first place. An appropriate and effective infrastructure, alongside expected reductions in the cost of vehicles and improvements in vehicle range, is necessary to stimulate a growing market.
- 3.5** Providing a successful infrastructure requires co-ordination among a wide range of different parties – electricity suppliers, distribution network operators, plug-in vehicle manufacturers, chargepost manufacturers, planning authorities, businesses and individuals. This, coupled with the relative permanence of infrastructure, means that it is important for the Government to set a strategic framework in which others can operate. This underlies the commitment to a recharging infrastructure as part of the Coalition’s Programme for Government.

The evidence base

- 3.6** The plug-in vehicle market is at an early stage and technology is still developing very fast. In producing this Strategy we have drawn on as wide a range of evidence as possible from the UK and abroad.
- 3.7** In the UK, important sources of learning include the Plugged-In Places projects, the Energy Technologies Institute Plug-In Vehicle Economics and Infrastructure Programme and the Technology Strategy Board’s Ultra-Low Carbon Vehicle Demonstrator programme. We have also worked closely with the energy utilities, plug-in vehicle manufacturers and chargepost manufacturers.
- 3.8** Internationally, we have sought insights from a range of global initiatives, through bilateral relationships as well as participation in global forums, such as the International Energy Agency¹⁵ and the Clean Energy Ministerial’s Electric Vehicle Initiative.¹⁶

14 Everett A, Walsh C, Smith K, Burgess M and Harris M, *Ultra-Low Carbon Vehicle Demonstrator Programme*, May 2011

15 www.ieahev.org/

16 www.cleanenergyministerial.org/EVI/index.html

The Plugged-In Places

3.9 The Plugged-In Places programme is the key mechanism for commencing the roll-out of recharging infrastructure in the UK and providing learning to inform the future development of a national network.

3.10 The Government is providing up to £30m in matched funding to support the installation and trialling of recharging infrastructure in eight places across the country (Figure 3.1). These are led by local consortia including private and public sector organisations, local utilities and businesses to secure investment in plug-in vehicle infrastructure for their areas.

3.11 As set out in the Carbon Plan,¹⁷ the eight projects in Central Scotland, the East of England, Greater Manchester, London, the Midlands, Milton Keynes, the North East of England and Northern Ireland aim to install up to 8,500 chargepoints, in homes, workplaces, car parks and on street. They are working collaboratively with each other and with the Office for Low Emission Vehicles (OLEV) to identify issues and solutions on the path to creating an effective plug-in vehicle recharging network in the UK. The early lessons learned have informed this Strategy and we will continue to learn more as the projects progress.

3.12 The projects are creating a geographical focus for the development of the early market (mitigating the risk of spreading infrastructure provision too thinly), with schemes now starting to become operational – for example, the North East’s ‘Charge Your Car’ scheme has been operational since 2010; the Milton Keynes scheme went live in early 2011 and Source London launched its pan-London membership scheme in May 2011. More will follow soon.

3.13 In addition, each of the projects offers unique insights into how the national picture will develop. For example:

- The projects are trialling different recharging technologies – including standard, fast, rapid and inductive recharging – in a range of different locations.
- Through connections to Ofgem’s Low Carbon Network Fund projects, the North East and London are investigating how electric vehicles will connect to the smart grid.
- The Northern Ireland project is working closely with a parallel scheme in the Republic of Ireland to test and resolve issues around international and cross-border operation.

Figure 3.1 The Plugged-In Places projects



¹⁷ www.decc.gov.uk/en/content/cms/tackling/carbon_plan/carbon_plan.aspx

- The projects are trialling different delivery models for infrastructure, including approaches that are led by the public sector (e.g. Milton Keynes, Scotland, Northern Ireland) and the private sector (East of England, Greater Manchester), as well as membership models (London, North East), pre-paid models (Northern Ireland) and pay-as-you-go systems (Greater Manchester).
- A number of projects are investigating recharging in the home, including East of England and Northern Ireland, with the Midlands project aiming to make 1,000 properties in a new housing development in Corby 'plug-in vehicle ready'.

3.14 At a national level, OLEV is working with all the Plugged-In Places to ensure the interoperability of the schemes. More information on this is set out in Chapter 6.

Energy Technologies Institute – Plug-In Vehicle Economics and Infrastructure programme¹⁸

The Energy Technologies Institute is a partnership between industry and government tasked with developing mass-scale technologies that will help the UK meet its 2020 and 2050 energy targets. The organisation is investing in a substantial programme of research to determine the business case for the mass-market deployment of plug-in vehicles in the UK and the required energy infrastructure.

The first three projects, due to be completed in summer 2011, are being delivered by world-class consortia including industry, academic and consultancy expertise.

Detailed projections of future vehicle performance (such as electric range and efficiency) and costs to 2050 have been developed for the full range of power-train options. Consumer attitudes and behaviours have been analysed through real-world trials and extensive surveys with mass-market consumers. The requirements and costs for the supporting recharging infrastructure and its integration into the UK electricity system have been identified. Lastly, opportunities for market transition have been evaluated through in-depth analysis of the economics and carbon benefits.

¹⁸ www.energytechnologies.co.uk/Home/Technology-Programmes/Transport_copy1.aspx

Technology Strategy Board – Ultra-Low Carbon Vehicle Demonstrator programme¹⁹

In June 2009, as part of the Technology Strategy Board's Low Carbon Vehicles Innovation Platform, with central and regional government support, £25m was allocated to highly innovative, industry-led collaborative research projects in the field of ultra-low carbon vehicle development and demonstration. The competition is focused on encouraging the development of industry-led consortia that can bring significant numbers of vehicles onto UK roads.

