BEAMA, ENA, Energy UK and SMMT Response to Government's Plug-In Vehicle Infrastructure Strategy

Industry recommendations on back-office functions and off-peak recharging for national Plug-In Vehicle recharging infrastructure

June 2012

Executive Summary

The Plug-In Vehicle, and more generally the decarbonisation of transport in the UK, will form an important part of the means by which national carbon output is reduced and air quality is improved.

In June 2011, the Government published *Making the Connection: The Plug-In Vehicle Infrastructure Strategy.* This stated the following:

> *Given [the] wide range of different parties that need to be brought together to make this [plug-in vehicle infrastructure] market a success we are asking the Society of Motor Manufacturers and Traders' Electric Vehicle Group, the Energy Retail Association[1] and the Energy Networks Association to, by the end of the year:*
>
> - *specify how the back-office functions for vehicle recharging infrastructure will operate; and*
> - *develop recommendations on the most cost-effective way to ensure facilitating recharging of vehicles occurs at times that are cost effective .*

To take this work forward the industry bodies BEAMA, ENA, Energy UK and SMMT have come together to share priorities and develop recommendations in respect of the two questions above. The two areas (back-office functionality and off-peak recharging) have been examined in detail and the recommendations below are made.

Back office functions

A single business model/approach across the country is not required but it is expected that multiple models will co-exist, including the following which are all available today:

- Membership model;
- Pay As You Go (PAYG); and
- Parking Plus and Value Add.

So called 'Follow Me' tariffs have not been explored further within this paper due to the complexities of this model twinned with the negative impact it would have on other commercial approaches.

Longer-term options for a national central back office system have also been considered, and the corresponding mechanisms by which this could be implemented.

General recommendations

i. 2012/2013: Industry will work with OLEV to identify and establish suitable mechanisms to provide interoperability in the UK. This will require:
   - OLEV to facilitate work between industry players and existing chargepoint schemes;
   - The development of technical standards and specifications for public recharging infrastructure, facilitated by an independent body;
   - The development of a central whitelist or a suitable alternative; and

[1] The ERA has merged with AEP and UKBSCE to become Energy UK

- Providing an assessment of the commercial business case for infrastructure post Plugged-In Places

ii. 2013+

- The development of a central back-office system and/or a mechanism to ensure national participation and interoperability will be investigated as the market matures.

Off-peak recharging measures

The aim is to ensure that Plug-In Vehicle recharging occurs as much as possible during periods of low electrical demand on the electricity distribution networks. By encouraging off-peak recharging the impact on the overall peak electricity demand will be minimised, therefore mitigating the potential need for costly electricity network reinforcement.

The available options for off-peak recharging were examined:

Short term solutions
- Timers
- Use of tariffs

Medium term solutions
- Home automation
- Smart metering

Medium to long term solutions
- Demand response
- Intelligent vehicle

General recommendations

1. Ultimately the decision to recharge a Plug-In Vehicle off-peak will always rest with the customer. However, Government and industry stakeholders should at all times be mindful of means by which off-peak recharging can be encouraged, incentivised and made easy to achieve. It is recommended then that all participants in the development of the Plug-In Vehicle market consider the ways in which the aforementioned techniques (e.g. tariffs) and technologies (e.g. timers) can be offered to customers to enable a choice to recharge off-peak.

2. All Plug-In Vehicle stakeholders to continue interaction on smart meter connectivity with DECC Smart Metering Implementation Programme.

3. The various stakeholders involved in this work will continue to collaborate on the outcomes and actions arising from this position paper.

Chapter One: Introduction

1. The Government is committed to reducing greenhouse gas emissions by 50 per cent from 1990 levels between 2023 to 2027. Twenty-two per cent of UK domestic carbon emissions is from transport. Passenger cars account for over half of the total UK's domestic transport emissions. People will need to have a range of options for their travel which encourages them to choose low carbon alternatives. The refinement of existing automotive technologies and development of next generation petrol and diesel engines, alongside a range of alternative fuel vehicles, including electric vehicles, will contribute to radically reducing transport CO_2 emissions.

2. In November 2010, the Government announced its decision to invest over £400 million in electric and low carbon vehicles, with a focus in three areas: testing out the technology through infrastructure investment as part of the Plugged-In Places programme; encouraging customers to buy into low carbon by means of the Plug-In Car Grant, and, more recently, the Plug-In Van Grant; and investing in low carbon innovation. Commitment from the Government to support the development of an early market for Plug-In Vehicles is welcomed by industry, recognising the importance of building customer confidence and sending a strong signal internationally about the UK's determination to be a leading market for ultra-low carbon vehicles.

3. Over 3,000 chargepoints have been installed in the UK since the end of March 2012. This figure includes publically accessible, domestic and private workplace chargepoints. 1,673 have been delivered through the Plugged-In Places program, of which sixty per cent are publically accessible. The remainder have been installed by private sector organisations and other local authorities. Market figures to the end of March 2012 show that 1,276 claims have been made through the Plug-In Car Grant[2].

4. In June 2011, the Government published *Making the Connection: The Plug-In Vehicle Infrastructure Strategy.* This stated the following:

   Given [the] wide range of different parties that need to be brought together to make this [plug-in vehicle infrastructure] market a success we are asking the Society of Motor Manufacturers and Traders' Electric Vehicle Group, the Energy Retail Association[3] and the Energy Networks Association to, by the end of the year:

   - *specify how the back-office functions for vehicle recharging infrastructure will operate; and*
   - *develop recommendations on the most cost-effective way to ensure facilitating recharging of vehicles occurs at times that are cost effective .*

5. To take this work forward and in response to Government's request for input as per the Plug-In Vehicle Infrastructure Strategy, industry bodies BEAMA, ENA, Energy UK and SMMT have come together to share priorities and develop

[2] Figures provided by OLEV, March 2012

[3] The ERA has merged with AEP and UKBSCE to become Energy UK

recommendations. The paper examines the two areas outlined above with chapters on back-office functions and off-peak recharging.

