



Department for
Business, Energy
& Industrial Strategy

ofgem

Electric Vehicle Smart Charging Action Plan

Affordable, sustainable power for electric
vehicles

January 2023



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Ministerial Foreword

By 2030 there will be up to 10 million electric vehicles on our roads, as the UK speeds ahead on its journey to net zero. This vast volume of EVs will take up a significant proportion of our country's total electricity demand. If we are going to park the combustion engine permanently, and cut our carbon emissions, we must secure our energy supply. We are accelerating our efforts to reduce reliance on expensive, imported fossil fuels, and we are increasing the availability and affordability of renewable and low-carbon electricity.



But supply is only part of the picture. We must harness transformative technologies to ensure that we can get the right energy to the right people at the right time – and at the right price.

In this context, smart charging for EVs – whether at home, in the workplace, or on the street – provides a win-win-win situation. The electricity used is cleaner and greener; drivers pay less to use it, with the option of returning it either to their home or to the grid should they wish; and overall system costs are reduced, bringing down prices for everyone.

We have already come a long way in developing and deploying smart charging technology. As of last year, all new charge points sold for private use will have smart functionality, and we have consulted on a new policy framework to reap the rewards of domestic, smart, flexible energy, and enhance its cybersecurity.

But we know that we need to move further and faster if we are to achieve our net zero ambitions. In March 2022, the Government set out its vision for EV charging infrastructure in the UK EV infrastructure strategy. Today's joint action plan, developed with Ofgem, builds on that vision and sets out the steps we must take with industry to make energy integration a reality and unleash innovation.

The plan sets out a roadmap for unlocking the enormous potential of smart charging to deliver for the environment and the economy as EV ownership grows, with real results for households across the country. Government, regulators, and industry are working together to build the transport and energy systems of our net zero future. Making smart charging the number one choice for EV drivers is the next step in this project.

Rt Hon Graham Stuart MP

Minister for Energy and Climate

Foreword from Ofgem

At a time when households and businesses are struggling with the cost of energy, decarbonising the nation's energy supply has never been more important. A rapid transition away from expensive oil and gas, whose price is set in volatile international markets, will both help hold bills down and meet the UK's 2050 climate change targets.



The rapid take up of electric vehicles (EVs) will be a crucial part of this transition. Ofgem's role is to ensure that the energy sector plays its role in the rapid move to EVs and does so at least cost to consumers. We are already developing the infrastructure and networks to enable around 10 million EVs on our roads by 2030. We are accelerating investment in the energy networks to ensure they are prepared for the increased electricity demand and facilitating the rollout of a nationwide network of EV charging points to help drivers charge their EVs at work, on the go, or at home.

We are also building a smart, more flexible energy system that can utilise the millions of EV batteries that will be plugged into the system. This will provide a huge opportunity for EVs to become 'batteries on wheels': smart charging when electricity is cheaper and selling electricity back to the grid when it is needed. This will reduce the need for new generating and grid capacity, reducing carbon emissions and benefitting not only EV drivers but also keeping costs down for all electricity bill payers.

This joint action plan with Government sets out how we plan to maximise energy flexibility from EVs. Our priority is to support EV uptake and ensure that all consumers see the benefits of smart charging, driving the right technological and behavioural changes we need to support decarbonisation at the lowest cost.

Working with Government, industry, and consumer groups, Ofgem will support the EV revolution by developing an energy system ready for EV charging, making smart charging affordable and convenient, and providing the right market for innovative smart charging products to flourish.

Chief Executive - Ofgem, Jonathan Brearley

Executive Summary

Decarbonisation of road transport is accelerating, and in 2022 one in six of all new vehicles sold in the UK was a plug-in electric vehicle.¹ The UK Electric Vehicle Infrastructure Strategy² set out how the rollout of charging infrastructure will be integrated into a smart energy system to maximise the efficient use of generation and network assets. Enabling intelligent and automated 'smart charging' at suitable locations will deliver a win-win situation; the electricity system costs are reduced lowering prices for everyone, the motorist pays less for charging their electric vehicle (EV), and the electricity powering the EVs is cleaner and greener.

Most EV drivers will do most of their charging overnight at or near home. Vehicles that are parked on charge for a few hours or more can be flexible in the power or exact timing of their charging, and still be fully ready to go when they are needed. These smart charging power adjustments will not inconvenience the EV driver but, by helping to efficiently balance the electricity system, will make their vehicle charging costs cheaper.

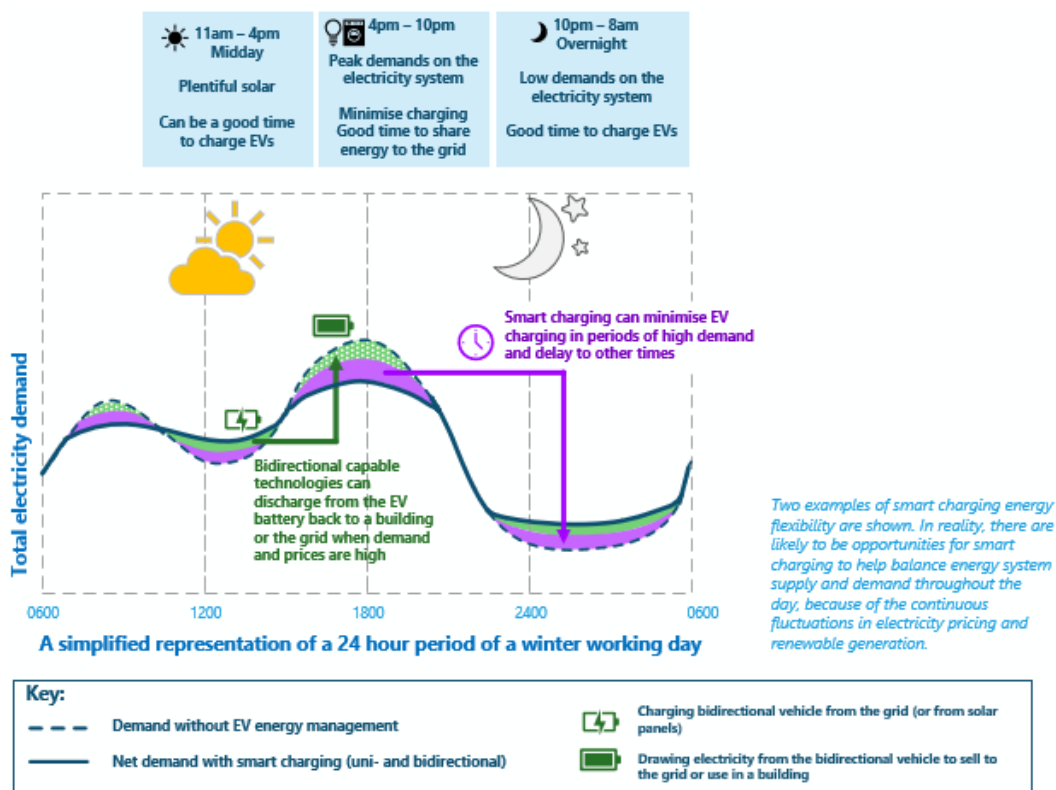


Figure 1: Illustration of how changing electricity demand from EVs, or using EVs as energy storage can ensure the energy system is used most efficiently.

On a typical business weekday, the system electricity demand is higher between about 8am and 10pm, with the largest demand usually experienced between 4pm to 10pm on winter evenings. Smart charging can delay the power demand from EVs to off-peak periods or to times of abundant renewable power, which overall minimises the investment costs for generation capacity, and for the electricity network (the cables and other electrical equipment) and reduces carbon dioxide emissions. Technologies that

¹ [Vehicle Licensing Statistics: January to September 2022](#), Table 1153

² <https://www.gov.uk/government/publications/uk-electric-vehicle-infrastructure-strategy>

change the timing of energy demand are called demand side response. In future, the energy system and EV drivers will further benefit from bidirectional smart charging technologies which enable EV batteries to act as storage, providing additional flexibility and financial advantages compared to smart charging in one direction. Energy may be exported to a home, building, other electrical loads, or the grid, so the term “Vehicle-to-X energy” (V2X energy) is used to describe all these propositions.

Vision

This EV Smart Charging Action Plan sets out the necessary actions to deliver energy flexibility from EVs, and to make sure the system is ready to respond in time for the upturn in energy demand. Government and Ofgem will seek to remove the barriers that currently prevent the full development and uptake of a diverse and competitive smart charging market.

Our ambition for energy flexibility from EVs is that:



Widespread EV smart charging³ keeps costs down for all electricity bill payers, whether they own an EV or otherwise.



Smart charging enables a secure and stable, net zero energy system as EV demand grows. EV energy flexibility responds to the needs of the electricity system, minimises carbon emissions, and EV charging leads the way for energy system digitalisation.



It is the norm for EV drivers to smart charge at all long duration charging locations.

EV drivers without off-street parking will be able to access smart charging when they use long-stay public charging, so direct benefits are not just available to those with access to a driveway.



EV drivers will find information and advice about EV charging online from consumer groups and from businesses to help them understand the charging basics and choose the most suitable products. Drivers and businesses will understand how they can reduce their carbon footprint and lower their charging costs through smart charging on their premises.



It will be straightforward and convenient to use smart charging at home, the workplace or in public settings to access cheaper charging. There will be continued innovation of goods and services to offer choice to all types of consumers, and to promote energy flexibility. **In future, it will also be the norm that EV drivers export energy from their EVs using Vehicle-to-X technology to keep the energy system secure and affordable for all.**



The UK is an incubator for competitive EV energy and charging businesses, creating net zero jobs and boosting international trade.

³ Our vision for smart charging includes bidirectional charging within the definition.

Delivering the steps set out in this Action Plan will ensure that smart charging should be the norm at home and work by about 2025. It is the ambition that in the late 2020s smart charging will also become available at long duration public charging, such as on-street or at transport hubs. Bidirectional Vehicle-to-X energy technologies will be more commonplace in this period, particularly for fleets of business vehicles and where households are powering their EVs from domestic-scale renewables such as solar panels, reaching widespread deployment by 2030.

Current state of play

The UK is a leader in smart charging, and home to a growing number of charge point manufacturers, operators, and other supporting businesses. There are already a growing range of EV charging services and energy tariffs available that can pass on the electricity system savings from off-peak charging to EV drivers, the vehicle fleet owners and site developers.

The identified challenges to delivering the vision are:

Consumers who are considering EVs are not always aware of the benefits of smart charging, or consumers are concerned about whether the vehicle will be ready when they need it and how to select the most suitable goods and services.

Today, households without off-street parking have more limited options for accessing smart charging, for example those living in flats or rental properties.

EV drivers are not likely to continue regularly smart charging if the economic savings or other form of incentives are not attractive to them, or if they are concerned about issues such as data security or privacy.

The cyber security and grid stability risks of digital, connected, smart energy assets (such as EV charge points) becoming integrated with the energy system need to be managed.

Vehicle-to-X bidirectional smart charging is still a nascent technology. It requires more vehicles compatible with the technology, and a clearer economic case for businesses wanting to serve the market and for consumers who will use the products. The connection process for V2X charge points is more difficult than for unidirectional smart charge points.

The electricity demand, and flexibility capacity from EV public charging is not clear for energy system and network operators. Specific predictions of the future mix of public rapid and slow charging are inherently uncertain at the beginning of 2023, due to the rapid strides in technology advances and developing consumer charging preferences.

Today we estimate that up to 70% of EV drivers with access to off-street parking have a dedicated charge point at home, most with some degree of 'smartness'.⁴ The Electric Vehicles (Smart Charge Points) Regulations 2021 will ensure that all private charge points sold in GB will have a minimum level

⁴ <https://www.gov.uk/government/publications/electric-vehicle-smart-chargepoint-survey-2022>

of smart functionality, so the time is right to enable the supporting changes to deliver energy flexibility. The UK is also a world leader in Vehicle-to-X energy technologies, which provide the ability to share electricity from the vehicle battery. It has the most diverse range of innovation projects including the largest demonstration of Vehicle-to-Grid (V2G), exporting to the wider energy system, in homes. More than five hundred bidirectional charge points were installed across the country through the V2G Innovation Programme.

Our Key Commitments

Making smart charging the affordable, convenient choice for EV drivers

Government, with Ofgem, will work with industry to improve smart charging information provision to customers from 2023.

Government and Ofgem will build a shared evidence base of how the different levels of smart charging uptake, including vehicle-to-X energy will reduce electricity unit costs and use this evidence to inform policy from 2023.

Government will support industry to implement voluntary EV energy consumer service code of best practice in 2024 and monitoring its take-up by 2025.

Providing the right business landscape for EV smart charging products

Government will ensure that all EV private charge points are secure and interoperable with Demand Side Response (DSR) service providers, enabling consumers to access the full range of smart tariffs and DSR services with confidence.

Government will investigate the technical and economic potential of public smart charging and address the barriers to smart charging at all long duration public charging settings.

Government will deliver the Vehicle-to-X Innovation Programme to address barriers to wide-scale deployment specific to this technology by 2025.