By May 2011 over 320 vehicles from 16 manufacturers had been used in the trial in eight different locations around the UK. Each project comprises at least one vehicle manufacturer, an energy supplier, a local authority, an infrastructure provider and a university. The demonstration will help to understand how the vehicles are actually used, measuring time and duration of journeys, energy used and recharging locations, as well as users' perception and behaviour before and after use.

Case Study: E-laad, the Netherlands²⁰

In the Netherlands, the Dutch national grid company and most of the local distribution network operators have jointly established the E-laad Foundation. The aim of the foundation is to install 10,000 chargepoints by 2012. This early stage deployment is designed to provide a better understanding for the participating companies of how recharging infrastructure will be used, the impacts on the grid and the market model required for the successful scale up of plug-in vehicles.

E-laad aims to install 2,000 chargepoints in high-profile locations across the Netherlands, with the remaining chargepoints installed at locations requested by customers. For an annual fee of €100, plug-in vehicle owners can gain access to the infrastructure, which is free to use, and are able to select a location for a chargepoint to suit their needs.

Safety and speed of charging

3.15 A plug-in vehicle represents the largest electrical appliance in a household, drawing more electricity than a cooker or a power shower. As with all electrical appliances, plug-in vehicles need to be treated sensibly and with respect. Owners who plan to charge their vehicles at home should have their wiring checked to ensure that it is appropriate. To support this:

- it is a **requirement of the Plug-In Car Grant** that manufacturers of eligible vehicles set out how they will engage with purchasers to ensure safe recharging of their vehicles; and
- the Institution of Engineering and Technology, the standards body responsible for electrical safety, is producing a **Code of Practice** to advise electricians how to ensure safe plug-in vehicle recharging installations.

¹⁹ www.innovateuk.org

²⁰ www.elaad.com/en.html

- 3.16** Currently most plug-in vehicles use a three-pin plug to recharge. This allows recharging at 10A, which is sufficient to allow most plug-in vehicles to charge fully overnight. However, consumers are likely to value the ability to charge faster, particularly at public infrastructure where it may not be possible to park for long periods. Industry – as represented by the Society of Motor Manufacturers and Traders’ Electric Vehicle Group, the Plugged-In Places and the Institution of Engineering and Technology’s Electric Vehicle Group – favours moving to a dedicated plug-in vehicle recharging connector (the IEC62196-2 Type 2) to allow faster recharging rates (up to 32A) than are possible with a three-pin plug. Given this clear direction of travel from industry, the Plugged-In Places will start to install public infrastructure with Type 2 connectors.
- 3.17** How consumers choose to recharge at home will be a personal choice for each consumer. A three-pin cable will remain an option, but plug-in vehicle manufacturers and electricity suppliers are also offering the option of dedicated domestic recharging units for those consumers who value safe faster recharging speeds at home.

4. Recharging at home



Recharging at home

We want people to recharge plug-in vehicles at home, at night, after the evening peak

4.1 We want recharging at home,²¹ at night, after the evening peak to be the way that the vast majority of plug-in vehicle recharging happens. This is not only most convenient for consumers but also delivers the greatest environmental and energy system benefits.

Environmental benefits

4.2 Utilisation of night-time, off-peak generation maximises the environmental benefits of plug-in vehicles. The marginal carbon intensity of night-time, off-peak electricity is 55% lower than electricity generated at the peak of the evening peak.²²

4.3 In the longer term, the extent of the environmental benefits derived from plug-in vehicles will depend on the rate of decarbonisation of the electricity system. The potential is significant – the average carbon intensity of generation in the UK could drop from 450gCO₂/kWh in 2010²³ to 50gCO₂/kWh in 2030, and the Committee on Climate Change has recommended that the grid should be fully decarbonised by 2050.

4.4 This means that plug-in vehicles represent a potentially significant environmental advantage to internal combustion engines now, and this will only increase as the Government's plans to increase low carbon generation progress.



21 'At home' could mean at a depot for fleet vehicles.