6. In developing this paper, the industry participants have remained conscious of two major factors that will have an influence on the development of Plug-In Vehicle Infrastructure in the UK. The first of these is regulatory and standards development within the European Union which may affect EU-wide energy industry structures, recharging points and back-office specifications and the vehicles themselves. Secondly, UK 'smart' developments (e.g. distributed generation, heat pumps, etc.) which will aid the UK in meeting its low carbon objectives but will also place additional demands on the electricity infrastructure. The operation and use of Plug-In Vehicles in the UK will ultimately form an important component of a Smart Grid. The delivery of fully interoperable standards (and therefore equipment) at both a European and UK level will be key in maximising the value of these interdependent 'smart' systems.

7. The Plug-In Vehicle, and in general the decarbonisation of transport in the UK, will form an important part of the overall answer. This is in addition to the significant contributions that will be made from improving vehicle efficiency, alternative heat generation and overall reduction in carbon intensive electricity generation.

8. The ideas set out in this paper are not intended as a final view but rather a series of thoughts for further industry debate. It is intended that this debate will continue in 2012 and the options available will be explored in more detail during this process.

High-Level Principles of Plug-In Vehicle Infrastructure

9. Below are listed some high-level principles we believe stakeholders should be aware of when considering the development and deployment of Plug-In Vehicle recharging infrastructure:

i. Any item of recharging infrastructure should be easy to use, fully interoperable and comply with all current and future standards (both UK and European).
ii. The development and deployment of Plug-In Vehicles should not be viewed in isolation to other current 'low carbon economy' initiatives (i.e. Smart Metering, Smart Grids etc).
iii. Ideally support should be shown for the use of a single European wide method of connection from the recharging unit to the Plug-In Vehicle, thereby providing a fully interoperable solution.
iv. There is a need to consider new EU reporting requirements for energy suppliers – and therefore the way energy suppliers communicate Plug-In Vehicle energy usage to the EU.
v. Plug-In Vehicle owners should be supported by industry to help them understand how to get the best use out of their Plug-In Vehicle. As an example this may mean ongoing manufacturer support, government education programmes and easy to access publicly available information on Plug-In Vehicles.
vi. Government should consider ways in which the costs to customers of recharging units can be minimised. To ensure that dedicated Plug-In Vehicle recharging infrastructure installations are safe and appropriate for the Plug-In Vehicle such installations should be completed by a competent electrician and be compliant

with the IET Code of Practice on Electric Vehicle Charging Equipment Installation.

Background

Back-office functions

10. There are a range of business models adopted by existing Plug-In Vehicle Infrastructure schemes in the UK, including membership models, Pay as You Go and Parking Plus and Value added services.

11. To control access to infrastructure, scheme operators have developed a number of relatively simple back-office systems. For example existing membership schemes are based on a basic "whitelist" system. This is a simple and effective initial solution for operating a membership model system but may not provide interoperability between separate membership schemes across the country

12. Depending on the models adopted, there are important variations that have implications for the supporting back-office, for example:
    - Pay-as-You-Go system could be based on stored value on a dedicated plug-in vehicle infrastructure RFID (Radio Frequency Identification) card; or
    - Stored value on a wider transport smartcard; or
    - Use of contactless debit cards (e.g. Barclaycard Swipe); or
    - Use of traditional credit / debit cards (chip and pin); or
    - Cash.

13. In order to help Plug-In Vehicle drivers' access to chargepoints, the Government has developed a National Chargepoint Registry (NCR). This is a database of publicly accessible chargepoints across the UK, available on data.gov.uk. It is envisaged that the Registry will be populated with chargepoint data over the coming months, allowing businesses to innovate and provide products, such as satnav and mobile apps, for Plug-In Vehicle owners to access.

14. The Plugged-In Places initiative has enabled the private sector to enter the market and make significant investments in recharging infrastructure, meaning the creation of an extensive public recharging network. With the growth of entrants from the private sector in the market, and if we are to ensure access to public chargepoints is as easy as possible for the customer, interoperability between the different schemes and regional back-office systems needs to be ensured.

15. As business models for the provision of publicly-accessible recharging infrastructure and recharging services continue to evolve, new back-office functions will need to be developed. Exactly what back-office functions are required will depend upon the commercial business models that develop around public recharging infrastructure.

16. The Office of Low Emission Vehicles (OLEV) is committed to promoting the development of an interoperable infrastructure system in the UK that is easy for customers to access and use, affordable and scalable. A Plug-In Vehicle owner should be able to easily gain access to all publicly accessible recharging infrastructure. This does not mean that electricity or access has to be free (there

will be commercial arrangements required to support interoperability), but from a technical perspective back-office operations will need to be designed in a way that makes accessing the national recharging network straightforward. With many potential mechanisms for delivering these requirements, industry has evaluated the different options and outlined a roadmap for further development of the national recharging network.

Off-peak recharging

17. The Government's Plug-In Vehicle Infrastructure Strategy stated that the majority of Plug-In Vehicle recharging should happen at home, at night, after the peak in electricity demand. This not only appears to be how drivers choose to recharge their vehicles but is also best for the energy system as a whole. It further stated that 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.

18. There is a lot of work already underway across the country to look at potential mechanisms for incentivising off-peak recharging. A number of electricity suppliers are beginning to bring specific off-peak tariffs for Plug-In Vehicles to market but it is not yet clear how effective such tariffs will be on recharging behaviour. Emerging evidence from Technology Strategy Board trials suggests that the natural behaviour of drivers is to plug their vehicle in when they get home (i.e. during the evening peak), although timers have been found to be effective in delaying recharging start times.

19. The Plugged-In Places (PIPs) trials and Low Carbon Network Fund projects in London and the North East of England are looking at a range of alternative methods for managing Plug-In Vehicle recharging. These include more sophisticated 'dynamic' tariffs and load control signals that allow recharging to respond in real time, when (e.g.) energy is in relatively short supply or the pressure on the local distribution system is high.

20. OLEV is committed to promoting the development of a recharging network that maximises carbon savings from Plug-In Vehicles and minimises the impact of recharging on the electricity system. With many potential mechanisms for ensuring that off-peak recharging occurs, industry has evaluated the different options and identified practical steps that can be taken in the short and longer term to make off-peak recharging the norm.

