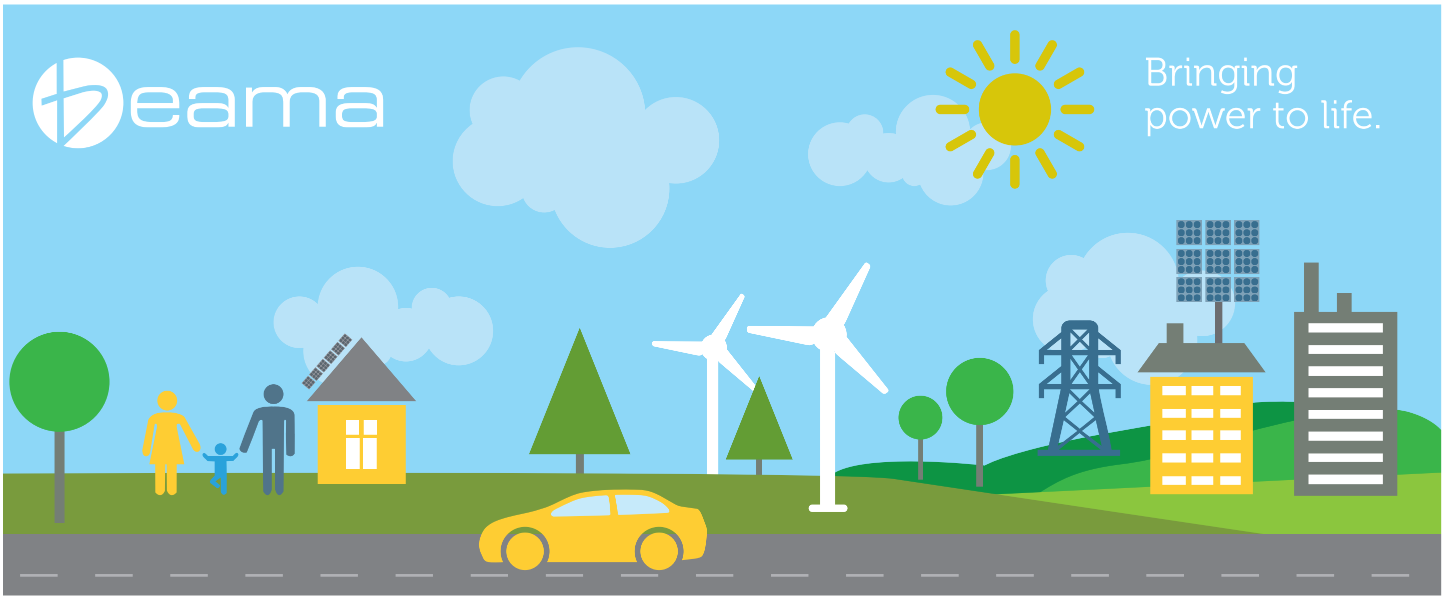
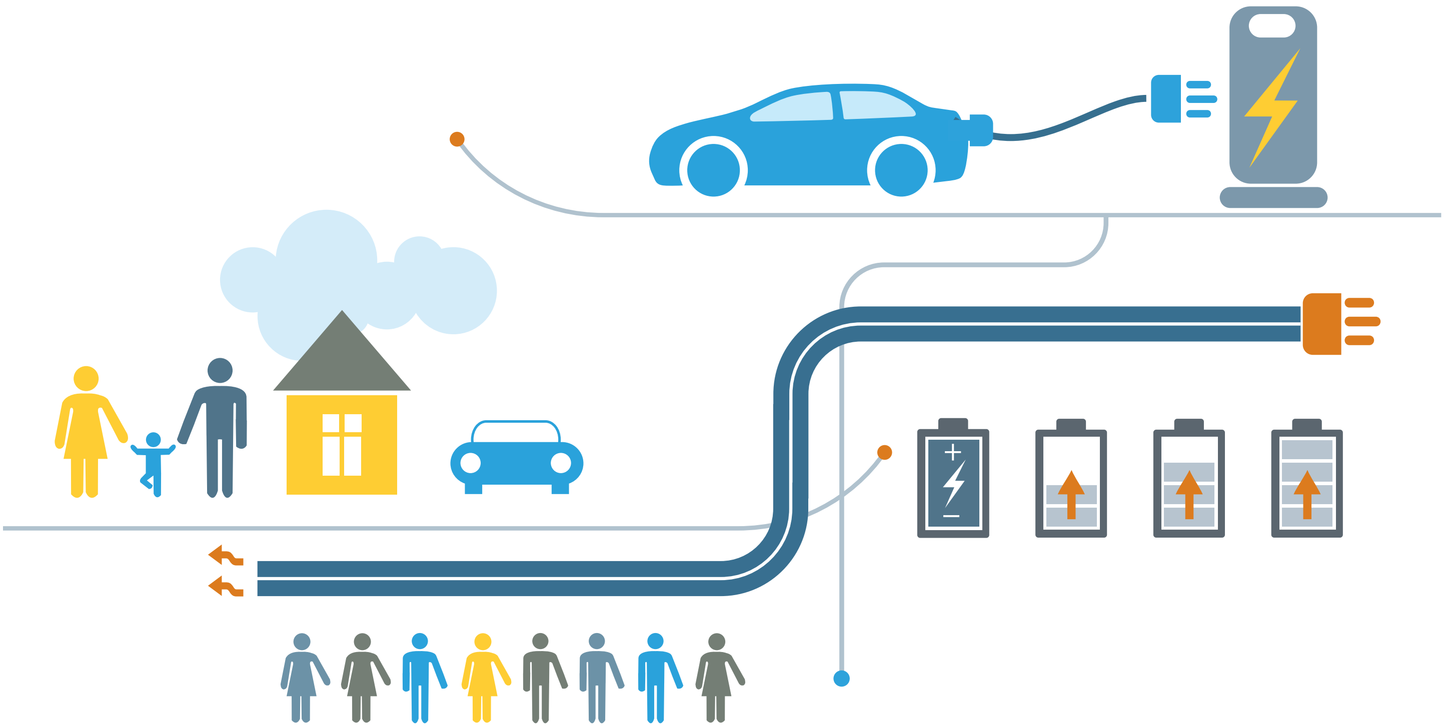


