

Developing standards for electric vehicle smart charging



Energy UK is the trade association for the GB energy industry, with a membership of over 100 suppliers, generators, and stakeholders with a business interest in the production and supply of electricity and gas for domestic and business consumers. Our membership encompasses the truly diverse nature of the UK's energy industry – from established FTSE 100 companies right through to new, growing suppliers and generators, which now make up over half of our membership. Energy UK has established an Electric Vehicle Working Group to define energy industry positions on the opportunities and impacts of a mass uptake of electric vehicles, as set out in our 2017 paper on the *Electric Vehicle Revolution*ⁱ.

Introduction

This document sets out energy industry views on how best to deliver electric vehicle charging solutions that put customers at the centre of a future energy system. The UK power sector has delivered significant reductions in the CO₂ concentrations of each unit of electricity produced; almost halving from 551 gCO₂/kWh in 2007 to 286 gCO₂/kWh in 2017ⁱⁱ. The result of this is that, on average, fuelling an electric vehicle now results in less than half of the carbon emissions of even the most efficient available hybridsⁱⁱⁱ. Smart charging solutions have the potential to facilitate further integration of existing and future low carbon generation, particularly intermittent renewable generation, given the battery storage capacity presented by electric vehicles.

The decarbonisation of transport is expected to result in 323 billion vehicle miles per year to be electrified in the UK, and these miles will be delivered by the energy system in a range of ways. Customers will utilise an as of yet unknown balance of residential low power charging, workplace charging, frequent opportunity charging (at shopping locations, city centres etc.), rapid charging at service stations, and off-grid charging solutions utilising on site generation or storage.

Road transport has been the focus of growing pressure for change, with a number of factors surrounding the increasing speed of travel for decarbonisation of the sector, including:

- Commitments from UK/Scottish Governments to ban the sale of traditionally fuelled cars by 2040/2032 and extensive Government funding and research;
- Transport's position as the most polluting sector in the UK, and ongoing air quality concerns;
- Exponential market growth of electric vehicles, alongside falling production costs;
- Local government action, including a London-based Ultra Low Emissions Zone, and;
- The Smart Systems and Flexibility Plan set out by Ofgem and BEIS to integrate heat, power, industry and transport assets into a single decarbonised energy system.

Given the breadth of this issue and the stakeholders involved, Energy UK will formally consult on acceptable smart charging standards across a range of stakeholders and invites organisations and individuals to add their voice to the debate. Details of the consultation can be found in Annex 1 of this paper.

Executive Summary

The energy industry fully supports the UK Government's objectives to reduce carbon emissions from road transport, and it will be important to ensure any enduring solutions deliver for consumers and businesses alike. Discourse surrounding the potential impact of electric vehicle uptake and the deployment of smart charging solutions has, to date, focussed on a) protecting national and local energy networks from unpredictable demand patterns, and b) technical specifications and standards. This approach has resulted in a number of negative media stories on worst case scenarios and a lack of consumer control. There is an immediate need for the discussion to be redirected to concentrate on the needs of the consumer.

The UK energy industry holds the following views on how the UK should approach smart electric vehicle charging:

- Charge points across domestic, privately-owned, and public domains need to **incorporate a series of controllable aspects** to enable any smart charging solution. It is important that smart

charging solutions offer more controllability than an 'ON/OFF' switch, and allow for the optimisation of power flows within the energy system.