Working with industry

21. OLEV was keen to work with the SMMT, ENA, Energy UK and BEAMA given their remits, as follows:

    - The **Society of Motor Manufacturers and Traders (SMMT)** exists to support and promote the interests of the UK automotive industry at home and abroad. Working closely with member companies, SMMT acts as the voice of the motor industry, promoting its position to government, stakeholders and the media. The SMMT has an EV Group involving SMMT members from the whole supply chain (OEM and niche vehicle manufacturers, charger suppliers, battery manufacturers, electricity providers), key stakeholders

(government, transport authorities) and like-minded organisations (IMechE, IET, EST). The Group meets quarterly and has an email circulation list.

- **Energy Networks Association (ENA)** is the industry body for UK wires and pipes companies that carry electricity and gas to UK homes and businesses. The ENA Electricity Network and Futures Group (ENFG) has formed an Electric Vehicle Task Force to ensure that network and future smart grid requirements are fully considered in decisions affecting the specification and implementation of electric vehicles and plug-in hybrid electric vehicles including those used in commercial and passenger transport.
- **Energy UK** was established in April 2012 following a merger of the Energy Retail Association, the Association of Electricity Producers and the UK Business Council for Sustainable Energy. Energy UK represents a wide range of interests and is driving forward the debates on the UK's strategy for achieving a low carbon, secure and affordable energy future. It includes small, medium and large companies working in electricity generation, energy networks and gas and electricity supply, as well as a number of businesses that provide equipment and services to the industry.
- The **British Electro-technical Allied Manufacturers Association (BEAMA**) is the independent expert knowledge base and forum for the UK electro-technical industry and has a strong presence in Europe. Representing over 200 manufacturing companies in the electro-technical sector, BEAMA has significant influence over UK and international political standardisation and commercial policy. BEAMA is providing a focus for the development of electrical infrastructure for electric vehicles in the UK and across Europe, covering the development of appropriate standards, building regulations, wiring regulations and the interaction between the different product sectors required for an operational infrastructure.

22. Industry has come together to respond to the challenges outlined by OLEV in their Plug-In Vehicle Infrastructure Strategy.

Work undertaken

23. Following the publication of the Strategy at the end of June 2011, work was undertaken by OLEV to prepare draft Terms of Reference for this work, in discussion with industry. The industry organisations then held various meetings to consult with their members, after which OLEV hosted a meeting of all of the organisations to share initial views and findings and to agree the way forward.

24. On 8 November 2011, an all-day workshop involving industry and wider stakeholders was held and convened by OLEV which comprised of presentations and a discussion session in the morning and work in breakout groups in the afternoon. The discussion and output from the workshop informed this work. A list of workshop participants can be found in Appendix One.

25. The chapters that follow outline:

1. Chapter Two: Back-office Functions
2. Chapter Three: Off-Peak Recharging measures
3. Chapter Four: Industry's recommendations and roadmap identifying action required in the short, medium and long-term.

26. Working with industry, OLEV will consider the recommendations and how any actions may best be taken forward. It is intended that this will feed into the update of the Plug-In Vehicle Infrastructure Strategy which it is intended to publish in 2013.

Chapter Two: Back-office Functions

27. The aim of this work is to enable interoperability across the UK recharging networks and remove customer barriers. It is essential that at this early stage of market development, the Government and industry work effectively with customers to incentivise the take up of recharging technologies that will enable 'smarter' recharging practices. Providing effective best practice guidance for the safe and 'smart' use of recharging infrastructure is necessary to encourage the take up of Plug-in Vehicles. Therefore there is a strong emphasis placed on the value of customer engagement initiatives and dialogue between Government, industry and the customer should be consistent and clear.

28. To ensure clarity, remove the risk of confusion and to aid future co-operative working, it is essential that definitions of public and back-office systems are agreed, along with a related terminology. For the purposes of this paper, definitions are provided in Appendix Two.

29. The high level principles of a back-office are:

- A back-office function needs to provide a range of services. This includes the ability to identify a user, deliver energy linked to a payment mechanism and receive and transmit data related to the transactions that take place. The back-office service provided will need to manage the transactions, in addition to the accounts, access and general asset management and maintenance. In developing these services the needs of all key industry groups and the customer must be considered.
- An interoperable back-office system that accommodates a range of different recharging infrastructures, owners' operators, service providers and market models will facilitate competition that will stimulate innovation and delivery value and choice to customers.
- Cross-industry collaboration is required to ensure safe, interoperable systems built on open standards and fit for purpose.
- Technical standards and national specifications need to be agreed across stakeholder groups; going forward models should be transparent to share learnings and enable cooperation. Consideration must be taken now regarding longer term requirements with models evaluated against the degree of their scalability and how future proof they are.

30. A single model should not be required across the country, multiple models should be able to co-exist, for example a networked membership model may exist for on-street posts across the country but some car parks may choose to operate independent recharging which they bill for through their existing parking payment system ("Parking Plus"). In addition, a supermarket may offer subsidised or free recharging of vehicles to customers as a marketing promotion and to attract/reward customers ("Value Add" or "Loss Leader"). It is essential that any activity on more national systems do not make such approaches commercially unviable.

31. It is vital that we can establish commercially viable business models that will ensure the success of public recharging systems. A back-office service should help to establish the commercial business case and interoperability across the UK public infrastructure. If this is not achieved the risk of creating stranded assets and defunct systems are high. The market needs to be centred on commercial opportunity, driven by the private sector and focussed on its cost effectiveness to

ensure longevity. Innovation and creativity is required to identify value creation opportunities, which could include the provision of data services to customers and businesses.

32. The customers' perspective is key to ensure recharging infrastructure is utilised and is an enabler to the take-up of Plug-In Vehicles in the UK. Infrastructure needs to be flexible, convenient and promote customer choice; easy to locate, access and pay across the country. Prohibiting some drivers from easily utilising infrastructure (for example through regional membership schemes) will not be a positive customer experience to encourage the use of Plug-In Vehicles. Recharging should be affordable to customers whilst taking into account the total cost of infrastructure. In the future, electricity prices could potentially be tailored to promote recharging at periods of lower electricity demand.