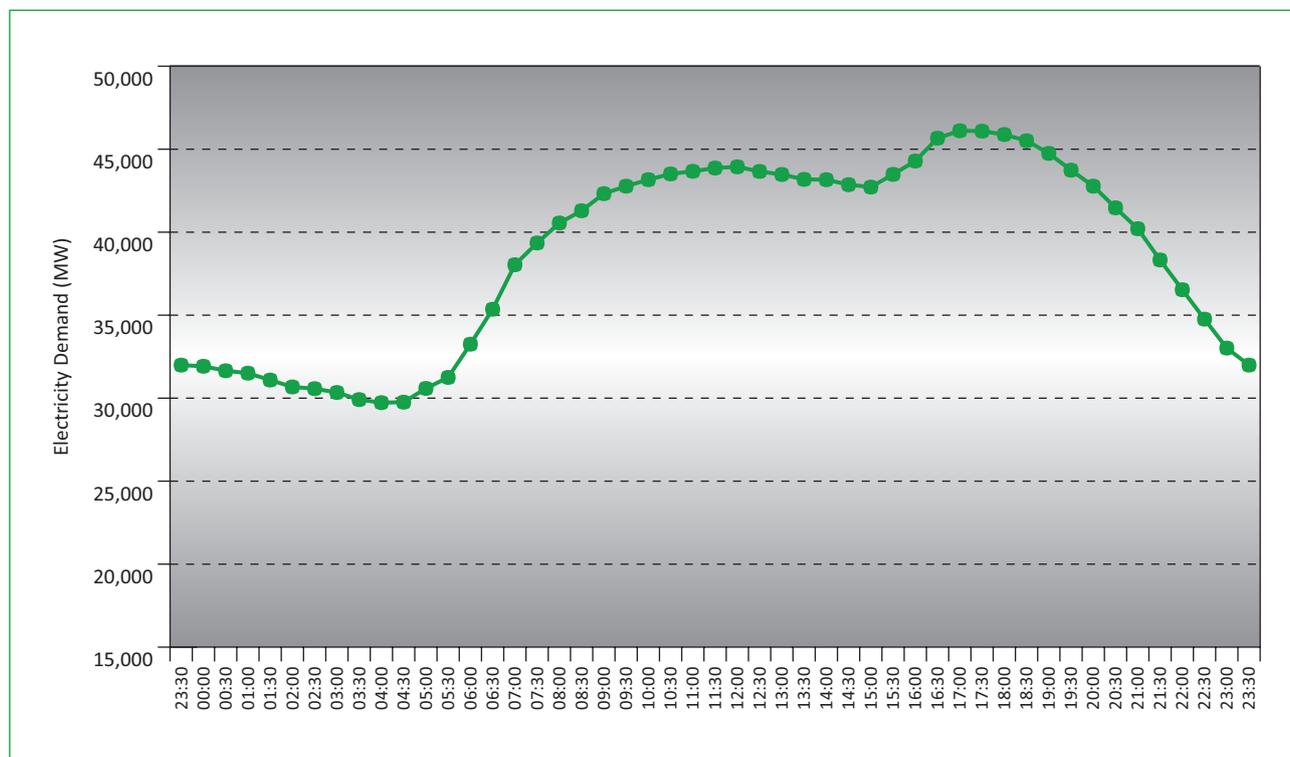
22 This assumes that the marginal plant used to generate electricity off-peak is natural gas and that the marginal plant at peak is coal. Data from Department of Energy and Climate Change *Energy Trends* Table 5.4 and *UK Emissions Statistics* Table 1, 2009, www.decc.gov.uk/en/content/cms/statistics/statistics.aspx

23 Data from DECC *Energy Trends* Table 5.4 and *UK Emissions Statistics* Table 1, 2010, provisional

Energy system benefits

- 4.5 Not only does recharging off-peak overnight deliver the largest environmental benefits, but it also maximises the benefits that plug-in vehicles represent for the energy system as a whole.
- 4.6 At a local level, avoiding the peak will lower the risk of stresses being placed on local distribution systems and could reduce the need for potential reinforcement of the local grid (for example sub-stations).
- 4.7 At a system level, concentrating plug-in vehicle demand in the off-peak period could also reduce the need for additional electricity generation capacity. Currently, additional demand for electricity at peak times comes largely from fossil fuel based generation. If vehicle recharging is managed so that it occurs off-peak, it will mitigate the need for more carbon intensive generation and offer an additional use for low carbon night-time electricity.

Figure 4.1 Average within-day electricity demand curve for Great Britain



Source: Elexon, for March 2010-February 2011

- 4.8 In the longer term, it is also possible that the recharging patterns of plug-in vehicles could be moved to the point in the day that is best for the electricity system as a whole (known as ‘dynamic demand response’). For example, if sufficient capability exists via a smart grid, plug-in vehicle recharging could be matched to wind patterns or to available network capacity. Further into the future, there may even be potential for plug-in vehicles to be used as a form of energy storage, with any remaining charge in the vehicle used to power the house when the vehicle is plugged in during peak periods, before fully recharging overnight (such ‘vehicle to home’ or ‘vehicle to grid’ concepts are at an early experimental stage).

- 4.9** Some of these energy system benefits are longer term, beyond the timescale of this Strategy, but it will be important to encourage the right recharging behaviours now to enable these benefits to be delivered most easily in the future.

Grid impacts

- 4.10** The level of uptake in plug-in vehicles to 2020 is not expected to represent an issue for the National Grid. Clustering of plug-in vehicles recharging in particular locations could lead to the need for local grid reinforcement. ‘Smart’ solutions such as managing demand around capacity availability may be able to reduce this need, and Government and Ofgem are working to improve incentives for Distribution Network Operators (DNOs) and energy suppliers to provide these. There is also potential to reduce local grid impacts of plug-in vehicles where distributed generation is installed alongside plug-in vehicle charging.
- 4.11** The DNOs are considering the potential impacts of plug-in vehicle charging, as well as other green technologies, such as heat pumps and distributed generation, on their networks. These are likely to be an integral part of the business plans they submit to Ofgem for the next Price Control Period (2015–22).
- 4.12** Government is considering the role of the electricity network in the context of increasing numbers of plug-in vehicles as part of the Electricity Market Reform White Paper, due to be published this summer.

Why do we think home night-time recharging will happen?

- 4.13** Recharging at home, at night, seems to be the natural recharging behaviour of plug-in vehicle drivers. Evidence from trials²⁴ suggests that the majority of plug-in vehicle owners want to charge their vehicles at home, at night, as this is the most convenient time. Incentives, such as cheaper off-peak tariffs for plug-in vehicle owners, may need to be put in place to ensure that domestic recharging is off-peak.
- 4.14** Recharging at home is a viable option for a significant proportion of UK households – evidence suggests that 65% of households in England (15 million households) have off-street parking.²⁵ In addition, new car purchasers are more likely than average to have off-street parking, meaning that recharging at home, at night, is likely to be possible for the majority of plug-in vehicle owners.
- 4.15** Electricity generators, suppliers and DNOs are also commercially incentivised to encourage off-peak charging. Off-peak, overnight electricity is cheaper to generate, and plug-in vehicles represent a potentially valuable market for this electricity. Recharging off-peak overnight will also minimise any reinforcement of the electricity grid, for which the DNOs are responsible. The market is now beginning to respond with new commercial business models. At the time of writing, British Gas, EDF Energy and npower have recently announced home installation packages, alongside low overnight off-peak tariffs, with more expected to follow.