An energy system ready for EV smart charging

Government, Ofgem and industry will build the evidence base to understand the relative costs and benefits of smart public and rapid public charging. This will include quantifying the energy system costs, carbon emissions, and potential charging costs to inform future policy direction in 2023.

Ofgem will work with the Distribution Network Operators (DNOs) through the Energy Networks Association (ENA), building on the incentives for an efficient connection process for all low carbon technologies, to ensure that there is a consistent connection process for V2X across all regions.

Ofgem and Government will consider and assess what barriers may exist to the development and uptake of innovative new smart charging products and services.

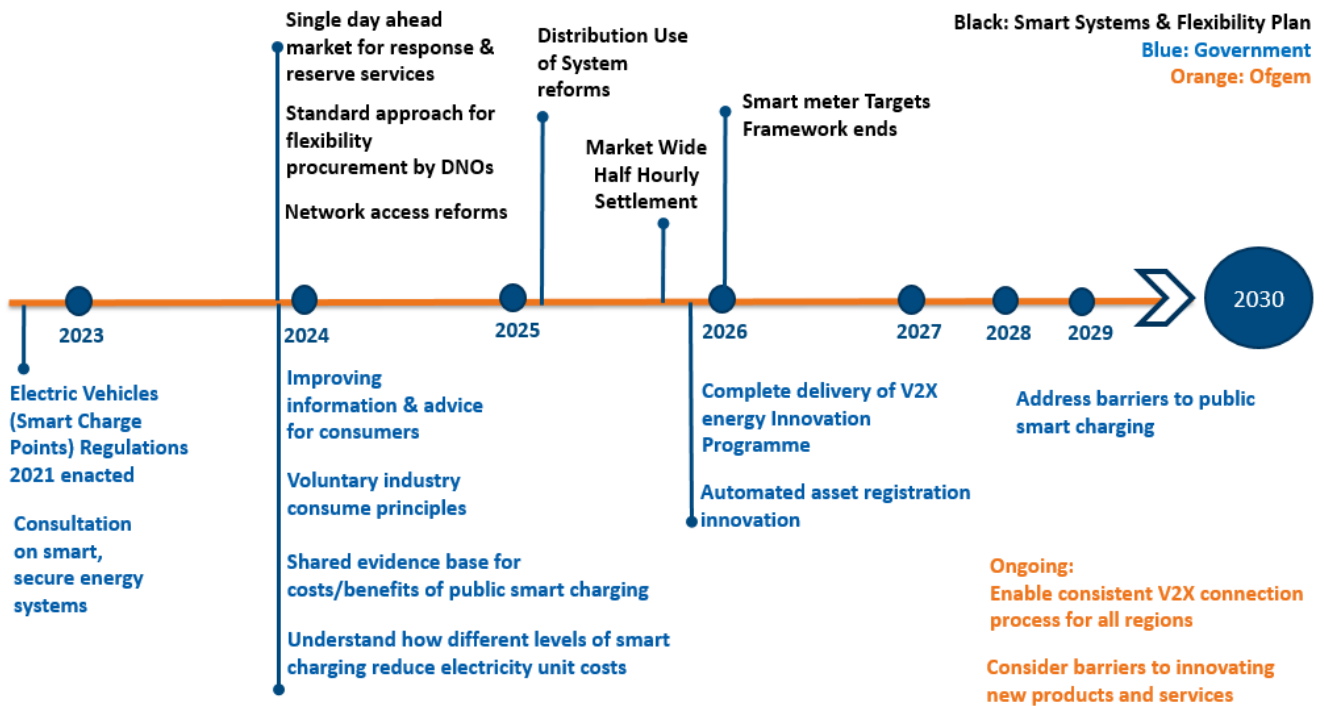


Figure 2: Roadmap of the Smart Charging Action Plan key milestones, plus relevant actions from the Smart Systems & Flexibility Plan.

Chapter 1: Introduction

In October 2021, the UK announced a world leading climate change target to reduce carbon emissions by approximately 77% by 2035 compared to 1990 levels, on a pathway to net zero by 2050.⁵ The energy sector has already made huge progress towards replacing fossil fuel generation with renewable and low carbon sources, with a commitment to have a fully decarbonised power system by 2035,⁶ subject to security of supply. This transition also reduces the dependence on imported oil and gas, to deliver clean, affordable, secure power. The British Energy Security Strategy recognised the importance of the connecting network infrastructure, and flexibility in matching supply and demand, to deliver the net zero transition.⁷

Decarbonisation needs to happen across the whole economy, and the electrification of road vehicles will make a significant contribution to reducing carbon emissions in the transport sector.⁸ The Government's commitment to phase out the sale of new petrol and diesel cars and vans by 2030 put the UK on course to be the fastest nation in the G7 to decarbonise its light vehicle road transport. The 2035 Delivery Plan⁹ set out the actions to ensure that all new cars and vans will be fully zero emission at the tailpipe by 2035.

However, together with electrification of heating and other sectors, transitioning from fossil fuels to electrified transport could double overall electricity demand by 2050.¹⁰ This will increase power generation and energy infrastructure requirements over the next decades.

By making the energy system more flexible, by adjusting when and how electricity is generated and used, the need for additional generation and network infrastructure over the coming decades can be reduced. There are two main sources of variability to optimise for: variation in power demand through the day with peaks experienced in the early evening; and variation in weather affecting the supply from renewable generation sources.

⁵ <https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035>
Net Zero Strategy Build Back Greener, 19 Oct 2021, <https://www.gov.uk/government/publications/net-zero-strategy>

⁶ <https://www.gov.uk/government/news/plans-unveiled-to-decarbonise-uk-power-system-by-2035>

⁷ <https://www.gov.uk/government/publications/british-energy-security-strategy>

⁸ Transport is the UK's largest emitting domestic sector. 91% of UK transport emissions come from road transport.

⁹ Transitioning to zero emission cars and vans: 2035 delivery plan:

<https://www.gov.uk/government/publications/transitioning-to-zero-emission-cars-and-vans-2035-delivery-plan>

¹⁰ BEIS (2020), Energy White Paper (page 42), <https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future>

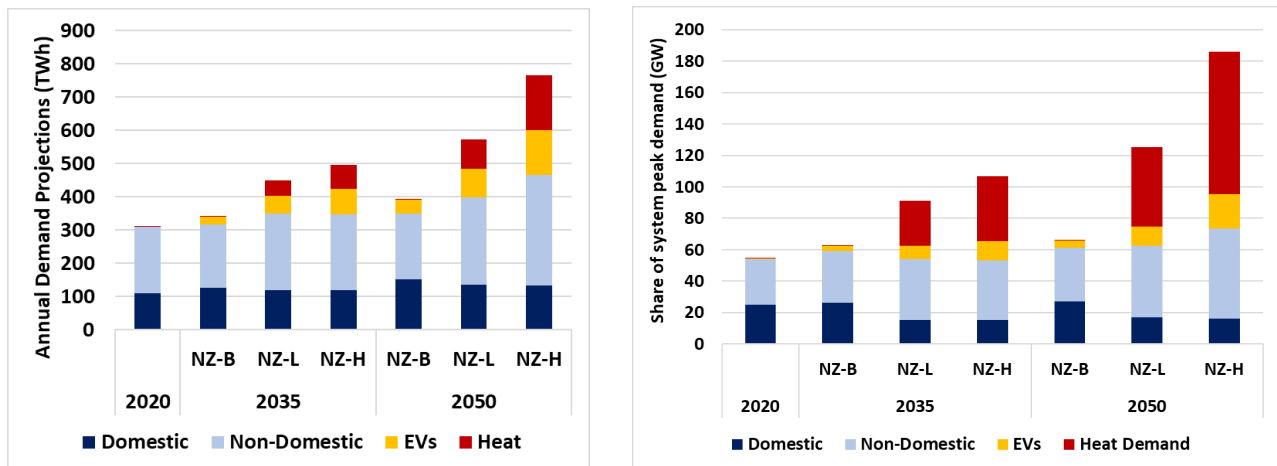


Figure 3: Electricity demand (TWh) and peak (GW) from different sources in illustrative net zero scenarios (BEIS model scenarios: Baseline, Net Zero Low and Net Zero High)¹¹

System flexibility can be provided by energy storage, low carbon rapidly-dispatchable generation, interconnectors to other countries, and changing the timing of when electricity is used (demand side response). EVs have the potential to provide significant demand side response and energy storage in response to electricity system needs. For example, by ensuring EVs charge overnight where possible, at times when demand is low, or by charging at times when there is plentiful renewable electricity generation. With Vehicle-to-X charging technologies, the energy stored in the vehicle battery can be used for other uses at times when energy system prices are high.

¹¹ Demand Side Response (including EV flexibility) is included within our illustrative net zero scenarios, this analysis aligns with the data shared in the Electricity Networks Strategic Framework and its analytical annex. <https://www.gov.uk/government/publications/electricity-networks-strategic-framework>

The necessary steps for delivering flexibility from EV charging

The Smart Systems and Flexibility Plan and Energy Digitalisation Strategy¹² set out the wide- and far-reaching range of actions that Government and Ofgem committed to deliver the flexibility needed for a net zero energy system. These lay the foundations that will enable consumer-scale smart technologies such as smart EV chargers and smart meters to effectively contribute to flexibility, and include:

- The introduction of a single day-ahead market for response and reserve services, and a standardised approach to buying network energy flexibility to improve the access to flexibility markets.
- Improved price signals for flexible network usage through charging reforms and preventing double charging of final consumption levies on electricity re-exported by domestic scale storage (including Vehicle-to-Grid).
- Industry implementation of increased accuracy of in-day trading across the retail market (called Market Wide Half Hourly Settlement) which will mean suppliers face accurate signals about the true cost of serving their customers throughout each day, so will be incentivised to reduce these costs, paving the way for bring more flexible energy tariffs and consumer choice.
- A smart meter policy framework to drive smart meter installations for domestic and small non-domestic consumers (smart meters enable time-of-use tariffs which reward consumers for using energy at off-peak times or when there is abundant clean energy).

The Smart Systems and Flexibility Plan, and Ofgem's 2021 publication on "Enabling the transition to electric vehicles"¹³ committed to publish a joint statement on how to maximise energy flexibility from EVs. This EV Smart Charging Action Plan describes the actions that are specific to delivering energy flexibility from EVs, and to make sure the system is ready to respond in time for the upturn in energy demand by complementing and adding detail to the previous documents.

The electric vehicle energy flexibility opportunity

Government analysis estimates there will be around 10 million EVs with zero tailpipe emissions on the roads by 2030.¹⁴ Last year, the UK Electric Vehicle Infrastructure Strategy set the vision for seamlessly integrating charging infrastructure into a smart energy system to minimise the impact on the grid and offer the lowest cost tariffs to consumers. Most vehicles are stationary for long periods of the day and

¹² BEIS/Ofgem (2021), Smart Systems and Flexibility Plan, <https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021>

¹³ <https://www.ofgem.gov.uk/sites/default/files/2021-09/Enabling%20the%20transition%20to%20electric%20vehicles%20-%20the%20regulators%20priorities%20for%20a%20green%20fair%20future.pdf>

¹⁴ <https://www.gov.uk/government/publications/uk-electric-vehicle-infrastructure-strategy>

week,¹⁵ particularly overnight. Therefore, EV drivers will be able to adjust the charging time, charging power, or share power from the vehicle battery for another use to provide financial and environmental benefits, without any effect on the consumer experience.

Flexibility from EVs is achieved by using smart charging technologies: the vehicle charging demand is managed, based on the user's preferences for the vehicle battery levels, the actual battery state of charge, and signals from the energy tariff, load control service provider or local energy management system. By matching electricity demand for EV charging to when there is cheaper, available power on the system it mitigates the need for upgrading electricity networks (the cables and other electrical equipment) and therefore minimises investment costs for the networks. Smart charging, and using EVs' energy storage potential, can also delay demand to times of abundant renewable energy, which prevents the renewable power not being used to its maximum potential or the requirement for more generation at other times and helps to reduce the carbon dioxide emissions produced by the overall electricity system.

EV power demand is expected to be the fastest growing source of energy flexibility from demand side response (DSR). The extent of future Demand Side Response from all sources is very uncertain. However, our analysis suggests that, in a scenario where Demand Side Response reduces peak demand by 15GW by 2050, this could lead to future system costs being reduced by £40-50bn (PV 2021-2050, 2020 prices). These estimates are broadly in line with that in the Smart Systems and Flexibility plan, which estimates flexibility from all sources could reduce system costs by £30-70bn by 2050 (PV 2020-2050, 2012 prices).¹⁶

Smart charging can also offer other grid services, to improve power security and stability, potentially avoiding the need for other auxiliary infrastructure. Together, these cost savings for the energy system as a whole will translate into savings on all electricity consumer bills. The EV driver will be rewarded for providing the energy flexibility through bill savings or other incentives.¹⁷ Energy flexibility from EVs is an efficient use of the battery capability and material resources; extending its usefulness from its prime use as transportation power, to provide further benefits when the vehicle is parked up.