Identified Options Available

Short to medium term business models

33. There are a number of options to provide public recharging infrastructure and associated back-office support to Plug-In Vehicle drivers. The following three models are available today, enabling Plug-In Vehicle drivers to access and use public infrastructure. There is confidence that these three models can operate accordingly over the long-term development of the market. Recommendations have been made to enable interoperability between the different models, with options to provide a longer-term national central back-office system.

Membership model

34. The majority of current infrastructure operates on a membership model, which allows drivers who are pre-subscribed members to access infrastructure at a local or national level via a means of identification (e.g. RFID tag) with the billing of membership fees fixed or made per usage. A back-office system could be used to enable identification of customers, tied to a simple billing structure that is remote from the physical posts.

35. This is a relatively simple and effective model which allows for multiple infrastructure owners and operators, enabling a competitive market. Success centres on collaboration across partners nationally; otherwise there is a risk of a lack of interoperability and duplication. There is the opportunity to provide a single access card for customers to increase ease of use; however multiple regional networks with individual access cards requiring drivers to subscribe and pay for separate schemes will cause customer dissatisfaction and create a barrier to public recharging. The membership model is compatible with existing technology in the short term and allows for further development.

36. The use of a common format for access cards and a back-office system with a shared whitelist of membership data across all schemes could enable interoperability across the UK. This will prevent customer dissatisfaction and remove a barrier to public recharging.

Pay As You Go (PAYG) model

37. The membership model can be adapted to a "Pay As You Go" mode of operation, allowing drivers who may or may not be pre-subscribed members to access infrastructure and pay per use via credit card, mobile phone or a PAYG card. A similar back-office to the membership scheme model would be required, with the additional requirement to allow for flow of money at the post.

38. As with the membership system, this is an effective model which promotes a competitive market. PAYG represents a universal payment system so the technology is available and well developed in other markets. Customers are familiar with the concept and its operation which increases ease of use and in addition, PAYG provides flexibility to drivers by enabling simple access across the country. It allows for pricing of recharging to vary across a chargepoint network, driven by factors such as location and time of charge, to ensure a commercial cost-reflective business model. The use of this model would require agreement across the market to ensure standards and keep the cost of implementation at a minimum.

Parking Plus and Value Add models

39. Parking Plus and Value Add models tend to be smaller scale and private market driven with minimum or no back-office system requirements. Both are relatively simple and cheap to implement, based on basic recharging posts and potentially utilising existing billing infrastructure. However because there is less of a requirement to have driver/vehicle identification at the post, data opportunities are restricted. Subsidised rates through the Value Add model is attractive to the customer; however posts are not likely to be available to the full public as drivers need to commit to purchasing the products and services of the provider.

Longer-term business models considered

Follow me tariffs

40. "Follow me" tariffs, whereby public recharging usage is billed back to the domestic energy supplier via the driver's home electricity bill has been explored as this could be seen as an innovative and customer-centric model. However, the complexities of this model twinned with the negative impact it could have on other commercial approaches mean that it is not explored further in this paper. It is recognised that this model has been adopted in some European member states.

41. Simple back-office infrastructure investment and development is required to implement a "follow me" tariff model as complex cross-industry systems would need to be established and extensive changes to energy suppliers billing structures made. The significant costs associated with this would impact the ability of the market to develop commercially viable business models. Furthermore, high costs would be a disincentive to potential new energy entrants.

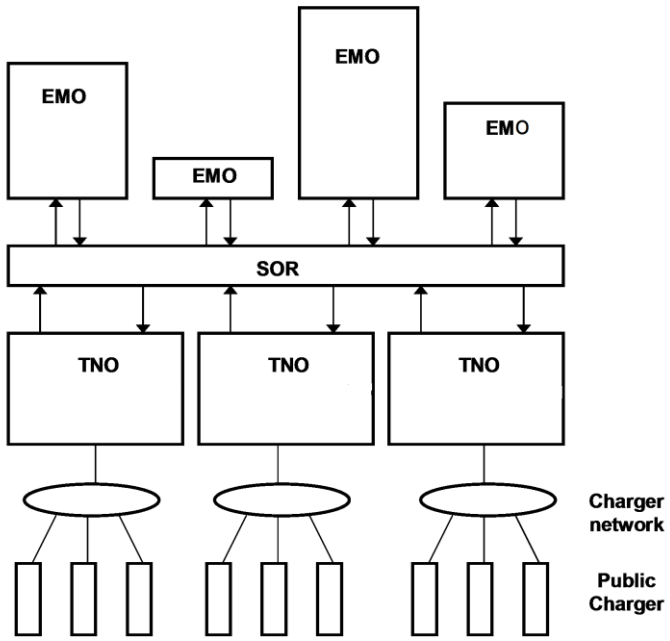
Long-term options for a national central back-office system

42. It is important that any central back-office system should not prohibit the provision of new services or the entrance of new players that wish to provide services. In identifying options for a national back-office structure, suitable in supporting a mass market of Plug-In Vehicles, the following system can be considered.

43. A centralised back-office system linking technical assets/data services and the commercial customer interface has been proposed by BEAMA and is outlined and discussed in their paper *"Considerations for the establishment of back-office services to support the UK deployment of electric vehicles: A proposal from the members of BEAMA"* . The model is flexible and customer focussed, enabling customer choice, multiple payment options and data services, providing a mechanism for the protected exchange of data. It allows for multiple business models, as identified above, to co-exist and serves to protect the historical investment whilst not inhibiting future growth. Industry standards are required for both the infrastructure and back-office interface, and governance is key in the operation of a single centralised back-office system.

Schematic of BEAMA segmented public recharging infrastructure model

Definitions:
EMO: Electro Mobility Operator: customer interface
SOR: System of Record (central back-office system)
TNO: Technical Network Operator: technical assets and services



Summary

44. In defining any back-office, it is important that the investments made to date are not isolated and that these schemes can be integrated into the future solution. Due to the current fragmentation of the market in the UK, with multiple schemes emerging with differing models for chargepoint access and regional back-office systems, islands of infrastructure are developing.