- Industry should ensure a **holistic review of wider ramifications** of smart charging solutions for customer experience, energy bills, policy and regulation, and energy markets throughout the development process, through the inclusion of a wide range of stakeholders.
- Charging Solutions should be approached from consumer points of view to ensure that the needs of the individual and the energy grid are met at **least overall cost to all consumers**, without acting as a disincentive to electric vehicle adoption.
- Customers should, wherever possible, retain **the ability to choose to participate** in smart charging, in order to maintain a positive consumer experience. It is, therefore, important to establish a market which enables the development of a range of attractive charging models for consumers to choose from, ensuring that the customer is rewarded for opting to provide an energy service via their electric vehicle.
- Charge point standards to be set by Government following on from the Autonomous and Electric Vehicles bill should be **performance based, technology neutral, and flexible** enough to allow for future charging innovations including Vehicle to Grid (V2G), Vehicle to Everything (V2X) and wireless charging. Further recommendations can be found below.
- The existing evidence base for electric vehicles' impact on the electricity grid is neither comprehensive nor extensive enough to warrant implementation of any permanent solution at present. There is a need for **focussed innovation projects targeting low voltage networks** with existing constraints, including a tender for market solutions to identify options for standardisation delivering at lowest cost for consumers. Where possible, trials should integrate Transmission, Distribution, and consumer-level innovation, to realise the value of flexibility provision at different levels.
- There will be a place for emergency controls should the network be overloaded, but it is important that these are only deployed in cases where **robust competitive markets** fail to provide a solution to a present and proven constraint. Interference, through deployment of a monopolised managed charging solution, would reduce the value of electric vehicles to the consumer, the energy system and UK Plc. Care should always be taken when deciding to implement emergency controls (i.e. remote shut-off) as these can erode customer trust/confidence in smart chargers.

Electric vehicle charging is an area of proven potential, both in terms of increased customer engagement in energy usage^{iv} and wider market applications for energy services^v, and solutions should reflect this potential. The number of consumers showing "little understanding" of the energy market has grown by two percentage points between 2014 and 2016^{vi}, and electric vehicles, and their charge points, will play a potentially important role in the engagement of consumers through the provision of flexibility. Many Energy UK members are working to integrate energy services, such as those offered by electric vehicles, into their respective business models by offering a range of services which will change the way customers interact with energy usage. Creating robust competitive markets for these services in conjunction with developing an attractive range of charging solutions, is the most effective approach to delivering for changing demand on the system at the lowest cost to consumers.

Smart charging solutions must be approached in a holistic and whole-systems manner to ensure effective development of a market for smart charging, incorporating wider efforts to develop a smart, flexible, decarbonised energy system. The UK energy system is undergoing a structural transformation, with increasing numbers of Distributed Energy Resources (DER), such as rooftop Solar PV, heat pumps, distribution-connected generation and storage assets, disrupting the traditional top-down structure. The Smart Systems and Flexibility Plan^{vii} and development of potential Distribution System Operator (DSO) frameworks are cemented in facilitating robust competitive markets to meet the changing demands of the system. Electric vehicles hold the potential to provide system assets which are mobile, respond in seconds, hold no deployment costs for the network and, given their broad appeal, could enable early market success. Smart charging will be a core part of enabling the UK to maximise this opportunity.

Smart Charging Equipment Standards

There is a need for enabling performance-based technical standards to be developed for the UK's domestic and public Electric Vehicle Supply Equipment (EVSE) to enable market applications for flexibility offered by electric vehicles. These standards should encourage the ongoing development of new technologies and minimise stranded asset costs. It is important that smart charging solutions offer more than an 'ON/OFF' switch, and that whatever solutions are chosen have a degree of controllability over rate of charge to allow for the optimisation of power flows within the energy system. Smart charging capabilities can be built into the vehicle, the charge point and the supporting energy system platforms to enable electric vehicles to support a smart flexible energy system, but charge points in particular will need to incorporate a series of controllable aspects in order to enable any smart charging solution.

Given the nascent term of this technology and the large number of interested parties, Energy UK believes that there is a requirement to establish industry-wide charge point standards that should include:

- **Communication:** Able to send and receive accurate, near to real-time data in a compatible format to allow for utilisation in the optimisation of power flows and ease of communication with third party platforms.
- **Interoperability:** Able to be used alongside a range of technologies in the context of an expanding smart technology industry; Able to integrate into broader systems in, for example, smart cities; Able to operate as part of a single charge point network accessible to all electric vehicle users; Maintains the customer's ability to switch energy supplier.
- **Monitoring:** Able to monitor, or receive and react to, information on voltage and frequency data from the grid; Able to monitor speed of charge and interpret state of charge data from the vehicle.
- **Accessibility:** Equipped with an open data standard and a respective digital interface; Able to be operated by the consumer, with lines of recourse and a level of consumer control.
- **Controllability:** Able to be controlled remotely by the consumer or a third party, with a set of command protocols clearly defined; Equipped with a customer override for when the customer does not wish to participate.
- **Safety and Security:** Equipped with a set of cyber security measures to protect consumer data and prevent unauthorised usage or control; Operated within a set of health and safety standards protecting the user and the general public.