²⁴ Everett A, Walsh C, Smith K, Burgess M and Harris M, *Ultra-Low Carbon Vehicle Demonstrator Programme*, May 2011

²⁵ *Communities and Local Government, Survey of English Housing 2008–09*, www.communities.gov.uk/publications/corporate/statistics/ehs200809headlinereport



4.16 To support off-peak recharging, Government has:

- ensured that **smart metering** in Great Britain will include the functionality to support smart charging of plug-in vehicles. This will allow charging to react to price signals, ensuring that it can happen when it is cheapest for consumers and the energy system, subject to appropriate technology in the chargepoint or plug-in vehicle; and
- through Ofgem's **Low Carbon Network Fund** supported smart grid projects linked to the Plugged-In Places projects in London and the North East, which will look at how plug-in vehicles and domestic recharging can be best managed.

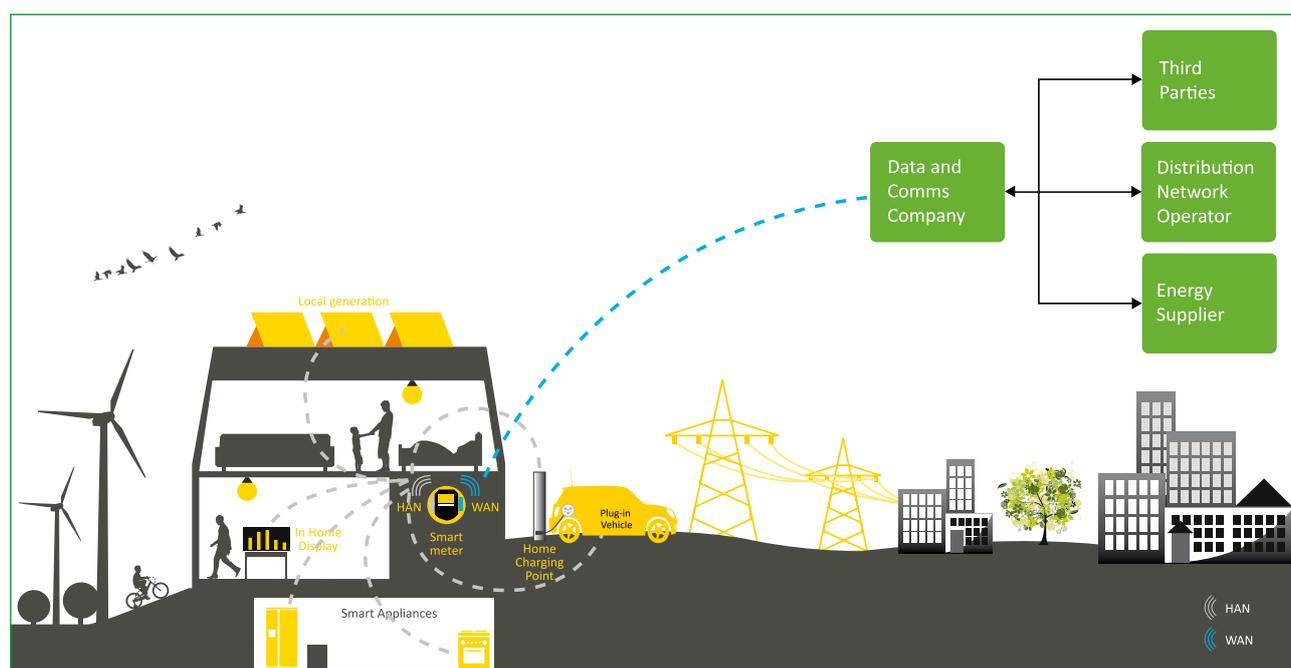
Smart metering

In March, the Government published its response to the Smart Metering Prospectus consultation.²⁶ This was accompanied by an updated functional requirements catalogue for the smart meter and the wider smart metering system. It is envisaged that plug-in vehicles and chargepoints could have the potential to interact with the system as smart appliances (Figure 4.2). This could allow them to respond to price signals and potentially to respond dynamically to real-time signals sent to plug-in vehicles via a future smart grid. Smart meters will offer:

- a common application layer and protocols allowing, through the 'end-to-end' smart metering system, remote communication with compatible chargepoints and plug-in vehicles;
- the opportunity for energy suppliers to introduce time-of-use tariffs to incentivise off-peak plug-in vehicle charging;
- the opportunity to meter and transmit plug-in vehicle usage separately, allowing energy suppliers to develop tariffs specifically for plug-in vehicles; and
- the ability to support dynamic Demand Side Response (DSR) in conjunction with a future smart grid, potentially allowing plug-in vehicle recharging to respond to signals from the grid in times of high electricity demand or high generation from wind.

The Government's intention is to consult on an obligation on suppliers to effectively complete the roll-out of smart meters in 2019.

²⁶ www.decc.gov.uk/en/content/cms/consultations/smart_mtr_imp/smart_mtr_imp.aspx

Figure 4.2 Smart metering and recharging plug-in vehicles²⁷

Source: Logica

4.17 To enable people to recharge at home as easily as possible, Government is:

- proposing the inclusion of policy on plug-in vehicle infrastructure in the **National Planning Policy Framework**, due for consultation in July 2011. This will encourage local authorities to consider adopting policies to include plug-in vehicle recharging infrastructure in new domestic developments;
- exploring whether **voluntary standards**, such as the Code for Sustainable Homes, can be used to encourage the inclusion of plug-in vehicle recharging infrastructure;
- already facilitating the installation of around 2,000 domestic chargepoints through the eight **Plugged-In Places** projects; and
- looking at enabling provision of information to consumers about plug-in vehicles and home recharging as part of the **Green Deal** customer journey – evidence suggests people taking up core Green Deal measures for their homes are also likely to be plug-in vehicle adopters.