45. It is essential that interoperability is achievable in the UK so that customer access to a UK wide network is made as easy as possible. Any decision made must allow for multiple models for use (Membership, PAYG, Parking Plus and Value Added),

while providing an open market platform. The commercial business case for either customer or technical services needs to be attractive to service providers and operators in the future infrastructure market, especially post Plugged-In Places.

46. To date the subsidies and grants provided through public funding have supported the installation of chargepoints and their ongoing use. However we now need to consider how this infrastructure can provide a commercial offer that ensures continued growth in the market and the long-term use and ongoing maintenance of the historical investments made.

47. The period between now and 2013 is seen as a critical stage in the UK Plug-In Vehicle market in the UK. As we see the Plugged-In Places coming to an end in 2013, the need to agree basic levels of interoperability through agreed technical standards and specifications for infrastructure is key.

General Recommendations

iii. 2012/2013: Industry will work with OLEV to identify and establish suitable mechanisms to provide interoperability in the UK. This will require:
- OLEV to facilitate work between industry players and existing chargepoint schemes;
- The development of technical standards and specifications for public recharging infrastructure, facilitated by an independent body;
- The development of a central whitelist or a suitable alternative; and
- Providing an assessment of the commercial business case for infrastructure post Plugged-In Places

iv. 2013+
- The development of a central back-office system and/or a mechanism to ensure national participation and interoperability will be investigated as the market matures.

Chapter Three: Off-peak Recharging Measures

48. The aim of this work is to help to ensure that Plug-In Vehicle recharging occurs as much as possible during periods of low electrical demand on the electricity distribution networks (i.e. 'off-peak'). Doing so will help to minimise the impact of Plug-In Vehicle recharging on the overall peak electrical demand and therefore mitigate against the potential need for costly electricity network reinforcement investments. It is vital for the operation of efficient electricity supply, generation and distribution that the energy industry including, Suppliers and Network Operators as well as other parties involved in the process, are aware of the following.

49. The high level principles of off-peak recharging are:

- That the energy industry is aware of where Plug-In Vehicles are being recharged so that electricity demand can be accurately forecasted, any possible impacts on local networks can be predicted, action taken where appropriate and suitable tariffs and infrastructure can be offered to customers;
- That the time periods required for recharging Plug-In Vehicles are fully understood and, where possible, modified in order that the effect on networks and generation can be minimised;
- That load through Plug-In Vehicle recharging is moved away from peak times to fill troughs in UK energy consumption;
- That the opportunity is taken for recharging of Plug-In Vehicles to keep the CO_2 output in the UK to a minimum; and
- That owners and users of Plug-In Vehicles are helped to understand how best to make use of their vehicle. This should include education programmes to ensure that vehicles are recharged to support efficient generation at minimum network impact and maximum carbon reduction.

Identified Options Available

50. The options listed below represent currently known and some potential future means for control of Plug-In Vehicle recharging times. However as technological development continues and knowledge of the Smart Grid develops it may be that other options or variations on those listed below are identified. As with other areas which make up the Smart Grid, the Plug-In Vehicle constitutes one part of a much wider ability to reduce CO_2 output in the UK.

51. Each option is considered generally and for specific advantages and disadvantages. In addition overall consideration for recommendations is explored in more detail at the end of this chapter.

Short term solutions

i. Timers

General

52. Timers are a well known and well used form of customer control of electrical equipment. Applying this means of control to Plug-In Vehicle recharging is therefore an easy step for customers and in the relatively short term will provide a simple and cost effective solution to making the best advantage of available lower energy costs.

53. There is a range of timers available, all of which can be activated to allow the recharging of a Plug-In Vehicle to take place off-peak. These include timers built into the vehicle as well as those connected to the outlet from which the vehicle is being recharged.

54. As the UK moves to a 'smarter' recharging system over the medium to long term (potentially including measures such as home automation and smart grid interoperability), it is anticipated that the use of basic timers will reduce.

Advantages	Disadvantages
Familiar and generally understandable for customers to operate.	Customer may have a perception of loss of control of recharging.
A relatively straightforward, low cost short term solution.	Simple controls will not provide future complex control functions
Easy to install.	Customers may get too comfortable with a timer and be difficult to shift to more dynamic means of recharging management.
User over-ride can be made available at all times - but should ideally reset timer to default timing after each activation.	Timers and default settings might establish the wrong habits / expectations in customers (if diversity / flexibility is the ultimate aim).
PIP and Technology Strategy Board (TSB) trials have shown timers to be effective.	

ii. Tariffs

General

55. The use of tariffs to encourage a shift in electricity consumption towards off-peak periods is a well understood and relatively straightforward option for reducing the customers' overall electricity bill with the consequent financial benefits to that customer. Any use of tariffs as a means of encouraging off-peak Plug-In Vehicle recharging would need to include the option for staggered recharging times (i.e. to ensure customers begin to recharge their Plug-In Vehicles at slightly different times) and would need to be easily understood within the context of the customer's overall energy tariffs.

Energy suppliers will need to remain cognisant of total Plug-In Vehicle running costs when setting tariffs when set against the typical costs associated with domestic energy consumption.

Advantages	Disadvantages
Could take advantage of the communications between recharging infrastructure and a Smart Meter.	Using existing tariff structures would rely on customer action and customer acceptance of industry arguments / reasoning for cheaper off-peak electricity.
Time of Use (TOU) tariffs are accepted by UK customers (e.g. Economy7/Economy10/Radio Teleswitch).	Simple controllers will never provide the degree of flexibility that could be required to help a system operator manage variable generation outputs.
Tariffs costs are driven by the competitive energy supply market (this may be a negative or positive aspect).	Default meter settings that accompany the tariff may be more important than the tariff itself (i.e. ensuring a sensible time of unit cost change may be of more importance than the actual value of that change).
There would be few barriers to introduction (as already in operation).	Tariffs costs are driven by the competitive energy supply market (this may be a negative or positive aspect).
The tariff structures themselves can naturally evolve over time and become increasing sophisticated.	The electricity industry benefits from common assumptions about customer behaviour for planning purposes which certain tariffs may distort (e.g. ADMD (After Diversity Maximum Demand).
Tariffs could be linked to CO2 produced by the generation of electricity consumed.	Early Plug-In Vehicle adopters may be fairly insensitive to tariff pricing and therefore have a low motivation to recharge off-peak.
May be a means of establishing good habits and expectations in early Plug-In Vehicle adopters.	Tariff complexity could potentially introduce a communications challenge for engaging with customers.
Energy suppliers in a highly competitive market may be naturally motivated to offer bespoke Plug-In Vehicle tariffs.	If ‘diversity’ and ‘flexibility’ of recharging is the ultimate goal then fixed timing of off-peak tariffs may instil bad habits in customers (e.g. if currently accepted ‘off-peak’ times change but customer behaviour doesn’t).
It is expected that energy costs will continue to rise which may make customers more price sensitive and therefore more responsive to time of use tariffs in future.	In the longer term (10 or more years), in a future smart grid enabled world, fixed TOU tariffs will have little role to play as use of sophisticated demand response capabilities becomes more prominent.
	Energy suppliers may need to develop new back-office systems to support more complex tariffs such as dynamic TOU.