It should also be noted that smart charging standards should integrate a level of flexibility to ensure that the market is able to adapt as technologies emerge, including developing applications of V2G/V2X and future innovations like wireless charging. This flexibility will need to include the ability to use a range of technologies to meet standards, and the ability for standards to be modified by ministers at a later date following a consultation period. Whilst there are existing open standards in use by some European charge point operators^{viii}, these may not be compatible with existing and developing energy infrastructure, including smart metering, across the UK.

Once standards are established, the deciding factor in what range of solutions are deployed where in the UK is likely to be found in a cost-benefit analysis taking into account whole system benefits and representing best value for consumers and UK Plc. Charging standards should enable participation in flexibility and system support services, as electric vehicle chargers can provide valuable services to distribution and transmission level systems at times of system stress. Individual consumers should, wherever possible, retain the ability to choose to participate in smart charging to maintain a positive consumer experience. It is, therefore, important to establish a market which sets out a selection of attractive options which encourage customers to adopt smart charging. The differentiation in the requirements and emerging business models for public, private and domestic charging may result in a need for charging standards to be segmented to reflect this.

Following the publication of this paper, Energy UK will formally consult with third parties on acceptable smart charging standards, as detailed in Annex 1, and we welcome early comments at this time.

Sustainable Growth in Electric Vehicle Energy Demand

Estimates of future energy demand from transport vary, as do estimates of the speed of growth of that demand, but most assessments agree that there will be a noticeable impact on the energy system by 2030. To enable a smooth transition to low carbon transport, this demand will need to be managed, making the most of existing network capacity and available generation resources. To enable this optimisation, the UK must deploy a range of smart charging solutions. Where robust competitive markets fail to provide, Energy UK agrees that emergency controls may be required, but feels that these must be limited in their deployment and use.

Research projects including My Electric Avenue, Electric Nation and the Smart EV Project, have begun identifying potential impacts of electric vehicles on electricity networks, setting out overarching theories which now need to be tested through targeted trials across areas of existing constraint. Ongoing research lacks a holistic view, often omitting an examination of ramifications for consumers, current and proposed policy and regulatory frameworks and the potential effect on existing and future markets for flexibility.

DNO-operated Managed Smart Charging gives direct control of EVSE to a DNO (Distribution Network Operator) or third party to slow or stop electric vehicle charging at times of constraint as defined by the DNO. DNO-operated managed smart charging solutions are an emergency measure, to be used where a network is unable to cope with additional demand in specific areas of existing constraint. Energy UK holds concerns regarding this proposal's impact on customer experience, if it were to impact charging expectations, potentially damaging take up of electric vehicles. Any solution of this kind should only be used as a temporary measure until a viable market solution or network reinforcement measure is implemented to address the local constraint. Care should always be taken when deciding to implement emergency controls, as these can erode customer trust and confidence in smart chargers.

Going forwards, Energy UK believes that investment in any DNO-operated managed charging solution would require:

- Proof of an existing constraint and a clear market failure to resolve the issue;
- A timeline for replacement of the solution via a market solution or network reinforcement;
- Extensive consumer engagement, including gaining informed customer consent for the operating party and the installation of hardware in consumer homes;
- Any organisation involved in the transfer or use of consumer data to meet a set of security standards under General Data Protection Regulation, as well as Smart Energy Code full user requirements or privacy assessments;
- Extensive consideration of the exposure of DNOs to cyber-attacks and legal action, including in those areas covered by the Networks and Information Systems Directive^{ix};
- The development of hardware and software, not only for charge points but for low voltage network monitoring and active network management;
- A programme of retraining and recruitment of DNO staff in areas required to implement a managed charging solution, drawing on technical expertise from a range of industries;
- Defined implementation costs and cost recovery methodology across all customers through energy bills or directly charged to the electric vehicle user, and;
- A counterfactual of traditional reinforcement defining comparative costs and benefits for consumers.