4.18 We will continue to monitor the development of domestic recharging and if its provision does not keep pace with the trajectory of plug-in vehicle uptake we will consider consulting on amendments to future iterations of Building Regulations, to ensure that the necessary wiring for safe plug-in vehicle recharging is in place.

²⁷ Plug-in vehicles and chargepoints have the potential to interact with the smart metering system through the Home Area Network (HAN). Smart meters will communicate with the wider smart metering system through the Wide Area Network (WAN).

Low Carbon Network Fund²⁸

CE Electric: Customer-led Network Revolution

A major project in North East England and Yorkshire is making important links between three key components of a smart grid: plug-in vehicles, smart meters and microrenewables. This £54m project is the largest in Ofgem's Low Carbon Network Fund and will explore interdependencies between these technologies, their impact on the electricity network and the potential to influence customer behaviours such as overnight recharging of plug-in vehicles.

A partnership of CE Electric, British Gas, Durham University and EA Technology, the project will engage around 11,000 households and up to 300 plug-in vehicle drivers. Working closely with North East England's Plugged-In Places project, incentives have been devised to integrate the installation of home chargers with the provision of smart meters. This will facilitate the monitoring of electricity usage and trialling of innovative tariff structures to develop smart grid responses to the introduction of plug-in vehicles.

Low Carbon London

The £29.9m Low Carbon London programme will investigate how best to develop a smarter electricity network that can continue to deliver a safe and secure electricity supply in a low carbon economy, while keeping costs as low as possible for electricity customers.

Plug-in vehicles will be one of the defining features of this low carbon economy – and London aspires, via the Mayor's Source London initiative, to be the electric vehicle capital of Europe. Low Carbon London is looking at how the behaviour of recharging plug-in vehicles in public, at home and at work impacts on the electricity network. It will also investigate the scope for different tariffs to reward customers for changing their plug-in vehicle recharging patterns to reflect periods of low electricity demand or high availability of greener electricity. Businesses and private plug-in vehicle owners may be able to realise significant reductions in their electricity bills by trialling these new tariffs.

28 www.ofgem.gov.uk/networks/elecdist/lcnf/pages/lcnf.aspx

5. Recharging at work



Recharging at work

The role of businesses

- 5.1** We want workplaces to be the second main pillar of the UK's plug-in vehicle recharging infrastructure. We want workplaces to be used primarily for top-up charging, although it will be the main recharging location for some plug-in vehicles, such as fleet vehicles or vehicles that cannot charge at home.
- 5.2** We expect businesses will want to install recharging infrastructure for a number of reasons. In the short term we expect that plug-in vehicles will be particularly attractive to fleet purchasers. The current favourable taxation regime through Enhanced Capital Allowances and Company Car Tax exemptions for plug-in vehicles, as well as running cost savings, mean that plug-in vehicles make commercial sense for many fleet purchasers. Plug-in vehicles are also likely to represent an opportunity for businesses to demonstrate their leadership on sustainability and potentially differentiate themselves from competitors.
- 5.3** Plug-in vehicles within business fleets will also be an important way for individuals to use and experience the vehicles, contributing to wider consumer acceptance of this technology. Over time, businesses will need to accommodate demand for workplace recharging infrastructure from their employees who may choose to purchase plug-in vehicles and want or need to recharge at work.
- 5.4** Workplace recharging will be particularly important if there is a significant take up of Plug-in Hybrid Electric Vehicles (PHEVs) or Extended-Range Electric Vehicles (E-REVs), as these may need a different pattern of charging to deliver their maximum environmental and financial benefits, making the benefits of workplace top-up recharging potentially significant.

Case Study: Durham County Council Workplace Chargepoints

Durham County Council, as part of its commitment to the plug-in vehicle agenda and the North East's Plugged-In Places project, has installed 28 chargeposts across County Durham, including in the Council office car park to support their Nissan LEAF pool car.

Over 30 staff are now able to use the pool car for business trips, and the vehicle is used every day for site visits within the county. The vehicle is being driven primarily by the Traffic Studies team and it is often used to promote plug-in vehicles at events, including summer shows, educational visits and seminars.

John McGargill, Strategic Traffic Studies Manager, said: 'We tend to charge overnight which gives us enough range for the day's journeys, and we estimate that during our first month the car was driven 502 miles. The cost of electricity for these journeys was only £8.21. Fuelling a conventional vehicle to make the same journeys would have cost around £48 so we are already seeing significant benefits to the Council owning an electric vehicle.'



What are we doing to encourage workplace recharging?

5.5 To help businesses respond to these demands we are:

- establishing a **Permitted Development Right** that will allow landowners to install plug-in vehicle chargepoints in car-parking areas without the need to apply for planning permission, removing a barrier for those interested in installing chargepoints;
- enabling businesses whose emissions are caught under the **Carbon Reduction Commitment** to discount electricity used to recharge plug-in vehicles from their total electricity consumption. This means businesses with workplace chargepoints will not face additional costs;
- proposing the inclusion of policy on plug-in vehicle infrastructure in the **National Planning Policy Framework**, due for consultation in July 2011. This will encourage local authorities to consider adopting policies to include plug-in vehicle recharging infrastructure in new workplace developments;

The London Plan

The Mayor's London Plan,²⁹ published for consultation in October 2009, includes a policy requiring all developments that include car parking to provide plug-in vehicle chargepoints at one in five of the car parking spaces.