Smart charging is connected, automated, intelligent control

Smart charging is a convenient way for EV owners to contribute to a flexible energy system. For most drivers smart charging involves using the settings on their home charge point to schedule charging to happen overnight or other times when prices are cheaper. From July 2022, new home and workplace charge points were required to be automatically set with an overnight schedule as the default, to help make it even easier to do this, and to make sure that EVs play their role in delivering benefits for all. Of course, drivers have the option to change these settings: charge points will also allow the consumer to 'boost' by overriding their settings and charging their cars immediately when they need to. Some EVs

¹⁵ According to the RAC, the average domestic car is in use for only 4% of its time. RAC Foundation Motoring FAQs, <https://racfoundation.org/motoring-faqs/mobility#a5>

¹⁶ <https://www.gov.uk/government/publications/electricity-networks-strategic-framework>

¹⁷ The Flexibly-Responsive Energy Delivery innovation project estimates an average saving of £110 per customer per year. Savings were generated by using half hourly settlement and providing balancing and flexibility services. The estimate doesn't include the benefits that some customers already received for smart charging with a dual level time of use tariff. <https://evergreensmartpower.co.uk/domestic-dsr-fred-trial/>

allow the driver to set smart charging preferences through the in-vehicle interface or the EV brand's app.

In a home or business setting, the economic savings can be realised by syncing charging times to the cheaper periods of a flexible energy tariff. Charge point operators or Demand Side Response service providers might offer alternative financial or other rewards based on the vehicle charging times. Sometimes this could come in the form of messages about short-lived offers, so there might be the option to hop onto some finite period low prices at short notice. In future we expect that these options will increasingly be available at long stay public parking.

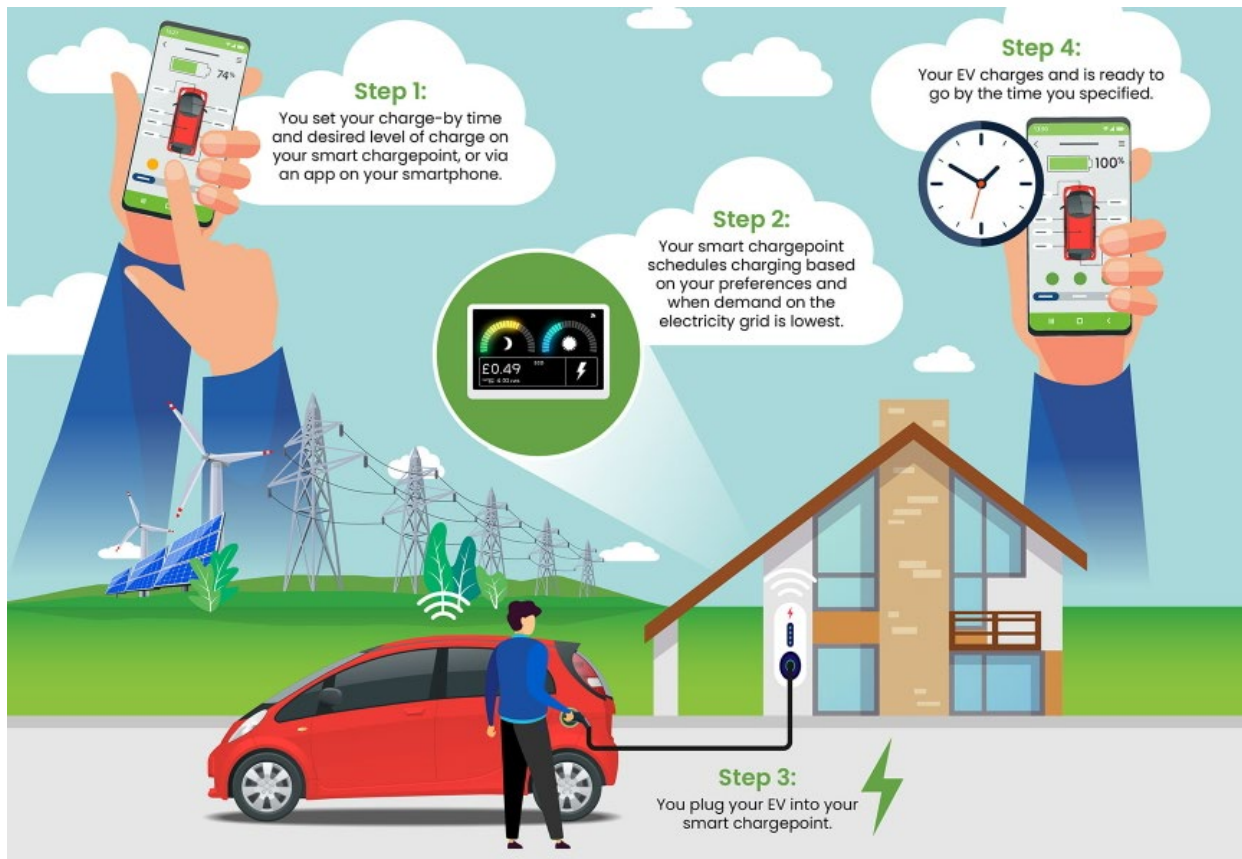


Figure 4: How to smart charge (reproduced with permission from Energy Savings Trust)

Today, the vast majority of smart charging products control the timing and rate of charging in one direction only. In the future, more Vehicle-to-X technologies will be available to consumers to offer bidirectional control to also enable discharging of the battery and export of energy to, for example, a home, a building or the grid (Vehicle-to-Home/Building/Grid). Essentially the vehicle battery will be a form of distributed energy storage, and this deeper integration has potential for significantly increased flexibility and associated energy system benefits – while smart charging enables just an EV's charging to the required capacity to be load-shifted, V2X can enable potentially multiple cycles of charging and discharging during a given stationary period.

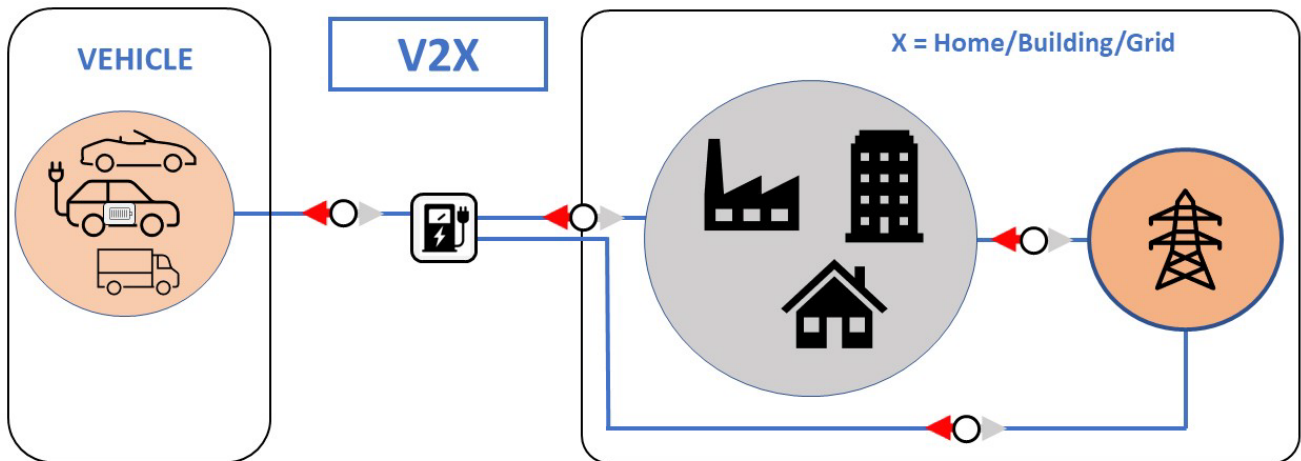


Figure 5: The bidirectional charge point controls the timing, rate of charge and direction of electricity flow between the vehicle and the home, building or grid. The bidirectional charging control could also be on-board the vehicle.

Vehicle-to-X energy technologies can reduce a consumer’s energy bills by providing energy for use in the home or business premises, optimising time-of-use tariffs to make the most effective use of cheaper off-peak electricity, and can generate revenue from exporting electricity, or providing services, to the grid. V2X can also help optimise the use of on-site renewables, enable appliances to be powered by an EV, and provide energy resilience through back-up power to buildings or sites. The potential scale of flexibility that could be provided by V2X energy is discussed in Chapter 3.

Government, Ofgem and industry all have a role to play to deliver the energy flexibility from EV charging.

The role of industry: Industry have a crucial role in delivering the cost-effective integration of EVs into the energy system. The EV Energy Taskforce¹⁸ was set up to bring together energy and transport stakeholders to address the challenges for the transition and has served as a trusted expert group, facilitating joint industry positions. Government plans to continue to build on these successes and evolve the Taskforce as the EV and charging markets develop.

Transparent, competitive markets will deliver the innovation, diversity of offer and keen pricing to serve all types of consumers. The manufacturers, service providers and consumer organisations will also be front and centre of the engagement and consumer experience of smart charging. The UK is in a strong position to create economic value from smart charging. UK companies offering smart charging goods and services are competing effectively in Europe and beyond.

The role of Government: Government will monitor uptake and intervene where necessary to ensure that consumers and the grid are protected from harm. Interventions will include standards to facilitate an effective market (for example for interoperability of demand side response, data security, data privacy or grid stability) and innovation investment (for example, access to smart charging infrastructure). Where appropriate, regulation will be developed across all types of energy flexibility products and will focus on desired outcomes, rather than detailed methods of implementation. Regulations specific to EV smart charging may still be necessary, for example because its transition is ahead of other load control technologies, or because of functionality unique to EV charging.

The role of Ofgem: The energy regulator has a vital role, along with Government, to protect energy consumers' interests and deliver decarbonisation at lowest cost. Specifically, Ofgem has a critical role in regulating the construction and operation of network infrastructure, ensuring the effective functioning of the wholesale and retail energy markets including setting out the regimes for distributing network costs between users.

Ofgem will take the lead for actions related to network operators and electricity supply. They will ensure that consumers can get smart charging technologies connected to the grid, no matter where they live in Great Britain. The regulator can also help to enable products and services that facilitate EV flexibility by improving pricing signals (supply, usage and balancing), plus the market mechanisms to enable participation and support energy flexibility.

¹⁸ EV Energy Taskforce, <https://evenergytaskforce.com/>

Chapter 2: Making smart charging the affordable, convenient choice for EV drivers

Our vision for Consumers

EV drivers have trust and confidence in the smart charging services and market. They are sufficiently incentivised, motivated, protected and enabled to use smart charging.

EV charging will encourage more consumers to consider time-of-use and other flexible tariffs and smart meters which enable these tariffs.

EV drivers and businesses have choice in the smart charging market and can find the best goods and services for their needs.

Habitual smart charging is the norm at charging locations where cars and vans can be parked for long periods of time.

The transition to EV smart charging meets the needs of the diverse consumer base.

Widespread EV smart charging delivers lower electricity unit prices.

Smart charging is a positive consumer experience.

Key commitments

Government, with Ofgem, will work with industry to improve smart charging information provision to customers from 2023.

Government and Ofgem will build a shared evidence base of how the different levels of smart charging uptake will reduce electricity unit costs and use this evidence to inform policy from 2023.

Government will support industry to implement voluntary EV energy consumer service code of best practice in 2024 and monitor its uptake by 2025.



© EV-velocity project

Consumer awareness and potential barriers to smart charging

Government and Ofgem have conducted social research and worked with the EV Energy Taskforce to understand the opportunities and challenges EV drivers could experience from using smart charging routinely. These insights are being used to bring smart charging benefits to all EV drivers by considering the factors necessary for effective behaviour change:¹⁹ capability (providing information and making technology easy to use), opportunity (making smart charging available), and motivation (incentives). Smart charging policy interventions that go with the grain of human behaviour are likely to have greatest impact, to ensure optimum energy system efficiency delivering a low-cost system which benefits all consumers.