Energy UK, therefore, considers that DNO-operated managed charging solutions would need to be developed and deployed in a way that complements competitive markets and avoids:

- Adversely affecting the uptake of electric vehicles and smart chargers through additional cost or complication for customers;
- Acting as a barrier to the development of customer-focused, market-based innovations in charge point technology, including development of V2G/V2X, which Government is backing through funding;

- Setting out a unilateral technical standard for EV chargers, causing significant additional costs to a growing market and blocking alternative innovative solutions;
- Imposing a technical solution which clashes with existing and developing technology standards, including those for Smart Meters and smart appliances, or otherwise creating barriers to the wider smart home offering;
- Restricting the ability of other parties to provide market-based solutions and smart-charging services, and the successful adoption of EV-specific tariffs, bundled service offerings, and developing business models;
- Becoming equivalent to DNO or DSO ownership of an energy storage asset for use in turndown or turn-up services opposed by Ofgem and BEIS, and potentially foreclosing wider markets for flexibility;
- Removing the potential for future successful markets for flexibility, due to lower market opportunities for electric vehicles as flexibility assets;
- Creating a bottleneck in aggregation of flexibility provided by electric vehicles and restricting participation of smart charging in transmission-level balancing markets;
- Causing any of a number of data protection and privacy concerns, or setting a precedent for DNO access to consumer data, or;
- Creating stranded network assets in the form of smart charging hardware.

Enabling a Market for Consumer-Focussed Smart Charging

For a range of solutions to be developed, a robust, competitive market should be established through the development of price signals reflective of the value of flexibility. Consumers should be rewarded for contributions to energy system resilience, and able to choose the form of this contribution from a range of attractive smart charging offerings. To avoid the use of emergency measures, in the form of DNO-operated managed charging, Energy UK and its members believe that smart charging driven by market signals should be the primary interface between electric vehicle owners, energy service providers and network operators. Only in extreme situations do we believe that a managed charging solution should be taken forward as a means to avoid damage to network resilience.

Contractual and consumer-operated smart charging solutions include an active decision by the consumer to take part in smart charging. A smart-enabled charge point changes the rate of charge, as agreed to by the consumer, based on signals sent by the service provider. The contract ensures a level of user control over acceptable charging levels, whilst establishing additional sources of revenue or energy savings for the consumer. Outside of initial engagement wherein a consumer chooses the solution, and the establishment of routes of recourse for the customer, a range of charging models will enable the consumer to do very little in terms of active monitoring of their vehicle's energy usage. The use of market-driven solutions including contractual and consumer-operated smart charging is dependent on the availability of Time of Use tariffs, and will be enabled by the ongoing deployment of smart meters.

If development is enabled through robust competitive markets, these solutions will:

- Aid consumers by automating processes;
- Support the market by creating value from the deployment of electric vehicles;
- Benefit network operators by creating an aggregated energy resource to be called upon as part of market mechanisms for reducing fluctuations in demand and protecting the network;
- Enable other forms of household flexibility to participate, utilising near real-time price signals to encourage a change in wider energy behaviours reflective of the needs of the network;
- Unlock a range of benefits for consumers via the use of smart tariffs;
- Result in greater engagement, as consumers decide to sign up to smart charging and agree settings for automation and controls based on the attractiveness of the offer, and;
- Enable recovery of equipment costs from market applications, further reducing the lifetime cost of electric vehicle ownership.

Transport is not the only aspect of changing consumer demand, as other developing factors, including increased energy efficiency measures and uptake of low carbon heat technologies, will impact on how much and what type of energy consumers use and when. It is important to understand that the needs of the customer will differ dependent on circumstances, and industry must endeavour to reflect this in the design of a range of attractive solutions and viable business models which hold the consumer as the focal point. Government should reflect this variation in developing smart charging standards.