29 www.london.gov.uk/thelondonplan

- already facilitating the installation of around 2,500 workplace chargepoints through the eight **Plugged-In Places** projects; and
- looking at enabling provision of information to consumers about plug-in vehicles and workplace recharging as part of the **Green Deal** customer journey – evidence suggests that people taking up core Green Deal measures for workplaces are also likely to be plug-in vehicle adopters.

Practical guidance on installing recharging infrastructure

A practical Tool Kit to provide guidance on the development of public and workplace recharging infrastructure in the UK will be launched at the end of July 2011, as part of the European funded ENEVATE project. The content draws upon learning from the Plugged-In Places programme, as well as other UK and European infrastructure and plug-in vehicle trial projects. It will provide a step-by-step guide for those businesses and local authorities wishing to install recharging infrastructure.

The Tool Kit will be non-prescriptive and provide practical advice about the various technical and non-technical factors that need to be considered when installing recharging infrastructure. It is designed for use by project managers and includes guidance notes, process maps, project examples and outline project management tools. It will also highlight factors to consider in relation to longer term future-proofing and interoperability.

The development of the Tool Kit is being led by Future Transport Systems and will be downloadable at www.switchev.co.uk.



Case Study: Fleets, TNT

TNT has set itself a target of reducing its overall climate impact by 40%. As part of this it has conducted a full review of the applicability of plug-in vehicles to its fleet. This has demonstrated that, without changing duty cycles, there is a case to switch around 10% of its global delivery fleet to electric. It also showed that, with changes to duty cycles and the way services were delivered, potentially more than 50% of the fleet could convert.

As a first step TNT is testing the operational and financial feasibility of plug-in vehicles in various countries across the world, including developing a substantial fleet of Smith electric vans in the UK. TNT believes that collaborating with other businesses through buying consortia offers an opportunity to help the plug-in vehicle market develop further. TNT is supporting the development of a buying consortium in the UK led by The Climate Group, with the Energy Saving Trust and Cenex as core team members.

6. Recharging in public places



Recharging in public places

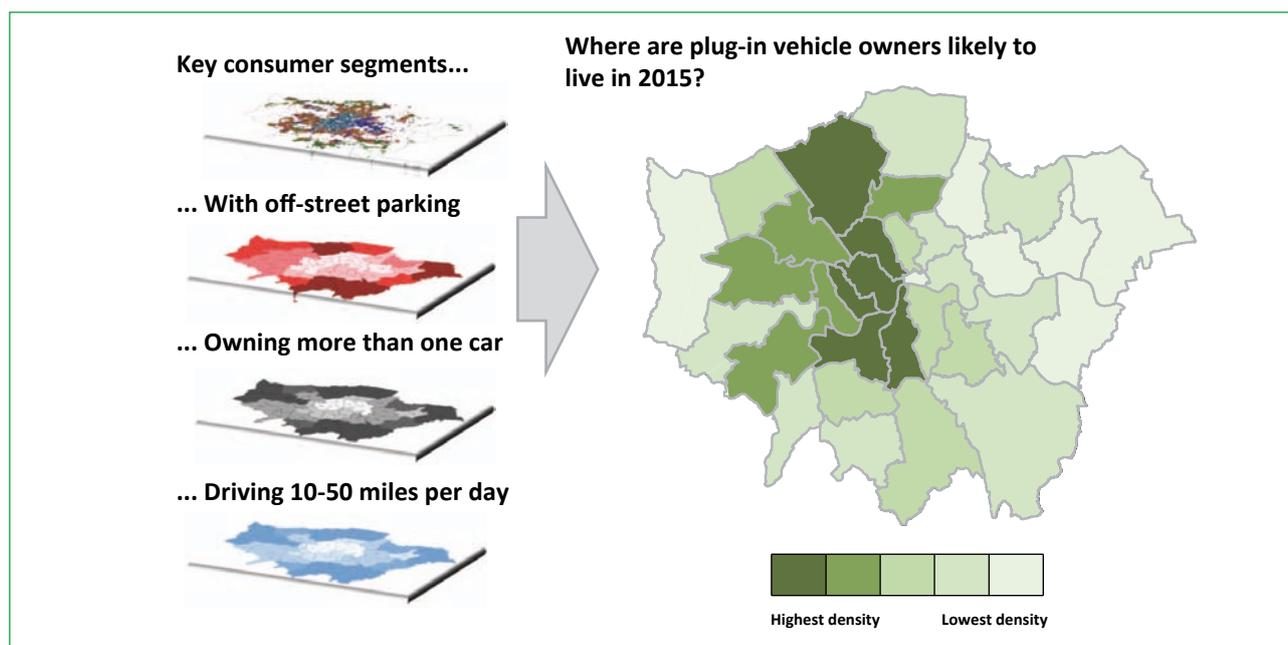
We want to see targeted public infrastructure that is easy to use and commercially viable

- 6.1 Although central and local Government is currently playing a key role in establishing the early public infrastructure,³⁰ in the longer term a commercial market for public recharging needs to develop.
- 6.2 We do not want to see a chargepoint on every corner; this is an unnecessary and expensive approach to allaying range anxiety. The majority of recharging is likely to take place at home and at work, so an extensive public recharging infrastructure would be underutilised and require a level of public subsidy that is neither sensible nor affordable. Instead we want public infrastructure that is targeted at those places where it is needed and is commercially viable.
- 6.3 Public infrastructure needs to be easy to locate and easy to access. Making it easy to locate and accessible will give the public the assurance they need to utilise the full range of their vehicles, and it will support the commercial case for public charging.