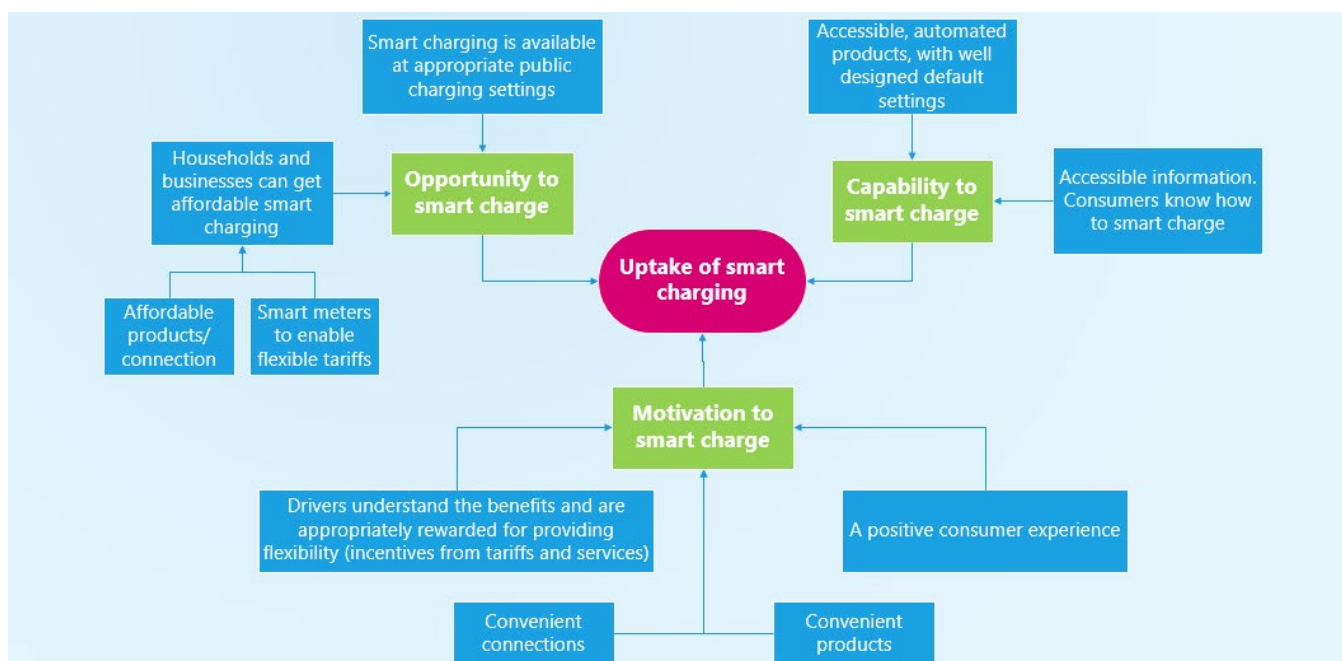


Figure 6: Policy analysis considers what needs to be in place (blue boxes) to address the potential opportunities or barriers to EV drivers enjoying the benefits of smart charging.

Engaging and incentivising EV drivers to smart charge (Capability and Motivation)

The simplest way of building knowledge, skills and confidence is through information provision. Whilst there is a growing body of EV charging information and advice available for consumers, feedback suggests that there are still some gaps. Government will support cross-industry collaboration to agree how independent smart charging information could be deployed in the places where consumers are already receiving or looking for information for convenience. Smart charging information provision could be part of a 'charging confidence' theme, to cover the benefits and address consumer concerns for home, workplace, or public charging. This also addresses the fact that the phrase 'smart charging' is not widely understood by EV drivers.

¹⁹ Michie et al (2011). <https://implementationscience.biomedcentral.com/articles/10.1186/1748-5908-6-42>

Government, with Ofgem, will work with industry to improve smart charging information provision to customers from 2023.



Figure 7: A smart meter being installed

In 2021, the government worked with the Energy Savings Trust to develop an EV smart charging advice webpage, primarily aimed at domestic consumers,²⁰ to test feedback on smart charging advice provision. The Energy Savings Trust smart charging advice explains the benefits of smart meters for EV smart charging. Smart meters can provide half hourly data to accurately log when electricity consumption or export has occurred which enables time-of-use tariffs to financially reward EV owners for charging their cars when energy demand is low or when there is abundant renewable energy on the grid. By providing energy consumption and cost information, smart meters also improve consumers' engagement with their energy use.

Government will continue to work with stakeholders to raise awareness that smart meters enable time-of-use tariffs.

Information provision is not enough; to feel motivated to smart charge, EV drivers must feel it is worthwhile. Consumer organisations, (for example Citizens Advice, Which, Money Saving Expert) and third-party services such as price comparison or switching services are well placed to help consumers navigate to the goods, services and tariffs for their needs. According to Cornwall Insight's market metrics there were 22 EV specific tariffs available in October 2021,²¹ however only a small number are currently accepting new customers. A recent smart charging survey by DG Cities reported that around a third of EV drivers are currently on a time-of-use tariff.²² Figure 8 gives high level estimates of potential savings on household electricity bills for some illustrative EV driver scenarios.

The number of specialist EV time-of-use tariffs has reduced as energy suppliers face unprecedented business pressures from high wholesale-gas prices. They are usually still the best deal for EV drivers who charge overnight, but consumers need to take into account the standing charges and higher peak time costs to work out what is best for them. Energy suppliers will explain the overall costs when the consumer is selecting a tariff. We remain confident that in the longer-term, the uptake of EVs should increase the popularity of these offerings. The continued roll out of smart meters, and implementation of Market Wide Half Hourly Settlement (increased accuracy of supplier energy settlement) will also enable

²⁰ Energy Savings Trust, <https://energysavingtrust.org.uk/advice/smart-charging-electric-vehicles/>

²¹ EV Market Metrics, Cornwall Insight, October 2022

²² <https://www.gov.uk/government/publications/electric-vehicle-smart-chargepoint-survey-2022>

the growth of smart tariffs and flexibility products more generally. Some independent price comparison sites with a focus on EVs²³ have entered the market.

Government with Ofgem will continue to review the provision of independent smart charging advice, to understand whether there are still gaps not met by the Energy Savings Trust advice and other parts of industry.



Michael - Retired, uses their car for local journeys and drives 4,400 miles per year. Only charges once per week, plugging-in at 16:00 and unplugging the next morning at 10:00.

In today's market, they may not save any money on their household electricity bill if they switched to an EV tariff



Lauren - a commuter, uses their car to travel to and from work every weekday. Total mileage is 18,400 miles per year and charges every day when they get home from work at 18:30 and unplugs at 06:30 when they leave for work

They could save £900 - £1,000 per year on their household electricity bill by smart charging



Paul - Home worker, uses their car mainly in the evenings during the week. Total mileage is 7,400. Charges twice per week.

They could save up around £100 - £200 per year on their household electricity bill by smart charging

Figure 8: High level estimates of potential savings on household electricity bill, comparing a standard and an off-peak energy domestic tariffs for illustrative EV driver scenarios.²⁴

Today, almost 70% of EV drivers surveyed had a dedicated charge point at home, most with some degree of smartness,²⁵ and it will be important to maintain those high levels of take up as the number of EV drivers increases. Many of today's EV owners can be categorised as 'early adopters' and may be willing to spend more time learning about, choosing, and setting up new products than future consumers. The appeal of EVs is widening rapidly, with one in six of all new vehicles sold in the UK in 2022 being a plug-in electric vehicle.²⁶ Clear financial rewards and convenience must be sufficient for

²³ For example; <https://rightcharge.co.uk/>; <https://lovemyev.com/find-the-right-tariff> ; <https://www.zap-map.com/charge-points/ev-energy-tariffs/> ; <https://www.moneysavingexpert.com/utilities/ev-energy-tariffs/>

²⁴ Assuming a 50kWh battery and 7kW charge point. All savings to the nearest £50 and are sensitive to location and payment type. Smart charging estimates based upon two different EV tariffs – EDF GoElectric35 (Peak: 52p/kWh, Off-peak: 4.5p/kWh) and Octopus Go (Peak: 43p/kWh, Off-peak: 12p/kWh). All non-EV demand (3,100kWh) consumed outside of the off-peak window. Energy Price Guarantee used as comparator (Flat-rate: 34p/kWh). All prices accurate as of November 2022.

²⁵ <https://www.gov.uk/government/publications/electric-vehicle-smart-chargepoint-survey-2022>

²⁶ [Vehicle Licensing Statistics: January to September 2022](#), Table 1153

mass market uptake. Other incentives, such as promoting the green electricity powering the vehicle could motivate some EV owners.

Automation of the flexibility optimisation and bundling of services or benefits increases the convenience of smart charging, and this could be a useful motivator. However, consumers will need to have trust in the automated charging control being managed by a third party to always have the vehicle battery ready when they need it, at lowest cost to the consumer. For charge point owners that do not want to choose their own settings, since July 2022 new charge points will be sold with factory default settings to avoid the peak hours of electricity demand.

Government and Ofgem will support industry to build the consumer behaviour understanding to be able to incentivise the off-peak and flexible charging by 2025.

There was encouraging evidence from a three-year vehicle charging behaviour trial in 2018 that explored how mainstream consumers (i.e., not early adopters) responded to time-of-use tariffs.²⁷ From interviewing them about their patterns of work and home life, the trial showed their usual charging time would overlap with peak demand periods (4-7pm) unless they were incentivised away from these times. However, the study found that 95% of drivers on the battery EV trial chose smart charging over simply plugging in and charging straight away even if the saving was relatively low.

Access to smart charging benefits (Opportunity)

Today, most smart charging is done at home using a dedicated smart charge point, although in future more vehicles might enable on-board charging control. EV owners living in accommodation without off-street parking will predominantly rely on workplace or public smart charging options and lower income consumers will be over-represented in the group who do not have access to off-street parking. Even for those consumers who do have access to off-street parking, some potential smart charging users face non-financial issues with installing a charge point such as undertaking necessary works to the property or requiring permission from third parties. For example, tenants may have more limited autonomy over decisions around energy providers and building improvements.

Last year the Government reformed the EV chargepoint grant²⁸ (replacing the Electric Vehicle Homecharge Scheme) to focus support on people who rent or live in flats, recognising that they may face more barriers to installing charge points.²⁹ Applicants can choose a charge point from the approved list of models, which all have smart functionality.

To help remove barriers for consumers who may otherwise struggle to participate in the smart energy system, the Government will consider supporting the development and testing of

²⁷ Consumers Vehicles and Energy Integration CEVI <https://es.catapult.org.uk/news/pioneering-electric-vehicle-study-shows-up-to-95-of-consumers-happy-to-use-smart-charging/>

²⁸ <https://www.gov.uk/government/collections/government-grants-for-low-emission-vehicles#ev-chargepoint-grant>

²⁹ The reforms will also permit landlords and building owners (or their representatives) to apply for grants to help install charge points and additionally apply to Government for grants of up to £30,000 to help provision the car parks of residential apartment blocks. To help fund this grant, the support for owner-occupiers of single unit housing was withdrawn.

innovative, smart energy products and services to support low-income and vulnerable consumers transition to a smart energy system.

The transition to EVs will require investment in the energy system, notably in electricity generation and network infrastructure to meet additional electricity demand. Government analysis indicates that, despite an increase in the total investment cost, the increase in demand from EVs means that costs are spread across significantly more units of electricity. As a result, the cost of electricity per MWh of electricity consumed (“unit costs”) could fall in real terms towards 2050.³⁰ Shifting demand through smart charging will lead to a more efficient use of networks and generation capacity, which is expected to further reduce the electricity unit cost predictions in that period.

A reduction in unit costs will benefit all electricity customers. The final cost they pay, however, will depend on their level and pattern of electricity consumption as well as their chosen tariff which will vary across households. For households where their overall electricity consumption remains at similar levels in future, such as non-EV owners, this could lead to a reduction in their annual electricity bills in real terms.

EV owners’ household electricity bills will increase if they are predominantly charging at home. This should be considered relative to savings from not having to buy petrol or diesel road fuel, however, which would be expected to outweigh this increase. Costs can also be reduced by smart charging which enables EV drivers to access cheaper rates. This analysis considers the impact of EV charging specifically and does not consider any further changes in future government policy or household consumption which will influence total expenditure. More detailed modelling analysis is required to better understand the potential impact of the different possible levels of EV smart charging on different types of consumers. This will include estimating how potential retail tariff structures will reflect the fixed costs in future wholesale market and network usage charges, which influences the potential savings between different types of energy usage.

Government and Ofgem will build a shared evidence base of how the different levels of smart charging take up, including bidirectional V2X energy will reduce electricity unit costs and use this evidence to inform policy from 2023.

Delivering a good consumer experience for smart charging (Motivation)

To deliver the potential of EV energy flexibility, consumers need to have trust and confidence in smart charging goods and services, to promote their continued uptake and use. If consumers find smart charging easy to set-up and receive good customer service across the entire user journey, they are more likely to habitually smart charge.

³⁰ This high-level analysis illustrates the impact smart charging EVs could have on the average unit price of electricity, relative to a baseline where there are no EVs on the system. The details and bill impacts depend on assumptions as to the role of the standing charge, as well as how network costs rise with demand and how benefits and costs of the demand side flexibility are shared across consumers in the future.

Presently, the number of EV smart charging complaints received by consumer organisations is relatively small. While it is encouraging that few consumers are making complaints today, Government will work with industry to monitor how things develop, to ensure that complaint numbers remain low with increasing EV ownership. This is to ensure smart charging offers the best consumer experience.

Consumer group feedback from today's limited complaints identifies the potential customer service issues around understanding the contract and effective complaint handling. The increase in bundled EV charging products such as a home charger with an EV purchase, a bundle of home and public charging services, a bundle with other products such as solar panels or perhaps in the future the provision of a home charger with an EV supply tariff could cause confusion for consumers to know where to turn for help. Consumers could find themselves being transferred between businesses and consumer bodies adding further frustration and delay before the issue is resolved. Product bundling can also make it more difficult for consumers to compare products on a like for like basis.