Moving Forwards

It is important that, in the development of standards for smart charging solutions, government and industry:

- **Resist oversimplification** by engaging with stakeholders across a range of industries throughout the formulation process.
- **Work with a range of Government departments, Consumer Groups and the Regulator** to highlight potential impacts on consumer choice, cost of energy and electric vehicle uptake, and identify potential regulatory and policy changes.
- **Directly address potential increases in generation demand and the risk of network constraints.** It is important to fully understand the extent of the potential constraint, and present low-cost, market-based smart charging solutions.
- **Work to continually assess the behavioural characteristics of consumers.** Existing work on consumer behaviours in electric vehicle charging and usage has focussed on a comparatively small number of early adopters of the technology. This may not necessarily be representative of wider market adoption, and will need to be monitored to ensure the needs of the consumer are reflected in the available solutions.
- **Suggest scope for innovation projects** targeted at the most at-risk networks. It is important that specific areas of existing constraint are identified and defined, and that a market approach, in coordination with National Grid's flexibility markets, be utilised to introduce consumer-focussed solutions.
- **Compromise.** It is important to recognise that there may be specific instances where a range of charging solutions, including DNO-operated managed charging^x, could be necessary for a limited time, and a cost benefit analysis should be core to the objective deployment of the most appropriate mix of smart charging solutions.

As the UK develops smart charging standards, it is important to develop the surrounding system of governance. As a key stakeholder with over 100 members encompassing the broad range of stakeholders across the energy industry, and with a broad range of close contacts across the electric vehicle sector, Energy UK would be well placed to aid in this role. We ask that government consider the role that Energy UK can play in continuing governance of UK smart charging standards.

To aid in the progression of a multilateral approach to smart charging, Energy UK will initiate a high-level consultation process, with the help of a range of other industry bodies, to gather opinions, focussing on those organisations and industries included in the OLEV-sponsored EV Networks Group. Energy UK hopes that this will prompt further discussion on consumer-controlled and contractual smart charging options as outlined in this paper. Building on areas of common agreement defined in this consultation process, areas of high potential for future constraints should be targeted for trials modelling a range of potential approaches by utilising market solutions. We would ask that Government continue with its initial engagement process and set out options for charging standards reflective of industry opinions revealed in this consultation process.

ⁱ <https://www.energy-uk.org.uk/files/docs/Research%20and%20reports/ElectricVehiclesRevolutionReport2017.pdf>

ⁱⁱ *Committee on Climate Change*, Report to Parliament, Meeting Carbon Budgets Closing the Policy Gap

ⁱⁱⁱ *Electric Cars Get Greener*, Drax Electric Insights Quarterly, Q2 2017

^{iv} *Tailored Emails Prompt Electric Vehicle Owners to Engage with Tariff Switching Information*, Moira Nicolson, Gesche M. Huebner, David Shipworth & Simon Elam for UCL UCL, Nature Energy Volume: 2 Article Number 17073

^v Market Potential Analysis for the Provision of Balancing Reserve with a Fleet of Electric Vehicles, CIRED Paper 0622, 2013

^{vi} Consumer engagement in the energy market since the Retail Market Review, 2016 Survey Findings, Ofgem August 2016

^{vii} <https://www.gov.uk/government/publications/upgrading-our-energy-system-smart-systems-and-flexibility-plan>

viii <http://www.openchargealliance.org/>

ix <https://www.ncsc.gov.uk/guidance/introduction-nis-directive>

x An example of which can be seen in SSEN's smart energy code modification proposal, SECMP0046:

<https://smartenergycodecompany.co.uk/modifications/allow-dnos-to-control-electric-vehicle-chargers-connected-to-smart-meter-infrastructure/>

Annex 1: Consultation on Acceptable Smart Charging Standards**Consultation Details**

Publication of this report marks the opening of a 6-week consultation period, closing on 23 April 2018.