A targeted infrastructure

- 6.4 We are taking a number of steps to ensure that infrastructure is where it is needed and that people are aware of its location:
 - We are supporting the **Plugged-In Places projects** to install around 4,000 chargepoints in public places. Across the projects we have encouraged an approach, pioneered by London, to use demographic, trip pattern and parking data to target public infrastructure where it is most likely to be needed.

Figure 6.1 Targeting plug-in vehicle infrastructure in London



Source: Transport for London

30 Public recharging infrastructure includes chargepoints in public, private and retail car parks, as well as on-street. Public charging infrastructure will not necessarily be owned by the public sector.

- **Establishing a National Chargepoint Registry** to allow all chargepoint manufacturers and infrastructure scheme operators to make data on their chargepoints available in one place, which will enable comprehensive information to be provided to consumers by satnavs and websites. Currently there is no single, comprehensive source of chargepoint data, with consumers faced with a significant amount of internet research before attempting any journey other than ones that they are already familiar with. The data will be made available through data.gov.uk and is due to be available by the end of the year. The Registry will be supported by the Government until the end of the Plugged-In Places programme, and from that point onwards it will be for the plug-in vehicle infrastructure market to provide and support the Registry.



- To make it easier to install public infrastructure we will shortly establish a **Permitted Development Right** that removes the requirement from local authorities and owners of publicly accessible car parks to apply for planning permission to install chargepoints.

Easy to use

- 6.5** To appeal to consumers, recharging at public infrastructure needs to be easy to use. Drivers should be able to drive up and charge at any public chargepoint with a minimum of fuss.
- 6.6** To date the majority of public recharging infrastructure in the UK has been installed by geographically focused membership schemes, such as the Plugged-In Places. These schemes typically use a membership model, with plug-in vehicle drivers paying a membership fee and then being able to use all the chargepoints within that scheme for free. We must ensure that a member of one scheme can go to another scheme and access the infrastructure there.
- 6.7** To enable this we are:

- **supporting a common standard for plug-in vehicle smartcards**³¹ issued by the Plugged-In Places to access their infrastructure. This will mean that any smartcard issued by one of the Plugged-In Places will be capable of being read by infrastructure from all the projects. It will also mean that these smartcards could be integrated in the future with public transport smartcard ticketing; and
- challenging industry to specify, by the end of the year, the back-office requirements for a system to **enable members of one scheme to be able to use the chargepoints of another**. As the essential first step, we are developing a central system to allow the back-offices of the Plugged-In Places, and other infrastructure schemes, to communicate with each other (a central whitelist).



31 High-frequency RFID card, 13.56 MHz frequency

Commercially viable

6.8 Private sector investment will be required to support the future provision of public recharging infrastructure. The Government is facilitating the development of this market through the Plugged-In Places, but it is not appropriate to create an infrastructure that is consistently reliant on public subsidy. There is a range of potential revenue streams that could support a commercial public recharging infrastructure in the future, including the sale of electricity, infrastructure as part of a wider mobility service and the sale of ancillary services, such as wi-fi hosting in public infrastructure.

6.9 Consumers will determine which business model for public infrastructure is most successful. Government's role is to create an environment that will allow successful businesses to develop.

6.10 To help create an attractive business environment we are:

- **sharing data on the Plugged-In Places programme.** We will make data freely available on how public infrastructure installed as part of the programme is used to help inform, de-risk and validate commercial business models;
- **working with Ofgem to remove regulatory barriers.** We do not think Maximum Resale Price rules should apply to electricity sold to recharge plug-in vehicles through publicly accessible chargepoints. Ofgem plans to consult on an exemption that would make this clear, enabling a free market to develop for the sale of electricity through public chargepoints; and
- supporting the sorts of infrastructure development needed to enable the transition to a green economy through the **Green Investment Bank (GIB)**. £3bn is available over the period to 2015, commencing with the Government making direct financial investments prior to the establishment of the GIB as a stand-alone institution, following State Aid approval. Depending on the choice of revenue mechanism for plug-in vehicle infrastructure and the business case for GIB intervention, it could potentially play a role both in terms of innovating new financial products to mobilise private sector investment and in acting as a co-financier to help introduce additional capital into the sector.



7. Enabling longer journeys



Enabling longer journeys

7.1 We want plug-in vehicles to become a viable, mass-market alternative to conventional cars. Recent data suggests that 95% of trips in Great Britain are less than 25 miles³² and the average trip length by car is only 8.4 miles,³³ well within the range of Battery Electric Vehicles (BEVs). However, consumers' purchasing decisions are influenced by the potential to travel further, not just their average journey patterns. Therefore it will be important for consumers to be reassured of the ability to make longer journeys and own plug-in vehicles, particularly when looking ahead to breaking into the mass-market of consumers in the 2020s and 2030s.

How to enable longer journeys

7.2 There is a variety of ways that plug-in vehicle ownership is compatible with longer journeys:

- **Plug-in Hybrid Electric Vehicles/Extended-Range Electric Vehicles** – PHEVs and E-REVs are themselves a means of extending the range of a plug-in vehicle. In these cases the battery is recharged not by an external charger but by an on-board generator in the form of an internal combustion engine, or an internal combustion engine driving the wheels when the battery is low.