Additionally, consumer groups have suggested that there is a potential disparity in the ability to get redress between the regulated energy suppliers and the businesses that install private charge points or provide the load control services. In the latter case, energy supply and Demand Side Response, are different types of business to each other, but the distinctions may be blurred to consumers.

With the aim of embedding consistent complaint handling for the evolving charging market, the EV Energy Taskforce proposed to develop a cross industry agreed position for consumer complaints handling voluntary code of best practice that will apply across public and private charging. Government fully supports this proposal and will continue to work with industry to gather evidence on existing or emerging areas of harm. The EV Energy Taskforce will monitor their usage in the market, providing more evidence on whether there are certain areas of the smart charging experience, or types of organisations that fall below the industry standards, and this could inform future policy interventions.

Government will support industry to implement voluntary EV energy consumer service code of best practice in 2024 and monitor its uptake.

Government will continue to review the options for strengthening consumer protections for EV charging in private and public settings and what a proportionate regulatory approach would be. Further action now when there is insufficient evidence on consumer issues could result in disproportionate financial and administrative burden, that might particularly impact charging business start ups and curtail innovative solutions for consumers from emerging.

Summary of the vision and actions associated with Consumers

Vision	Actions
EV drivers have trust and confidence in the smart charging services and market. They are sufficiently incentivised, motivated, protected and enabled to use smart charging.	Government, with Ofgem, will work with industry to improve smart charging information provision to customers from 2023.
EV charging will encourage more consumers to consider time-of-use and other flexible tariffs and smart meters which enable these tariffs.	Government will work with stakeholders to raise awareness that smart meters enable time-of-use tariffs.
EV drivers and businesses have choice in the smart charging market and can find the best goods and services for their needs.	Government will continue to review the provision of independent smart charging advice to understand whether there are still gaps not met by the Energy Savings Trust advice and other parts of industry by 2024.
Habitual smart charging is the norm at charging locations where cars and vans can be parked for long periods of time.	Government and Ofgem will support industry to build the consumer behaviour understanding to be able to incentivise off peak charging by 2025.
The transition to EV smart charging meets the needs of the diverse consumer base.	To help remove barriers for consumers who may otherwise struggle to participate in the smart energy system, the Government will consider supporting the development and testing of innovative, smart energy products and services to support low-income and vulnerable consumers transition to a smart energy system.
Widespread EV smart charging delivers lower electricity unit prices.	Government and Ofgem will build a shared evidence base of how the different levels of smart charging take up will reduce electricity unit costs and use this evidence to inform policy by 2023.
Smart charging is a positive consumer experience.	Government will support industry to implement voluntary EV energy consumer service voluntary code of best practice in 2024 and monitor its uptake.

Chapter 3: Providing the right business landscape for EV smart charging products

Our vision for smart charging technology

The smart energy system meets the objectives of cyber security, grid stability, interoperability and data privacy.

Smart charging is the leading technology exemplar for energy system digitalisation.

Smart charging becomes widespread across the market, with the initial focus on private settings (home and workplace) where parking times will be longer.

There are successful UK smart charging and related businesses, which continue to innovate and develop goods and services (including Vehicle-to-X energy) that are attractive for different consumer groups and that promote the use of flexible tariffs and demand side response products.

Bidirectional Vehicle-to-X energy reaches commercial deployment.

Key commitments

Government will ensure all EV private charge points are secure and interoperable with Demand Side Response (DSR) service providers, enabling consumers to access the full range of smart tariffs and DSR services with confidence.

Government will investigate the technical and economic potential of public smart charging and address the barriers to smart charging at all long duration public charging settings.

Government will deliver the Vehicle-to-X innovation programme to address barriers to wide-scale deployment specific to this technology by 2025.



Regulating smart charge points at domestic and workplace settings

Charging at private charge points (in the home and at workplaces) accounts for the majority of the projected future energy demand for EVs. Around 70% of households with a vehicle in England currently have access to private, off-street parking.³¹ Charging events at private charge points are likely to be of long duration, and thus particularly suited to demand shifting.

A significant milestone for enabling energy flexibility from EVs was the Electric Vehicles (Smart Charge Points) Regulations,³² made into law in December 2021. The regulations mandate that, as of 30 June 2022,³³ all charge points sold for charging cars and small vans in private (domestic and workplace) settings in Great Britain must have smart capability and have a default off-peak schedule. The regulations also mitigate risks associated with making charge points smart and connected, by mandating minimum requirements for device-level cyber security and measures to provide grid stability and interoperability of energy supply. High power 'rapid' chargers (>50kW) are exempt from the regulations because the shorter charging times are less suited to energy flexibility. The Office for Product Safety and Standards (the national regulator for consumer products) will enforce the regulations and will take a collaborative and proportionate approach to bringing industry into compliance.³⁴

In November 2021, Government announced the requirement for new buildings, and those undergoing major renovation, with associated parking in England and Wales to have an EV charge point installed, which also enables the opportunity for many more consumers to access EV smart charging.³⁵

The Electric Vehicles (Smart Charge Points) Regulations set a firm direction for EV charge point manufacturers, load control service providers, and the wider smart appliance market, to encourage development of further smart capabilities of their devices and services in the future. In January 2022 Government commissioned a survey to better understand public attitudes and perceptions towards smart charging technologies,³⁶ as well as their access to and use of them, ahead of enforcement of the regulations beginning in June 2022.

The survey is designed to act as a baseline to support the rollout of forthcoming regulations. It is anticipated that over the course of several phases of regulation, surveys will provide insights as to their impact and effectiveness; this survey provides a baseline against which we can measure the impact and changes in the EV driver population. Government will also monitor the development of time-of-use tariffs, including those marketed for EV drivers, and the uptake of these tariffs by consumers.

³¹ Department for Transport (2021). National Travel Survey Table NTS0908: Where vehicle parked overnight by Rural-Urban Classification of residence. Available at: <https://www.gov.uk/government/statistics/national-travel-survey-2020>

³² <https://www.legislation.gov.uk/ukxi/2021/1467/contents/made>

³³ Apart from the security requirements in Schedule 1 of the regulations, which came into force on 30 December 2022.

³⁴ <https://www.gov.uk/guidance/regulations-electric-vehicle-smart-charge-points>

³⁵ <https://www.gov.uk/government/news/pm-to-announce-electric-vehicle-revolution>

³⁶ <https://www.gov.uk/government/publications/electric-vehicle-smart-chargepoint-survey-2022>

Government will monitor and evaluate the impact of the Electric Vehicles (Smart Charge Points) Regulations, and the market evolution. Interim impact evaluations findings are expected by 2025, and the final impact evaluation by 2027.

Market wide regulation for demand side response

Building on the Electric Vehicles (Smart Charge Points) Regulations, Government consulted³⁷ on the overarching regulatory framework for technologies and services that will enable flexibility to be facilitated from consumers, setting out proposals for minimum standards to apply to the broad range of energy smart appliances, including private EV charge points and heat pumps, as well as how a licensing regime can mitigate risks. This consultation includes further device-level requirements for smart appliances that would therefore apply to private EV charge points (including Vehicle-to-X bidirectional charge points). The requirements cover cyber security, grid stability, data security and data privacy, as well as requirements to be interoperable with Demand Side Response service providers, and obligations on energy suppliers to provide tariff information in a consistent format.

The consultation also sets out proposals for organisations providing Demand Side Response (also known as aggregators or Flexibility Service Providers) to domestic and small non-domestic consumers to be licensed and regulated by Ofgem, underpinned by the principles of achieving interoperability, data privacy, grid stability, cyber security and consumer protection. The aim is to ensure that Government enables the growth of devices with smart functionality and the flexibility that can be facilitated from them, whilst ensuring both the energy system and consumers are protected, increasing confidence and trust in third-party managed flexibility.

Most EV charge point operators will be providing some form of DSR, so will be in scope of the proposed licence regulation, including in scope of the National Cyber Security Centre's Network and Information Systems Regulations. The interoperability proposals, at a device level and for organisations, will ensure consumers aren't unfairly 'locked-in' if their preferences or circumstances change, or 'locked-out' from certain services or tariffs.

Government will ensure all EV private charge points are secure and interoperable with Demand Side Response (DSR) service providers, enabling consumers to access the full range of smart tariffs and DSR services with confidence.

Today, most smart charging is done at home using a dedicated smart charge point, although in future more vehicles might enable on-board charging control for drivers. Longer term, Government will consider the role of on-board smart charging in relation to the energy system, and whether regulatory approaches to deliver interoperable solutions, similar to those being considered for smart charging more broadly, should apply.

³⁷ <https://www.gov.uk/government/consultations/delivering-a-smart-and-secure-electricity-system-the-interoperability-and-cyber-security-of-energy-smart-appliances-and-remote-load-control>

Whilst existing approaches to accessing time-of-use tariff data may be sufficient for simple tariffs, they are unlikely to be suitable for more complex tariffs expected in the future. The Government's proposals in the consultation for common data standards for time-of-use tariff information, and common ways to access this data, would make it easier for smart appliances to use this data for Demand Side Response, and enable an improved consumer experience of time-of-use tariffs. In turn, this should help promote their uptake, benefitting consumers.

Government proposes³⁸ to introduce a licence condition on energy suppliers to make the information about the tariffs they offer available in a consistent format

Facilitating smart charging at public charging locations

There are some types of public charge point setting where vehicles will be parked for longer stays, for example on-street, destination or transport hubs, where demand shifting may be particularly beneficial. Smart charging may also offer some opportunities for shorter duration charging events – for example, capitalising on very brief spikes of negative energy pricing, or the ability to be aggregated to provide grid services. Therefore, Government will investigate the technical and economic potential of public smart charging, as well as industry and consumer views. Government will particularly seek to address any barriers to smart charging at all long duration public charging settings.

Government will investigate the technical and economic potential of public smart charging and address the barriers to smart charging at all long duration public charging settings.

Bidirectional charging control (Vehicle-to-X energy) offers more benefits to consumers and the energy system

In future, more Vehicle-to-X (V2X) energy technologies will become available to consumers offering bidirectional control. This will enable discharging of the vehicle battery and export of energy to, for example, a home, a building, or the grid (Vehicle-to-Home/Building/Grid). Forecasting V2X capacity is challenging as it is highly dependent on technology, energy system development, and consumer behaviour. However, there is clearly a significant technical potential from using EV batteries which could provide an estimated 1500GWh of storage capacity by 2035.³⁹

It is estimated that if every battery electric vehicle with domestic off-street parking across GB was capable of exporting power it could provide a potential capacity of 60GW in 2035 (for context, peak

³⁸<https://www.gov.uk/government/consultations/delivering-a-smart-and-secure-electricity-system-the-interopability-and-cyber-security-of-energy-smart-appliances-and-remote-load-control> . This action is subject to the outcomes of the consultation

³⁹ Total battery storage capacity (1500GWh) has been calculated by multiplying the number of battery EVs (cars and vans) by the average battery capacity.

demand in 2035 is expected to rise to approximately 90-105GW).⁴⁰ In reality, it is unlikely that the full technical potential will be realised – for example not all vehicles are likely to be discharging at the same time. We will undertake further analysis to understand the realistic potential capacity for V2X. Government and Ofgem will seek to unlock the huge potential of Vehicle-to-X bidirectional charging. We will assess our activities' impact and identify priority actions for enabling deployment of V2X.

- By 2025, innovation projects and scaling up of the technology will have reduced barriers to entry for consumers and Vehicle-to-X will become more commercially viable, with increasing amounts of compatible vehicles, increasingly affordable charge points, and appropriate tariffs and business models providing revenue opportunities to consumers. Vehicle-to-Home/Vehicle-to-Building technology will be an attractive prospect with 'behind the meter' energy optimisation and time-of-use tariffs. Vehicle-to-Grid will increasingly compete in the markets and services of the energy system.
- By 2035, all new cars and vans will be zero emissions at the tailpipe and a significant proportion of these are expected to be V2X-capable. In a zero-carbon power system, these vehicles will be providing significant amounts of bidirectional flexibility behind-the-meter, and at local and national levels. Domestic and business consumers participating in V2X will plug in every time they are parked at suitable locations, allowing their car battery to discharge, saving on their energy bills, and potentially earning money, while helping to decarbonise the energy system. The car battery will also charge at optimal times during the parked period, enabling the driver to return to their vehicle and begin their next journey with the required charge, while also protecting the battery life.