Responses can be submitted to Charles.Wood@Energy-UK.org.uk, with the email heading including 'Consultation on Acceptable Smart Charging Standards'. Alternatively, submissions can be sent to the following address:

Charles Wood
Energy UK
6th Floor, 5-11 Regent St.
London
SW1Y 4LR

Enquiries and concerns can also be sent using those details.

Following the deadline, Energy UK will produce a report detailing the findings, alongside a list of respondents and, where permissions are given, submitted responses. Areas of common agreement will be outlined to government, and areas of disagreement or contention highlighted for further discussion, with the aim of aiding government in the development of secondary legislation on smart charging standards.

If you do not wish for your submission to be published by Energy UK, please note this in your response.

Respondent Information

Please give details of the following information when responding:

Name of Respondent		
Name of Company		
Type of Company		
Contact Details	Email:	Telephone:
Do you agree to the publication of your response by Energy UK?		

Requested Feedback

Overarching smart charging functionality

Q1: Do you agree that **Smart Charging Equipment Standards** should be technology neutral and performance based? If not, what technical specifications do you believe need to be laid out by Government?

Q2: Do you agree with the overarching requirements for smart charging standards as defined in the section of the paper entitled **Smart Charging Equipment Standards**? Is there anything you believe should be added or removed?

Q3: Is there a need for segmentation of smart charging standards to reflect variation between public, private, and domestic charging? If so, what are the key variations which should be addressed?

Please reflect your thoughts on appropriate measures to address these variations in your answers to questions 4 – 12.

Q4: What standards should be set for **Communication** capabilities across electric vehicle charge point equipment based on the following requirements, and why?

Able to send and receive accurate, near to real-time data in a compatible format to allow for utilisation in the optimisation of power flows and ease of communication with third party platforms.

Q5: What standards should be set for **Interoperability** capabilities across electric vehicle charge point equipment based on the following requirements, and why?

Able to be used alongside a range of technologies in the context of an expanding smart technology industry; Able to integrate into broader systems in, for example, smart cities; Able to operate as part of a single charge point network accessible to all electric vehicle users.

Q6: What standards should be set for **Monitoring** capabilities across electric vehicle charge point equipment based on the following requirements, and why?

Able to monitor, or receive and react to, information on voltage and frequency data from the grid; Able to monitor speed of charge and state of charge from the vehicle.

Q7: What standards should be set for **Accessibility** capabilities across electric vehicle charge point equipment based on the following requirements, and why?

Equipped with an open data standard and a respective digital interface; Able to be operated by the consumer, with lines of recourse and a level of consumer control.

Q8: What standards should be set for **Controllability** capabilities across electric vehicle charge point equipment based on the following requirements, and why?

Able to be controlled remotely by the consumer or a third party, with a set of command protocols clearly set out.

Q9: What standards should be set for **Safety and Security** capabilities across electric vehicle charge point equipment based on the following requirements, and why?

Equipped with a set of cyber security measures to protect consumer data and prevent unauthorised usage or control; Operated within a set of health and safety standards protecting the user and the general public.

Q10: How can Government ensure that standards are futureproofed and flexible enough to enable the integration of developing technologies?

Q11: What are the broader systems and workstreams across government and industry with which the development of charge point standards should be integrated or aligned with?

Q12: Are there any standards you or your members would find unacceptable? If yes, what are they and why would they be unacceptable? Please supply acceptable alternatives where possible.

Consumer-Focussed Smart Charging

Q13: Do you agree that, as far as is possible, participation in smart charging should be an active choice for individual consumers?

Q14: Do you agree that DNO-operated managed charging should only be deployed, as a temporary emergency control, where robust competitive markets fail to provide a solution to a present and proven constraint? If not, under what circumstances would you find the deployment of these solutions acceptable?

Developing robust, competitive markets for smart charging solutions

Q15: What are the most significant barriers and risks to the development of robust, competitive markets for smart charging solutions?

Q16: How could DNO-operated managed charging solutions be developed and deployed, in specific circumstances, in a way which complements competitive markets and avoids hindering innovation?

Further comments

Q17: Do you have any other comments you wish to raise, which you feel were not covered by other questions?