- **Rapid chargers** – rapid charging technology enables batteries to be recharged much more quickly, for example a 24 kWh battery can be recharged from flat to 80% in less than an hour, representing a method of enabling longer distance journeys without the need for long recharging stops.
- **Battery swap** – has the potential to allow vehicles to be recharged with comparable speed to refuelling an Internal Combustion Engine (ICE) vehicle. However, there are a number of significant challenges that remain before this has a mass market application, for example, standardisation of battery size and location, the number of compatible vehicles and cost. We watch international pilot projects with interest.
- **Alternatives** – for many, even ownership of a BEV is unlikely to be a constraint on their ability to make longer distance journeys. Thirty-two per cent of households in the UK have more than one car,³⁴ and demographically these households are most likely to be among the first to purchase plug-in vehicles, which will allow them to use their ICE vehicle for

32 *National Travel Survey 2010*, Average number of trips by trip length and main mode: Great Britain, 2009
www2.dft.gov.uk/pgr/statistics/datatablespublications/nts/latest/nts2009-03.pdf

33 *National Travel Survey 2010*, Average trip length by main mode: Great Britain, 2009
www2.dft.gov.uk/pgr/statistics/datatablespublications/nts/how-mode/nts0306.xls

34 *National Travel Survey 2010*, Household car availability: Great Britain, 1951 to 2009
www2.dft.gov.uk/pgr/statistics/datatablespublications/nts/driving-availability/nts0205a.xls

longer journeys. For many longer journeys, rail travel will also present a viable alternative to the car. In addition, a range of innovative business models is being developed to address this issue – for example, the Peugeot Mu scheme allows plug-in vehicle owners access to the whole range of Peugeot vehicles, and car clubs are exploring whether they could play a role.

7.3 Given the early stage in the plug-in vehicle market, it is not clear which of these will become the dominant business model to enable longer distance journeys. At this stage, as Government, we are supporting the demonstration of these business models in a number of ways:

- The **Plug-In Car Grant** applies to PHEVs and E-REVs, as well as BEVs.
- We are **linking up the Plugged-In Places**. The projects plan to install around 50 rapid chargers. We are working with them to ensure that their plans are properly co-ordinated so that the maximum number of journeys are enabled. For example, strategic placement of rapid chargers by the projects in the north of the country would enable journeys between Manchester, Newcastle, Edinburgh and Glasgow.

7.4 We will continue to monitor the development of this market alongside industry to understand whether further steps are necessary to support the market.

8. Taking this Strategy forward



Taking this Strategy forward

- 8.1** Rolling out infrastructure for plug-in vehicles is going to require the combined efforts of several sectors. The chapters above set out the framework being established by central Government to facilitate the provision of recharging infrastructure and our vision for how the market will develop. **This is a fast-moving market and we will therefore provide an update to this document at the start of 2013.** Central Government will also continue to work with the EU and international partners to ensure the right incentives and standards are introduced to help the UK market grow further.
- 8.2** However, to realise this vision for the UK, it will be essential that a range of others play their part too:
- **Local leaders and initiatives** in cities, towns and communities will have an important role in stimulating the provision of infrastructure in their areas. Those involved in Plugged-In Places projects will make a critical contribution to the development of national infrastructure. Others should look to the experience of these and projects elsewhere, such as in Amsterdam or Paris, to assess how such schemes might fit with their local priorities and could be promoted through tools such as local planning policy.
 - **Electricity distributors** will need to take account of additional electricity demand from the growing plug-in vehicle market. They will need to factor additional demand, including where and how vehicles are recharged, in their plans for network reinforcement, working closely with Ofgem. They will also need to investigate ways to achieve consistency and transparency in connecting recharging infrastructure to the distribution network. Finally, they must continue to work with the Department of Energy and Climate Change (DECC) and the plug-in vehicle industries to ensure that the development and roll-out of smart meters and the smart grid appropriately consider the requirements of plug-in vehicles.
 - **Electricity suppliers** have a valuable opportunity to take advantage of the growing market for plug-in vehicles and recharging infrastructure. We encourage them to continue developing commercial models for the provision of recharging infrastructure at home, at work and in publicly accessible locations. This will include the introduction of innovative tariffs for plug-in vehicle owners that allow them to benefit from cheaper off-peak recharging and potentially to spread the costs of domestic infrastructure. Finally, it is essential that they work with electricity distributors, DECC and the plug-in vehicle industries on the roll-out of smart metering and the smart grid.
 - **Business and investors** need to act on the new commercial opportunities presented by recharging infrastructure and harness revenue from the sale of electricity and auxiliary services, such as media, communications and mobility services, recharging infrastructure and back-office systems. The opportunity exists for businesses that have a strong interest in the plug-in vehicle market to engage through the Society of Motor Manufacturers and Traders, the Energy Retail Association and the Energy Networks Association in developing a consensus view on immediate challenges, including interoperability, commercialisation and off-peak charging. Planning policies should ease the installation of infrastructure, and Government is initiating the development of the tools needed to create an interoperable network and keep users informed about recharging locations as this network grows.

- The ultimate aim of this Strategy is to ensure that recharging a plug-in vehicle is simple and attractive for **consumers**. Measures to address the up-front cost of vehicles, such as the Plug-In Car Grant and tax benefits, will help to make plug-in vehicles a more attractive option to fleets and individuals from a cost perspective.

8.3 The actions set out in this Strategy should stimulate the provision of more infrastructure at key locations around the UK. They should enable ease of use and better information. They should also foster the development of commercial offers and tariff structures. Taken together they should increasingly make the use of plug-in vehicles a part of everyday life in the UK.

List of abbreviations

BEV	Battery Electric Vehicle
DECC	Department of Energy and Climate Change
DNOs	Distribution Network Operators
DSR	Demand Side Response
E-REV	Extended-Range Electric Vehicle
GIB	Green Investment Bank
ICE	Internal Combustion Engine
Ofgem	Office of Gas and Electricity Markets
OLEV	Office for Low Emission Vehicles
PHEV	Plug-in Hybrid Electric Vehicle
PICG	Plug-In Car Grant
RAB	Regulated Asset Base
VED	Vehicle Excise Duty