There are trials worldwide, but Vehicle-to-X energy technology is not yet at wide-scale deployment. From 2018 to 2022, Government provided £21m of funding, through an Innovate UK competition, to twenty Vehicle-to-Grid projects, including the Sciurus project highlighted on the next page.⁴¹ The wide-ranging projects covered feasibility studies, collaborative R&D and real-world demonstrators with fleets of vans and buses as well as private car users. The programme positioned the UK as a world-leader in this field, including having the largest demonstration of Vehicle-to-Grid in homes. The achievements included: engaging real consumers with the technology; helping pioneer new Vehicle-to-Grid tariffs and new aggregation business models; and developing new, lower cost bidirectional charge points. Despite these achievements, the programme highlighted that barriers still remain to wider deployment of

⁴⁰ Total V2X generation capacity (60GW) represents the maximum power that can be provided to the system and has been calculated by estimating the number of battery EVs plugged-in at one time and available to provide V2X services. The availability of EVs is averaged across the day and does not represent availability at any specific hour (e.g. the evening peak). As such, the estimated V2X capacity should not be compared to peak demand. All EVs with access to off-street parking are assumed to have a V2G charge point and are able to discharge 100% of their battery. The analysis considers battery electric cars and vans and assumes domestic charging only. Fleet size has been forecast by applying ownership trends from the National Trip End Model (NTEM) v7.2 (<https://www.data.gov.uk/dataset/11bc7aaf-ddf6-4133-a91d-84e6f20a663e/national-trip-end-model-ntem>) to Vehicle Licensing Statistics (<https://www.gov.uk/government/collections/vehicles-statistics>). The number of battery EVs has been calculated using an ambitious EV deployment trajectory consistent with delivering the ambition of phasing out petrol and diesel cars and vans by 2030 and only allowing the sale of zero emission cars and vans by 2035. These forecasts do not include assumptions about Covid recovery, or future changes in travel behaviour (e.g. shared mobility, autonomous vehicles). While zero emission vehicle uptake is assumed to be battery electric in the short-term, future demand for zero emission vehicles could include hydrogen vehicles. Plug-in hybrid EVs (PHEVs) are not included.

⁴¹ <https://www.gov.uk/government/news/30-million-investment-in-revolutionary-v2g-technologies>

Vehicle-to-X charging, including the cost of the bidirectional charge points on the market today, a limited range of compatible vehicles, and a lack of revenue certainty for a wide range of consumers.

Case Study:

Sciurus Vehicle-to-Grid trial

A two-year Government-funded project called [Sciurus](#) enlisted 320 Nissan Leaf EV owners across the UK who received Indra V2G charge points to enable their cars to use two-way charging linked to their home energy supply. They saved 30 tonnes of carbon between them in 2020 by charging their EVs at cheaper, lower carbon times and exporting electricity back into the grid at peak. This saved the average V2G customer £420 on their annual electricity bills with the OVO tariff, which pays them for their V2G exports.



The Sciurus partners discovered that EV batteries could add significant resilience to the energy system. At Least 36% of cars were plugged in at any given time and at the 4.30pm start of peak demand, nearly half of the Sciurus fleet were exporting back to the grid. One example of the valuable services provided to the grid occurred in Lincolnshire, where V2G chargers responded to support the local electricity network 12 times during a colder-than-usual month in May 2020.

Market views on bidirectional charging

In July 2021, BEIS published a [Call for Evidence](#), seeking views on the potential role of V2X, and the barriers preventing this.⁴² The Call for Evidence received 50 responses from across the transport and energy sectors. A full summary of responses is published alongside this document, as well as more detailed discussion of expectations, actions and next steps regarding specific barriers. Some key conclusions and how they will be taken forward are covered in the table below:

⁴² <https://www.gov.uk/government/consultations/role-of-vehicle-to-x-technologies-in-a-net-zero-energy-system-call-for-evidence>

Key points from Call for Evidence	Response measures
<p>V2X can offer a significant source of flexibility, particularly behind-the-meter in the nearer term.</p>	<p>Continued monitoring and appraisal of the V2X bidirectional charging market, support through innovation funding, and including V2X charging in scope of further charge point or storage regulation where appropriate.</p>
<p>Enabling factors will help facilitate growth of V2X over the coming years.</p>	<p>Monitor the development of standards, the compatible EVs and market suitability. Engage with key stakeholders (e.g. EV manufacturers) to encourage V2X developments in these areas, and assess the need for specific intervention.</p>
<p>Key barriers include cost of V2X systems and lack of V2X compatible vehicles, and uncertain viability of business cases for wide variety of consumers.</p> <p>Innovation can help to facilitate new V2X technologies and business models, to address these barriers.</p>	<p>BEIS-funded (up to £12.6m) innovation programme to tackle key barriers, with continued monitoring of these key barriers and assessment of the need for further intervention.</p>
<p>Key energy system barriers highlighted included the connection process for bidirectional charge points, and the need for V2X to compete equally with other sources of aggregated small-scale flexibility in markets that appropriately value flexibility.</p>	<p>Work through the Energy Networks Association and distribution network operators, to develop a consistent connection process for V2X across all regions (discussed in the following chapter).</p> <p>Taking forward the actions in the Smart Systems and Flexibility Plan to develop markets appropriate for flexibility.</p> <p>Supporting innovation to pioneer new flexibility provision from V2X, monitoring the growth of V2X in flexibility markets, and using this to inform future policy.</p>
<p>Consumers need to be reassured that they will ultimately be in control of their charging behaviour, and that there are no significant impacts on battery life.</p>	<p>Considering consumer attitudes to V2X by gathering views from innovation project participants.</p> <p>Encouraging research, innovation and dissemination on V2X as a tool to promote battery performance.</p> <p>Monitoring the need for increasing engagement as V2X becomes more mainstream.</p>

Innovation is still needed to make V2X charging a commercial reality

The V2G project experiences and the Call for Evidence feedback underlined that further innovation is essential to address many of the barriers to commercial deployment. A new up to £12.6m innovation programme was therefore launched in March 2022.⁴³ This programme is one part of the Flexibility Innovation Programme, part of the £1bn Net Zero Innovation Portfolio.⁴⁴

Government will deliver the Vehicle-to-X Innovation Programme to address barriers to wide-scale deployment specific to this technology by 2025, part of the £1 billion Net Zero Innovation Portfolio.

The innovation programme has been designed to directly address key deployment barriers, to help accelerate commercialisation of V2X and increase its attractiveness to consumers. It aims to lower the cost of V2X charge points and incentivise an increase in the number of V2X-capable vehicles. It is expected that the innovation support will increase the number of energy suppliers, consumers and other market actors engaged in V2X, by providing the opportunity to test technologies and business models. The innovation programme will run in two phases: initial prototyping/development, followed by anticipated small-scale demonstrations, from September 2022 to March 2025. Phase 1 of the up to £12.6m V2X Innovation Programme, subject to due diligence and grant agreement, expects to support 17 successful projects with over £3.2m in innovation funding to develop prototype innovative hardware, software and business model based V2X solutions.

Government will continue to monitor the growing V2X market and expected uptake in deployment where vehicles are likely to be parked for extended periods, such as homes, return-to-depot fleets, workplaces, and long duration public charging, and will use this insight to consider next steps on V2X - for example, the range of V2X energy goods and services, bidirectional capable vehicles, product pricing, and consumer attitudes.

Government and Ofgem will continue to identify, monitor and address key barriers to unlock the huge potential of the commercial deployment of Vehicle-to-X energy technologies.

While innovation projects and regulation can help address some barriers to V2X, Government and Ofgem are conscious there are wider energy system barriers to its deployment, which are discussed further in the next chapter.

⁴³ <https://www.gov.uk/government/publications/v2x-innovation-programme>

⁴⁴ <https://www.gov.uk/government/publications/flexibility-innovation>

Providing the right business landscape for EV smart charging products

Vision	Actions
Choice of smart charging goods and services that are attractive to consumers and promote the use of smart charging	Government will monitor and evaluate the impact of the Electric Vehicles (Smart Charge Points) Regulations. Interim impact evaluation findings are expected by 2025, and the final impact evaluation by 2027
The smart system meets the objectives of cyber security, grid stability, interoperability and data privacy	Government will ensure all EV private charge points are secure and interoperable with Demand Side Response (DSR) service providers, enabling consumers to access the full range of smart tariffs and DSR services with confidence
Smart charging is the leading exemplar of energy digitalisation	Government proposes to introduce a licence condition on energy suppliers to make the information about the tariffs they offer available in a consistent format
Smart charging becomes widespread across the market, with the initial focus on private settings (home and workplace) where parking times will be longer	Government will investigate the technical and economic potential of public smart charging and address the barriers to smart charging at all long duration public charging settings.
<p>Bidirectional V2X energy reaches commercial deployment</p> <p>Successful UK smart charging and related businesses</p>	<p>Government will deliver the Vehicle-to-X Innovation Programme to address barriers to wide-scale deployment specific to this technology, by 2025</p> <p>Government and Ofgem will continue to identify, monitor and address key barriers to unlock the huge potential the commercial deployment of Vehicle-to-X energy technologies</p>

Chapter 4: An energy system ready for EV smart charging

Our vision for the energy system

The integration of EV charging with the electricity network is optimised for a sustainable, efficient energy system and EV driver convenience.

The energy system is secure and stable as EV charging demand grows.

Electricity system actors have visibility of EV charge point installations for future planning of energy system investment.

Consumers are incentivised to smart charge, and costs/rewards are reflective.

The electricity markets work for EV flexibility;

- Pricing signals incentivise use of electricity away from peak times

- Pricing signals indicate variations in demand for time and location

Consumers have an efficient, transparent process for charge point connections.

Key commitments

Government, Ofgem and industry will build the evidence base to understand the relative costs and benefits of smart public and rapid public charging. This will include quantifying the energy system costs, carbon emissions, and potential charging costs to inform future policy direction in 2023.

Ofgem will work with the Distribution Network Operators (DNOs) through the Energy Networks Association (ENA), building on the incentives for an efficient connection process for all low carbon technologies, to ensure that there is a consistent connection process for V2X across all regions (ongoing).

Ofgem and Government will consider and assess what barriers may exist to the development and uptake of innovative new products and services (ongoing).



Networks

The public charging vision

The number of EV charge points will need to be scaled up rapidly through the 2020s. Whilst most drivers will charge at home, those without access to off street parking will rely on public or workplace charging. [Government's EV Infrastructure Strategy](#)⁴⁵ defined the vision for the continued roll-out of a world-leading charging infrastructure network across the UK. The strategy emphasises the need for localised charge point planning. Government is considering options for introducing a unified consent process for installing EV charge points, including consideration of a streamlined process for obtaining both the planning permission consent and the highways consent for the traffic management works at the same time. A consultation was held in 2022, and the Government's response will be published in early 2023

Local EV infrastructure planning must be guided by the high-level system outcomes of achieving a net zero energy system, at lowest investment costs, while meeting the needs of EV drivers and local communities. A group of several high-power, rapid charging points in a single 'hub' location may require one large upgrade to the high voltage network, but each brief customer charging period is less amenable to shifting energy demand. Providing the equivalent availability of low power, public chargers on-street require a much higher number of small connections to the low voltage network, but the slow, long duration charging is more suited to providing energy flexibility which is likely to factor into the business model. The previous chapter set out how Government will seek to address the barriers to smart charging at all long duration public charging settings.

Government, Ofgem and industry will build the evidence base to understand the relative costs and benefits of smart public and rapid public charging. This will include quantifying the energy system costs, carbon emissions, and potential charging costs to inform future policy direction in 2023.

Forecasting and monitoring EV demand and flexibility potential

The electricity network infrastructure must be ready for the increase in demand from the take up of EVs and in the future heat pumps. [The Electricity Networks Strategic Framework](#),⁴⁶ a joint publication by Government and Ofgem, seeks to set out our approach to this transformation.

There could be locations where clusters of new domestic owned EVs could exceed the existing capacity of the local network. DNOs need to plan for their network to meet the expected demand, and do so at lowest cost, including by maximising the use of flexibility within their networks. Ofgem therefore expects DNOs to account for smart charging of EVs in their planning, and to take steps to secure the smart charging capabilities of connected EVs particularly where that flexibility could delay or avoid low voltage network upgrades.

⁴⁵https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1063567/taking-charge-the-electric-vehicle-infrastructure-strategy.pdf

⁴⁶ <https://www.gov.uk/government/publications/electricity-networks-strategic-framework>

The RIIO-ED2 price control sets the outputs that the 14 electricity Distribution Network Operators (DNOs) need to deliver for their consumers and the associated revenues they are allowed to collect for the five year period from 1 April 2023 to 31 March 2028. Within RIIO-ED2⁴⁷ (underway):

- *Ofgem has set an expectation that DNOs should improve their monitoring capability, either through installing network diagnostic equipment where it has demonstrable net value for network planning, using smart meter data and/or improved Artificial Intelligence tools.*
- *Ofgem has set expectations around Data Best Practice for DNOs, including how their network visibility data should be shared in a common, open and consistent way to improve decision making across the sector.*
- *A new licence condition will require all six DNOs to communicate annually to Ofgem the flexibility requirements for the future and the detailed information about the outcome of their procurement of flexibility services.*
- *A Distribution System Operator (DSO) incentive, has been established to drive DNOs to more efficiently develop and use their network, taking into account flexibility alternatives to reinforcement.*

DNOs are not always notified of EV charge point installations in advance of the additional power demand. Sufficient prior notification of installations will help DNOs to better understand the theoretical peak loads against the capacity of transformers and feeders on that part of the network and understand what EV charging assets could be available for demand shifting or energy storage.