Medium term solutions

iii. Home automation

General

56. Home automation technology is available now and increasingly households across the UK are taking advantage of controlling home lighting, heating, appliances etc. A range of systems are available from the simple and cheap to the complex and expensive. In the medium term it is expected such technology will be used to manage the recharging of plug-in vehicles.

57. Systems to facilitate off-peak recharging of Plug-In Vehicles could be 'stand-alone' and focussed fully on the vehicle or they could be part of a wider home automation system. Discussions are currently taking place for computer and smart phone systems to be available to take advantage of the installation of a smart metering system. As an example this could be via a 'dongle' plugged into a laptop which provides a customer access to their specific smart meter data along with the ability to directly interact with suitably enabled appliances, Plug-In Vehicles etc, via the computer or smart phone.

Advantages	Disadvantages
May utilise anticipated smart meter communications infrastructure.	Although relatively low cost this option would nevertheless involve some additional cost for the customer.
Customers will be familiar with the technology as it is expected they will be using it for the control of other home-based equipment.	It would require the customer to be reasonably computer literate and own a computer.
Relatively simple, low cost and well understood technology.	The Plug-In Vehicle owned by the customer would have to be suitably enabled to allow control via the home automation network.
Customer can remotely see the current level of charge in the Plug-In Vehicle.	
Customers can adapt or modify recharging times to make best use of tariffs available whilst still ensuring that the vehicle is sufficiently recharged and ready for when they need to use it.	
Opportunity for Plug-In Vehicle recharge to be initiated whilst customer is away from home via a smart phone or similar.	

iv. Smart Meter

General

58. The UK Smart Meter Implementation Programme (DECC's programme for the roll-out of smart meters to all UK electricity and gas customers by the end of 2019) provides an ideal opportunity for greater customer interaction with their energy consumption. In addition it also provides for 'smarter' control of equipment either in or connected to the home. This will likely include home appliances, electric heating and potentially, through additional equipment, the recharging of a Plug-In Vehicle.

Advantages	Disadvantages
The use of smart meters to manage recharging of Plug-In Vehicles will fit with customer expectation as to the capabilities of smart meters.	Higher costs (e.g. for communications) compared to other approached (such as timers) which might be used to facilitate off-peak recharging.
Smart meters should allow customers to change tariffs and indeed energy suppliers much more quickly than currently possible. Customers can then easily choose supplier/tariff combinations that both lower the cost of Plug-In Vehicle recharging but also encourage off-peak recharging.	Access to usage data may be complex or not available, depending on customer views.
High coverage of properties – under current plans, all UK domestic premises will receive a smart meter by 2019.	May require the purchase of additional control equipment by the customer – likely a suitably enabled Plug-In Vehicle recharging unit.
Has the added benefit of giving the DNO visibility of unusual loads being added to the network.	There is potential for the smart meter roll out programme to not deliver the necessary functionality (in both the smart meters themselves and the data/communications infrastructure) to enable off-peak recharging of Plug-In Vehicles to be delivered in this way.
All UK smart meters will be built to a consistent functional and technical specification, enabling easier interoperability with Plug-In Vehicle recharging infrastructure.	Complexity of the system (when compared with timers/time of use tariffs/home automation) may present a customer communications challenge.
Provided customers are suitably comfortable with the provision of energy usage data to industry they may consequently be more willing to provide similar data related to the Plug-In Vehicle recharging.	May require the enablement of the Plug-In Vehicles to interact with the smart meter system, and display information on usage.
Increased customer visibility of Plug-In Vehicle electricity usage.	May still be reliant on behaviour change in customers.
Potential to support (TOU) and dynamic tariffs.	
Will aid information capture to inform the actions of key energy market stakeholders (e.g. network operators, generators, etc).	

Potential to link Plug-In Vehicles to the smart meter via the home area network (HAN), or to link vehicles directly to the smart meter central communications and data infrastructure via another communication medium (e.g. public internet, etc).	

Medium to long term solutions

v. Demand Response

General

59. ENA and Energy UK members have been cooperating on assessment of how 'Smart Demand Response' could make a wide contribution to the future energy industry. This project will publish a discussion document in early 2012, looking at the benefits demand response can provide and the issues and complexities of demand response making this contribution in the UK. It is intended as a document to further discussion with DECC and other parties.

60. Demand Response (DR), as currently envisaged, could allow approved parties (suppliers, DNOs, Transmission System Operators (TSOs), etc.) to dispatch requests to suitable enabled appliances (e.g. Plug-In Vehicle chargers) to temporarily switch off in certain situations (e.g. when demand on generation or the network reaches certain levels). Such DR functionality could enable these approved parties to manage both intermittent generation from renewable sources and local network congestion constraints whilst still providing a secure, sustainable and low cost electricity supply.