Government is supporting innovation projects to develop technology to automatically register small scale energy assets (including EV charge points) through the Automatic Asset Registration programme⁴⁸, part of the £1 billion Net Zero Innovation Portfolio.

Incentivising consumer behaviours

Market wide Half-Hourly Settlement

In April 2021, Ofgem published a decision that the industry should lead the implementation of market wide half-hourly settlement (MHHS) and established an initial plan for completion by October 2025. Following the conclusion of the detailed design for new systems and processes, Elexon, who are leading the Market wide Half Hourly Settlement implementation are currently consulting on a revised plan which would see some parts of industry move to the new systems and processes in 2025, with the whole market moving across by the end of 2026.

⁴⁷ See Chapter 4 in this document Final Determinations Core Methodology:
<https://www.ofgem.gov.uk/publications/riio-ed2-final-determinations>

⁴⁸ <https://www.gov.uk/government/publications/automatic-asset-registration-aar-programme>

Market wide Half Hourly Settlement will send accurate signals to suppliers about the cost of serving their customers throughout each day. This will place the right incentives on suppliers to develop and offer new tariffs and products that encourage more flexible use of energy and help consumers to lower their bills. The demand side response from EV charging may be delivered by the electricity supplier, the charge point operator or a third-party provider. By providing access to half-hourly consumption data (in line with privacy rules), Market wide Half Hourly Settlement will greatly strengthen the opportunity for these providers to offer new tariffs and products that encourage more flexible use of energy and help consumers to lower their bills. Examples include new time-of-use tariffs, third-party managed energy services or bundled 'asset and tariff' offerings.

Market wide Half Hourly Settlement will also bring other substantial benefits. Access to half-hourly consumption data should improve suppliers' demand forecasting and reduce the costs to industry of dealing with energy imbalances. Better quality data will mean fewer settlement errors and a faster settlement timetable should reduce suppliers' financial exposure and the amount of collateral they must post to cover it. Ofgem estimates that Market wide Half Hourly Settlement will bring net benefits for consumers in GB of between £1.6bn to £4.5bn over the period 2021- 2045.⁴⁹

Last year, Ofgem looked at the barriers to the use of elective HHS and found that the most significant was limited commercial incentives. The barriers from some technical and operational issues, do not appear to be particularly significant in their impact.

Ofgem sponsors the delivery and implementation of Market Wide Half Hourly Settlement and with the Programme SRO, will support industry to implement the programme (underway and expected to be complete by 2025/2026).

Distribution Use of System charges

Distribution Use of System (DUoS) charges for distribution system users could provide more granular signals about the cost of using the network at certain times and in certain places, to incentivise efficient and flexible consumer behaviours, including smart EV charging.

Ofgem is undertaking a dedicated Distribution Use of System Charging Significant Code Review⁵⁰. This review will determine whether there are feasible changes to the current charge design that could unlock these behaviours and provide benefits for all energy consumers. Consumer responses to new charges would vary depending on factors such as the size, gradient or variability of the signal, the type of consumer, and access to enabling technology.

Ofgem will review Distribution Use of System charges (network charging) to determine whether alternative charge designs (e.g. through improved signals for flexibility) would deliver benefits for consumers by incentivising more efficient use and development of the distribution network, and to ensure fair design for distributed storage including V2X, for implementation by 2026.

⁴⁹ <https://www.ofgem.gov.uk/publications/electricity-retail-market-wide-half-hourly-settlement-decision-and-full-business-case>

⁵⁰ <https://www.ofgem.gov.uk/publications/distribution-use-system-charges-significant-code-review-launch>

Future electricity market arrangements

The Government is undertaking a Review of Electricity Market Arrangements (REMA), which will identify and implement the reforms to electricity market arrangements needed to drive the necessary investment in, and efficient operation of a secure, low carbon electricity system by 2035.⁵¹ The review will consider whether stronger locational and/or temporal signals are needed in the wholesale and balancing markets.

Using dynamic market signals

Case study: Project Shift, led by UK Power Networks



To accommodate the increased demand from EVs at network level and help reduce the need for network reinforcement, the Ofgem Network Innovation Allowance funded project, “Shift”, aimed to explore innovative technical and commercial solutions to help accommodate increased demand within the existing network capacity.

The study found that on average EVs only charge for 19% of the time they are plugged in at home, providing an opportunity to shift demand away from typical plug-in times when demand is already high. UK Power Networks trialled three different market mechanisms with Kaluza, Octopus Energy and ev.energy to incentivise customer charging behaviour: time-of-use (ToU), Distributed Use of System (DUoS) pricing, Capacity based DUoS pricing and Low Voltage network flexibility procurement.

The project, which ended in October 2021, found that customers chose to smart charge for 85% of all charging sessions which led to a reduction in EV demand during the evening peak by an average of 79%. It was also found that the customer proposition is important for the reliability of response, with ongoing financial incentives increasing the turn-down response.

The most efficient energy system usage will be achieved if Demand Side Response providers are working with a variety of dynamic market signals to deliver a range of flexibility outcomes. If all load control assets responded in a similar fashion concurrently, to the same market signals, the demand could be shifted from the current evening peak, but there is a risk that a new secondary peak would emerge. Managing the overall demand envelope and mitigating against such unwanted outcomes will require an iterative development of market signals and technological solutions as the uptake of smart charging expands.

⁵¹ <https://www.gov.uk/government/consultations/review-of-electricity-market-arrangements>

Ofgem and Government will monitor how electricity demand changes as the EV transition continues and will work with industry to consider whether any further steps (for example, tariff structures, or optimisation technologies) are needed to change how electricity usage is incentivised.

Connections

Government and Ofgem recognise that the EV charge point installation process can on occasion be difficult, time-consuming and expensive, particularly for non-domestic customers. Ofgem are making it possible to connect, and do so affordably at low upfront cost, through RIIO-ED2 and Access SCR.⁵² This will accelerate the transition to a low-carbon energy system and manage the cost, whilst supporting the uptake of low carbon technologies through lower connection charges.

Some households will need additional support from their DNO to connect a smart charge point; for example, where a low voltage service cable is shared between two adjacent properties (a 'looped' supply), or where the domestic cut-out fuse, and possibly service cable, might need upgrading. Ofgem is ensuring a pro-active approach in increasing network capacity to support EVs, including removing any constraints from looped services and has set out its decisions in this area as part of its RIIO-ED2 Final Determinations⁵³. DNOs are increasingly digitalising the connections process to improve the customer experience. However, stakeholders have raised the issue of accreditation restrictions for work on the cut-out fuse (which is the responsibility of DNOs) causing delays to the installation of EV chargers. The ENA are exploring the possibility of allowing accredited third parties to access cut-out fuses.

The connection process for V2G charging infrastructure is generally more complex because there are additional requirements such as a G99 application, an export Meter Point Administration Number⁵⁴ and in some circumstances onsite DNO commissioning checks, which differ in cost and timescales for each DNO region.

Ofgem will work with the Distribution Network Operators (DNOs) through the Energy Networks Association (ENA), building on the incentives for an efficient connection process for all low carbon technologies, to ensure that there is a consistent connection process for V2X across all regions (ongoing).

⁵² <https://www.ofgem.gov.uk/publications/access-and-forward-looking-charges-significant-code-review-decision-and-direction>

⁵³ See 'Low Voltage Services Volume Driver' section in Chapter 3 of Ofgem's RIIO-ED2 Core Methodology Document: [RIIO-ED2 Final Determinations Core Methodology \(1\).pdf](#)

⁵⁴ [ENA EREC template v1.0 \(energynetworks.org\)](#) - G99 sets out the requirement for commissioning tests and checks

Enabling energy products and services from suppliers and Demand Side Response providers that meet EV consumer needs (suppliers and aggregators)

Government and Ofgem are both working to ensure that the right market arrangements are in place to deliver a retail market that can support the take up of EV products and services at the same time as delivering positive outcomes for all consumers, including EV users. The aim is to unlock innovative EV products and services that drive improved competition, add significant value to consumer offerings and improve consumer outcomes. This may require changes to the current regulatory arrangements to be considered.

Some innovators are concerned that regulations and industry rules create undue barriers to innovation. For example, current metering arrangements typically only allow one supplier per meter point (and its unique Meter Point Administration Number). Therefore, an additional meter point would be needed to supply electricity to an EV excluding the rest of a premise's needs.

Ofgem and Government will consider and assess what barriers may exist to the development and uptake of innovative new smart charging products and services. (ongoing).

The Treasury's Autumn Statement⁵⁵ committed government to considering the best approach to consumer protection in the energy market from April 2024, as part of wider retail market reforms. The objectives for these reforms will be to deliver a retail market that works for consumers, that is resilient and investable over the long-term, and that supports system transformation.

Maximising EV participation across multiple markets

Government is undertaking a comprehensive Review of Electricity Market Arrangements, joined up with retail market reform, to make sure that customers benefit from the net zero transition. Ofgem are working with the DNOs and the Energy System Operator (ESO) to open up flexibility from EVs to allow participation across multiple markets and maximise the value of flexibility from EVs.

Historically, DNO local flexibility markets have tended towards larger assets with increased certainty. Increasingly, DNOs have been contracting aggregated EV flexibility. This stems from aggregators improving their standardisation ('productisation'), probabilistic calculation methodologies, baselining and visibility. In turn, these lead to increased buyer confidence.

Ofgem is also reforming DNOs data standardisation in planning publications to allow network users to transparently access information which will allow them to understand how and where the distribution networks require flexibility services both now and in the future. This will mean smart charge point aggregators have more insight as to where their services will have value.

There needs to be more consistent, detailed DSO-ESO coordination about the Low Voltage (LV) network's capacity in all areas and at all times (not just the flexibility-alleviated congestion), so that

⁵⁵ <https://www.gov.uk/government/news/beis-in-the-autumn-statement>
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1118417/CCS1_022065440-001_SECURE_HMT_Autumn_Statement_November_2022_Web_accessible_1_.pdf

smart charging EVs can help arbitrate and utilise the variable renewable energy in the wholesale market. This is complex, relies on underlying network data and forms an ongoing area of work.

Ofgem will keep under review and seek to remove barriers that prevent aggregated EVs participating in energy markets (ongoing).

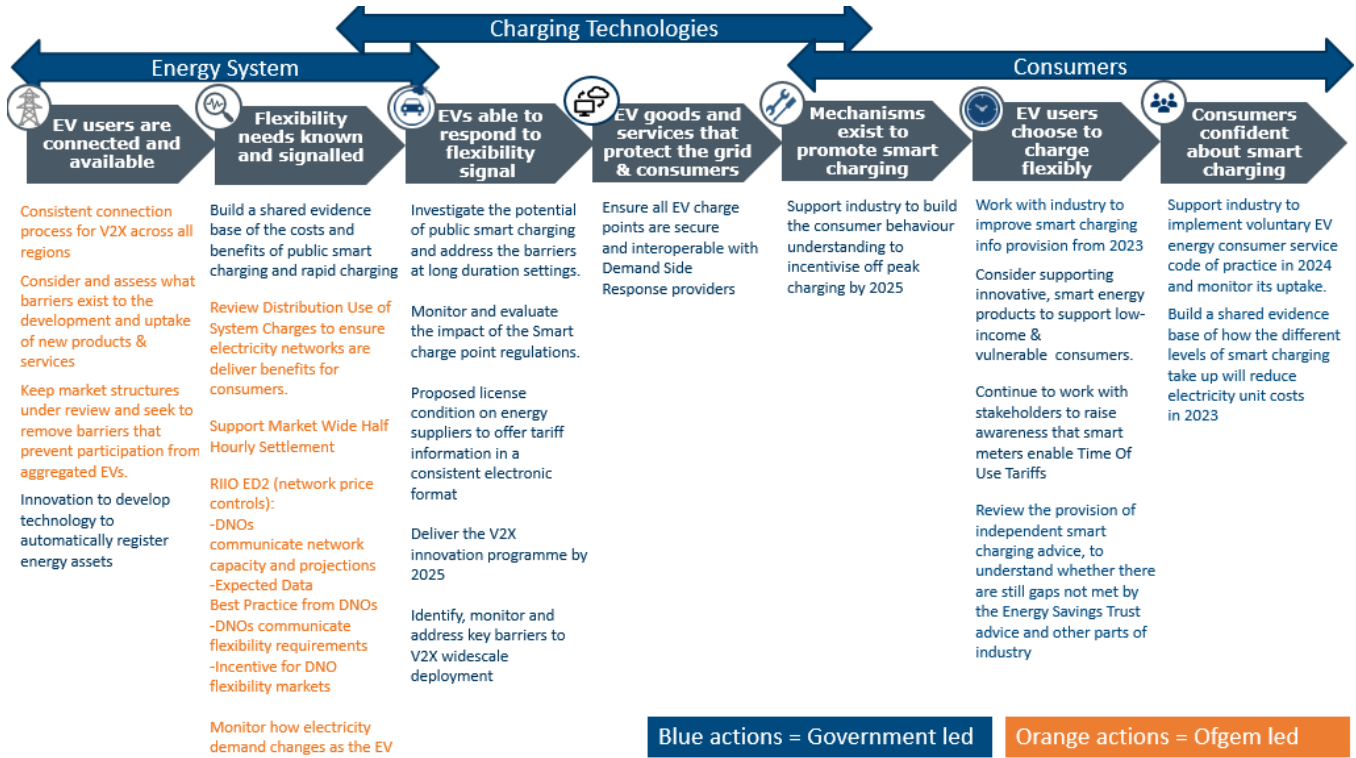
An energy system ready for EV smart charging