Advantages	Disadvantages
Allows for wider variation in energy supply packages to customers whilst managing energy supply constraints, facilitating wider customer choice.	Will require extensive work to ensure appropriate standards are developed and interoperability maintained.
May require a customer activated DR override which will 'recharge at any cost'.	A new regulatory regime will be required for the energy supply industry to implement DR.
Will allow suitable parties to engage in active management of customer demand.	Plug-in vehicle manufacturers will need to be involved with DR discussions to ensure their products are suitably enabled.
Can aid network operators in avoiding local electricity network overloading and therefore the deferment of investment in reinforcement.	Customers may become less engaged with their energy consumption due to recharging potentially being managed by a third party.
Similar to the point above, DR may help to avoid electricity network overloading at	A certain amount of customer information will be required to enable this solution and

regional and national levels and therefore the deferment of investment.	customer concerns regarding data privacy and security would need to be carefully handled.
Will aid in the ability to balance variable or inflexible generation (e.g. renewable) at national level.	
Will aid the balancing of the trading position of energy suppliers.	
Will aid the integration of a cleaner energy/generation mix and subsequent savings in CO_2 emissions.	
Potential savings for individual customers by reducing energy consumption during times of peak load.	
Will aid network operators to improve the security of the electricity supply to customers.	
Will also aid network operators in improving the quality of electricity supply to customers.	
Will take account of all load in premises and optimise - both for grid and building owner.	
Provides ability to schedule demand use.	

Long term solutions

vi. Intelligent vehicle

General

61. Use of intelligence built into the Plug-In Vehicle as a means of delivering off-peak recharging has had little in the way of exploration but it may be an option significantly further into the future. It is anticipated that as the sophistication of Plug-In Vehicles develop, manufacturers may consider how 'intelligent vehicle' applications could be built into the vehicle.

62. Discussions so far have described an intelligent vehicle as one which manages its recharging 'on board' and is able to communicate its state of charge at any time via either fixed or wireless internet connections. This level of 'intelligence' will enable the vehicle to manage various aspects of its own operation, including recharging when necessary and most optimal.

Advantages	Disadvantages
Could enable 'Vehicle to Grid' data sharing.	Potentially an option which is a long time in the future.
Could automatically interact with intelligent network operator and energy	Will require the development of proposed initiatives such as smart grid and demand

supplier management systems.	response.
May supersede many of the options outlined in this chapter.	Requires significant Plug-In Vehicle manufacturer development and investment.
Enables the Plug-In Vehicle to manage its own recharging in the most optimal fashion.	Would need significantly further research to understand the potential for this option.
Could be designed to automatically identify the need for a fast or slow charge and the cheapest time available for recharging.	A certain amount of customer information will be required to enable this solution and customer concerns regarding data privacy and security would need to be carefully handled.
Could still be directly controlled via smart phone or laptop.	
Can become an integrated part of an intelligent home network.	

Summary

63. The observations recorded above capture a wide range of views around off-peak recharging of Plug-In Vehicles and more specifically the views of members of the OLEV Plug-In Vehicle Workshop. It is anticipated that this background material collected in the process of delivering the recommendations of this report will form useful subject areas for debate over the next few years.

Specific observations for supporting off-peak vehicle recharging

64. Energy Suppliers may need to consider innovative tariff offerings (i.e. not purely related to unit price of electricity) to attract customers to recharging their Plug-In Vehicles off-peak (which in turn may require more complex back-office functionality). It is expected, however, that Energy Suppliers will develop such tariffs in the course of their natural competitive business activities. The reason for this is that with the relatively low cost of recharging a Plug-In Vehicle (likely to be no more than £3.50 at current prices) and the comparatively high price of the vehicles themselves it seems unlikely that those customers purchasing such vehicles will be easily influenced to charge off-peak via purely financial incentives (i.e. cheaper off-peak tariffs).

65. Vehicle manufacturers will have a role to play jointly with the energy industry to consider how Plug-In Vehicles will interact with the smart metering system from 2012. This may include early consideration of the minimum requirements for Plug-In Vehicles to be interoperable with smart meters. DECC and Suppliers will therefore need to ensure that the required functionality is allowed/not excluded in the smart metering specification.

66. It seems likely that social drivers other than outright cost will encourage customers to purchase Plug-In Vehicles - at least for the next few years. These may include:

concern for the carbon impact of current vehicles, peer pressure from family, friends and neighbours and people responding to a general interest in 'gadgets'.

67. Finally, it is important to note that whilst Plug-In Vehicle recharging may introduce substantial new levels of demand onto the electricity networks in the UK there are many other 'future' activities taking place which will have a significant impact on the way in which these networks are utilised going forward. The decarbonisation of heating (via electric heat pumps), high penetration of domestic-scale distributed generation (such as photovoltaic panels), GB-wide installation of smart meters and the subsequent smart grid network and generation management techniques they will enable will all drive future networks and generation strategies.

68. Roadmap:

    The six options highlighted in detail above are not just individual options but are more likely to be 'progressive options' available to the customer i.e.:

- **Timers** are available now to enable control of when vehicles are recharged.
- **Tariffs** are available to make use of through time controllers now but TOU Tariffs will be developed over the next few years, particularly towards the end of the UK smart meter roll out programme and in the years after completion of the programme.
- **Home automation** will help customers to take advantage of cheaper tariffs and will make control easy. Available now but will only become fully useable to control the vehicle recharge once the smart meter is installed.
- **Smart Meters** as they come on line between now and 2019 will enable more accurate control through special tariffs. Once the programme is complete and all meters are fitted, the potential for controlled recharging will become a significant component of the future smart grid.
- **Demand response** will become important and in fact a necessity as the load and generation mix across the UK develops. This option will become increasingly important when the smart meter programme is complete and will develop in the years beyond 2020.
- **Intelligent vehicles** are a longer term option but may be available and may make use of or replace other options. It is likely that some of the systems listed above will need to be in place before the intelligent vehicle (as envisioned here) becomes a reality and therefore it is more likely that this option will not be available until 2025 – 2030 or beyond.

The options form a logical roadmap from the use of existing technologies through to increasingly sophisticated solutions to deliver off-peak recharging of Plug-In Vehicles. It has the added benefit of ensuring that the complexity and cost of these solutions are matched against the wider take up of Plug-In Vehicles and thus keep investments in infrastructure aligned with need.