Vision	Actions
The integration of EV charging with the electricity network is optimised for a sustainable, efficient energy system and EV driver convenience.	Government, Ofgem and industry will build the evidence base to understand the relative costs and benefits of smart public and rapid public charging. This will include quantifying the energy system costs, carbon emissions, and potential charging costs to inform future policy direction in 2023.
The energy system is secure and stable as EV charging demand grows.	<p>Ofgem has allocated funding for network monitoring in RIIO-ED2 so DNOs can communicate their underlying LV network capacity and projections by 2023.</p> <p>Ofgem has set expectations around Data Best Practise for DNOs to improve decision making across the sector by 2023.</p> <p>Ofgem will introduce a new licence condition that will require all six DNOs to communicate annually to Ofgem, the flexibility requirements for the future and the detailed information about the outcome of their procurement of flexibility services from 2023.</p> <p>Ofgem has included a Distribution System Operator incentive in the networks RIIO-ED2 price control to encourage DNOs to plan, operate and facilitate markets for flexibility more actively from 2023.</p>
Electricity system actors have visibility of EV charge point installations for future planning of energy system investment.	Government is supporting innovation programmes to develop technology to automatically register small scale energy assets (including EV charge points) through the Automatic Asset Registration programme.
Consumers incentivised to smart charge, and costs/rewards are reflective.	Ofgem sponsors the delivery and implementation of Market Wide Half Hourly Settlement and with the programme lead, will support industry to implement the programme (underway and expected to be complete by 2025/26).

Vision	Actions
Pricing signals indicate variations in demand for time and location.	Ofgem will review Distribution Use of System charges (network charging) to determine whether alternative charge designs (eg. through improved signals for flexibility) would deliver benefits for consumers by incentivising more efficient use and development of the distribution network and to ensure fair design for distributed storage, including V2X, for implementation by 2026.
Consumers have an efficient, transparent process for charge point connections.	Ofgem will work with the Distribution Network Operators (DNOs) through the Energy Networks Association (ENA), building on the incentives for an efficient connection process for all low carbon technologies, to ensure that there is a consistent connection process for V2X across all regions.
The electricity markets work for EV flexibility	<p>Ofgem and Government will monitor how the electricity demand changes as the EV transition continues and will work with industry to consider whether any further steps are needed to change how electricity usage is incentivised</p> <p>Ofgem and Government consider and assess what barriers may exist to the development and uptake of innovative new smart charging products and services (ongoing).</p> <p>Ofgem will keep under review and seek to remove barriers to market structures that prevent participation in energy markets from aggregated EVs (ongoing).</p>

Annex 1: Full list of measures

The following diagram⁵⁶ demonstrates how the measures cover the entire system.



⁵⁶ The diagram is based on Figure 3 in Ofgem’s 2021 report [Enabling the transition to electric vehicles: The regulator’s priorities for a green, fair future.](#)

Making smart charging the affordable, convenient choice for EV drivers

Vision	Actions
EV drivers have trust and confidence in the smart charging services and market. They are sufficiently incentivised, motivated, protected and enabled to use smart charging.	Government, with Ofgem, will work with industry to improve smart charging information provision to customers from 2023.
EV charging will encourage more consumers to consider time-of-use and other flexible tariffs and smart meters which enable these tariffs.	Government will continue to work with stakeholders to raise awareness that smart meters enable time-of-use tariffs.
EV drivers and businesses have choice in the smart charging market, and can find the best goods and services for their needs.	Government will continue to review the provision of independent smart charging advice, to understand whether there are still gaps not met by the Energy Savings Trust advice and other parts of industry by 2024.
Habitual smart charging is the norm at charging locations where cars and vans can be parked for long periods of time.	Government and Ofgem will support industry to build the consumer behaviour understanding to be able to incentivise off peak charging by 2025.
The transition to EV smart charging meets the needs of the diverse consumer base.	To help remove barriers for consumers who may otherwise struggle to participate in the smart energy system, the Government will consider supporting the development and testing of innovative, smart energy products and services to support low-income and vulnerable consumers transition to a smart energy system.
Widespread EV smart charging delivers lower electricity unit prices.	Government and Ofgem will build a shared evidence base of how the different levels of smart charging take up will reduce electricity unit costs, and use this evidence to inform policy by 2023.
Smart charging is a positive consumer experience.	Government will support industry to implement voluntary EV energy consumer service code of best practice in 2024 and monitor its uptake.

Providing the right business landscape for EV smart charging products

Vision	Actions
Choice of smart charging goods and services that are attractive to consumers and promote the use of smart charging	Government will monitor and evaluate the impact of the Electric Vehicles (Smart Charge Points) Regulations. Interim impact evaluation findings are expected by 2025, and the final impact evaluation by 2027
The smart system meets the objectives of cyber security, grid stability, interoperability and data privacy	Government will ensure all EV private charge points are secure and interoperable with Demand Side Response (DSR) service providers, enabling consumers to access the full range of smart tariffs and DSR services with confidence
Smart charging is the leading exemplar of energy digitalisation	Government proposes to introduce a licence condition on energy suppliers to make the information about the tariffs they offer available in a consistent format
Smart charging becomes widespread across the market, with the initial focus on private settings (home and workplace) where parking times will be longer	Government will investigate the technical and economic potential of public smart charging and address the barriers to smart charging at all long duration public charging settings.
<p>Bidirectional V2X energy reaches commercial deployment</p> <p>Successful UK smart charging and related businesses</p>	<p>Government will deliver the Vehicle-to-X Innovation Programme to address barriers to wide-scale deployment specific to this technology, by 2025</p> <p>Government and Ofgem will continue to identify, monitor and address key barriers to unlock the huge potential the commercial deployment of Vehicle-to-X energy technologies</p>

An energy system ready for EV smart charging

Vision	Actions
<p>The integration of EV charging with the electricity network is optimised for a sustainable, efficient energy system and EV driver convenience.</p>	<p>Government, Ofgem and industry will build the evidence base to understand the relative costs and benefits of smart public and rapid public charging. This will include quantifying the energy system costs, carbon emissions, and potential charging costs to inform future policy direction in 2023.</p>
<p>The energy system is secure and stable as EV charging demand grows.</p>	<p>Ofgem has allocated funding for network monitoring in RIIO-ED2 so DNOs can communicate their underlying LV network capacity and projections by 2023.</p> <p>Ofgem has set expectations around Data Best Practise for DNOs to improve decision making across the sector by 2023.</p> <p>Ofgem will introduce a new licence condition that will require all six DNOs to communicate annually to Ofgem, the flexibility requirements for the future and the detailed information about the outcome of their procurement of flexibility services from 2023.</p> <p>Ofgem has included a Distribution System Operator incentive in the networks RIIO-ED2 price control to encourage DNOs to plan, operate and facilitate markets for flexibility more actively from 2023.</p>
<p>Electricity system actors have visibility of EV charge point installations for future planning of energy system investment.</p>	<p>Government is supporting innovation programmes to develop technology to automatically register small scale energy assets (including EV charge points) through the Automatic Asset Registration programme.</p>
<p>Consumers are incentivised to smart charge, and costs/rewards are reflective.</p>	<p>Ofgem sponsors the delivery and implementation of Market Wide Half Hourly Settlement and with the programme lead, will support industry to implement the programme (underway and expected to be complete by 2025/26).</p>
<p>Pricing signals indicate variations in demand for time and location.</p>	<p>Ofgem will review Distribution Use of System charges (network charging) to determine whether alternative charge designs (eg. through improved signals for flexibility) would deliver benefits for consumers by incentivising more efficient use and development of the distribution network and to ensure fair design for distributed storage, including V2X, for implementation by 2026.</p>

Vision	Actions
<p>Consumers have an efficient, transparent process for charge point connections.</p>	<p>Ofgem will work with the Distribution Network Operators (DNOs) through the Energy Networks Association (ENA), building on the incentives for an efficient connection process for all low carbon technologies, to ensure that there is a consistent connection process for V2X across all regions.</p>
<p>The electricity markets work for EV flexibility</p>	<p>Ofgem and Government will monitor how the electricity demand changes as the EV transition continues and will work with industry to consider whether any further steps are needed to change how electricity usage is incentivised</p> <p>Ofgem and Government consider and assess what barriers may exist to the development and uptake of innovative new smart charging products and services (ongoing).</p> <p>Ofgem will keep under review and seek to remove barriers to market structures that prevent participation in energy markets from aggregated EVs (ongoing).</p>

Annex 2: Glossary

A smart and flexible electricity system	A system that uses smart technologies to provide flexibility to the electricity system, to balance supply and demand, and manage constraints on the electricity network
Bundling	Selling different items ie., products and services, together as a package
Charge point	The hardware used to charge EVs
Charge point operators (CPO)	Entities that manage, maintain and operate charge points
Demand side response service providers (also known as ‘aggregators’ or flexibility service providers)	Organisations controlling or configuring the energy consumption or production of devices including EV charge points and wider energy smart appliances such as heat pumps
Depot	A building or site where fleet vehicles are stored
Distribution network operator (DNO)	Companies licensed to distribute electricity in Great Britain by the Office of Gas and Electricity Markets (Ofgem). They bring electricity to homes and businesses at lower voltages from the transmission network.
Distribution system operation	The set of activities that are needed to support the transition to a smarter, flexible and digitally enabled local energy system. DNOs have been building capabilities in planning, operating and market facilitation of flexible resources to drive more efficient development and use of the decarbonising electricity system. This differs from the more traditional responsibility of a DNO, which is to take power from the transmission network and deliver it at safe, lower voltages to homes and businesses.
Electricity suppliers	The companies that supply electricity to your home. They do not own any of the network of cables and pipes that deliver the electricity to your home.
Energy flexibility	Energy generation or consumption patterns are modified to balance the network.
Energy smart appliances (ESA)	Electrical consumer devices that are communications-enabled and capable of responding automatically to price and/or other signals by shifting or modulating electricity consumption and/or production. They enable flexibility to be facilitated by consumers and will represent an increasing source of flexibility for the grid in the future

EVET	The Electric Vehicle Energy Taskforce (EVET) was convened by the Government at the behest of ministers. It is chaired by Energy Systems Catapult, facilitated by Zemo Partnership and overseen by the members of the EV Energy Taskforce Steering Group.
Fleet	Groups of vehicles owned by a single organisation
HHS	Half Hourly Settlement. Settlement reconciles differences between an electricity supplier's contractual purchases of electricity and demand from its customers.
Kilowatt hour (kWh)	Measure of EV battery or charging capacity
Market wide half hourly settlement (MHHS)	MHHS refers to the industry implementation of half hourly energy settlement across the retail market. This means electricity suppliers will face accurate signals about the true cost of serving their customers throughout each day. It will place the right incentives on electricity suppliers to develop and offer new tariffs and innovations that encourage and enable more flexible use of energy.
Net zero	A target of reaching a balance in emissions, with the amount of greenhouse gas produced and the amount removed from the atmosphere equally zero. The UK Government has committed to net zero emissions across the UK by 2050.
Off-street charging	Charging EVs anywhere that is not on or next to the streets. This could involve charging hubs/stations
On-street charging	Charging EVs on the street, anywhere on or along the pavement of streets.
Public charging	EV charge points that are in publicly accessible locations and are not exclusive for specific members such as residents or workers. Broadly includes on-route, on-street and destination charging.
Smart	The ability of a device to respond in real time to communication signals, using digital technologies, to deliver a service.
Smart charging	Charging an EV in response to communication signals, at times when demand for electricity is lower, for example at night, or when there is lots of renewable energy on the grid. Advanced forms of smart charging also enable energy to be shared from the vehicle battery for another use providing additional benefits to the EV driver and the energy system.

Smart charge point	A charge point that is able to respond to communication signals. The Electric Vehicles (Smart Charge Point) Regulations 2021 set the minimum standards for charge points in homes and workplaces.
Time-of-use tariff (ToUT)	Tariffs which reward consumers for using energy at off-peak times or when there is abundant clean energy
Vehicle-to-everything (V2X) energy	V2X, where “X” stands for everything, is the umbrella for all forms of technology whereby the EV battery can export electricity back to a system, be that a home (V2H), a building (V2B) such as a business or back to the electricity grid (V2G).
Vehicle-to-grid (V2G) energy	A leading example of V2X – it allows electric batteries to store energy and discharge it back to the electricity network when it is most needed.

This publication is available from: www.gov.uk/government/publications/electric-vehicle-smart-charging-action-plan

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