General Recommendations

69. Ultimately the decision to recharge a Plug-In Vehicle off-peak will always rest with the customer. However, Government and industry stakeholders should at all times be mindful of means by which off-peak recharging can be encouraged, incentivised and made easy to achieve. It is recommended then that all participants in the development of the Plug-In Vehicle market consider the ways in which the aforementioned techniques (e.g. tariffs) and technologies (e.g. timers) can be offered to customers to enable a choice to recharge off-peak.

70. All Plug-In Vehicle stakeholders to continue interaction on smart meter connectivity with DECC Smart Metering Implementation Programme.

71. The various stakeholders involved in this work should continue to provide a structure to coordinate the outcomes and actions arising from this position paper.

Chapter Four: Industry's recommendations and roadmap identifying action required in the short, medium and long-term.

Short-term (2012/2014)

- Industry will work with OLEV to identify and establish suitable mechanisms to provide interoperability in the UK.
    - OLEV to facilitate work between industry stakeholders and existing chargepoint schemes
    - The development of technical standards and specifications for public recharging infrastructure, facilitated by an independent body;
    - The development of a central whitelist or a suitable alternative.
    - Provide an assessment of the commercial business case for infrastructures post Plugged-In Places
- Timers are available now to enable control of when vehicles are recharged, and the use of these can be recommended to suitable industry partners (e.g. Plug-In Vehicle OEMs and chargepoint manufacturers and installers).
- Tariffs are available to make use of through time controllers
- Home automation is available to some customers now but this will become fully useable to control the vehicle charge after smart meters have been rolled-out

Medium-term (2015-2020)

- An established commercial market for Plug-In Vehicle Infrastructure is secured
- As the market matures the establishment of a central back-office system needs to be investigated.
- Smart meters as they come on line between now and 2019 will enable more accurate control through special tariffs. Once the programme is complete and all meters are fitted, the potential for controlled Plug-In Vehicle recharging will become a significant component of the future smart grid.
- Develop TOU Tariffs for Plug-In Vehicle recharging
- Enable home automation of the residential Plug-In Vehicle recharging system, with over ride function

Long-term (2020 onwards)

- When the smart meter programme is complete, demand response can be developed. This is a necessary step to manage demand for Plug-In Vehicle recharging as the generation mix develops in the UK.
- Intelligent vehicles are a longer term option but may be available and may make use of, or replace, other options. It is likely that some of the systems listed above will need to be in place before the intelligent vehicle becomes a reality and therefore it is more likely that this option will not be available until 2025 – 2030 or beyond.

Appendix One: Participants in the Workshop held on 8 November 2011

SMMT

- Samantha Larner, SMMT
- Jonathan Hawkings, SMMT
- Stuart Butterfield, ABB
- Emmanuelle Desbrosse, Renault
- Frederic Malefant, Renault

Energy UK

- Frances Williamson, Energy UK
- John Mason, EDF
- Ishbel Hughes-D'Aeth, EDF
- Lesley Queripel, E.ON UK
- Willie Kinnaird, Scottish Power
- Kevin Woollard, British Gas
- Helen Wagstaff, British Gas

ENA

- Paul Smith, ENA
- Richard Le Gros, ENA
- Lilian MacLeod, National Grid
- Jon Bird, Northern Powergrid
- David Densley, SSE
- Cristiano Marantes, UK Power Networks
- Roger Hey, Western Power Distribution

BEAMA

- Yselkla Farmer, BEAMA
- Vikas Kashyap, Advanced Energy Monitoring Systems Ltd
- David Greaves, Schneider Electric
- Christian Chevalley, Schneider Electric
- Phil Skipper, Siemens

DECC

- Adrian Butt, Energy Markets & Networks

Ofgem

- Dora Guzeleva, Head of Distribution Policy
- Lia Santis, Distribution Policy
- Tabish Khan, Smarter Markets

Plugged-In Places Projects

- Keith Bevis, East of England
- Sam Kennedy, London
- Christine Linke, London
- Santino Pietrosanti, Greater Manchester
- Dave Busby, Greater Manchester
- Peter Speers, Midlands

- Irene Breen, Northern Ireland
- Senan McGrath, Northern Ireland
- Mike Foster, Scotland

SE EV Network
- Nigel Jenkins

ETI
- John Batterbee

IET Standards
- Carolyn White
- Robin Haycock

National Chargepoint Register/Central Whitelist
- Steve Large, Podpoint
- Alex Rose, Podpoint

Elektromotive
- Calvey Taylor-Haw
- Keith Johnston

Office for Low Emission Vehicles
- Michael Hurwitz
- Eamonn Beirne
- Sean Frisby
- Susan Claris

Appendix Two: Glossary

ADMD	After Diversity Maximum Demand
BEAMA	British Electro-technical Allied Manufacturers Association
DCC	Data and Communications Company
DECC	Department of Energy and Climate Change
DNO	Distribution Network Operator
DR	Demand Response
ENA	Energy Networks Association
HAN	Home Area Network
NETSO	National Electricity Transmission System Operator
OEM	Original Equipment Manufacturer
OLEV	Office for Low Emission Vehicles
PAYG	Pay As You Go
PIP	Plugged in Places
RFID	Radio Frequency Identification
SMMT	Society of Motor Manufacturers and Traders
SOR	System of Record
TNO	Technical Network Operator
TOU	Time Of Use
TSB	Technology Strategy Board
TSO	Transmission System Operators

Appendix Three: Definitions

Back-office system

- Customer interaction: service provision for the end customer. This may include; registration for membership, card issuing, help desk, searching and reservation.
- Account management: This may include payment and billing, management of customer membership details and account history.
- Access management: This may include the management of access to recharging assets, by right and/ or availability.
- Transaction management: This relates to the capture, holding and storing of transactional data relating to the usage of the recharging asset.
- Asset management: Day to day maintenance and fault reporting.
- Technical network management: this may include services associated with the installation of an asset such as transferring data to and from an asset.
- Public: Defined here as any infrastructure found on-the street or in any other publicly accessible destination.

References

BEAMA, 2012, Considerations for the establishment of back office services to support the UK deployment of Electric Vehicles: A proposal from the members of the BEAMA EV Infrastructure Project. To view this paper please contact BEAMA, bevip@beama.org.uk