ELECTRIFYING ROAD TRANSPORT



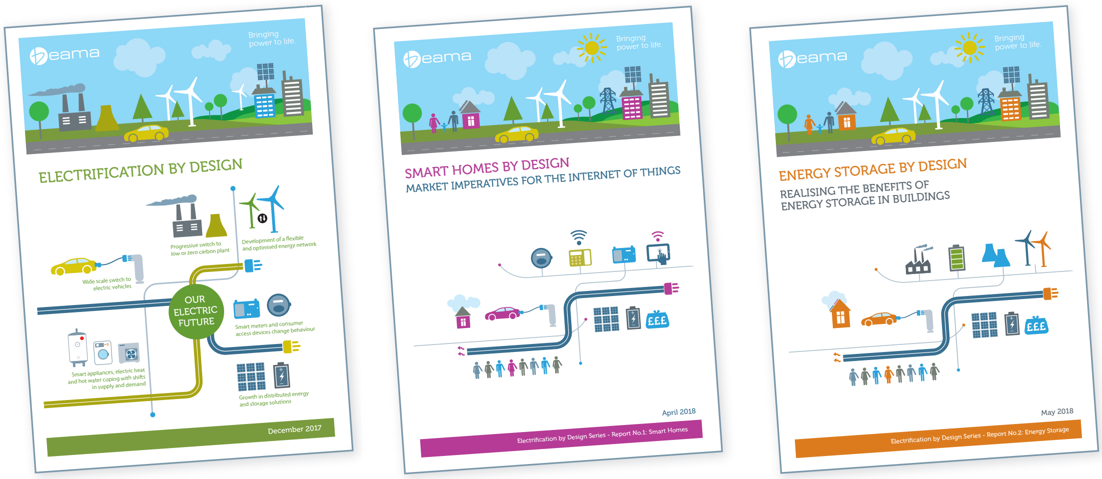
May 2018

Electrification by Design Series - Report No.3: Electrifying road transport

BEAMA Electrification by Design Series

In December 2017 BEAMA published a report, Electrification by Design[1], exploring simple policy and market mechanisms to promote deployment of low-carbon electric systems. In it we identified some of the critical enablers of a flexible and efficient low-carbon energy system. These include consumer engagement with energy use, energy storage, the electrification of heat and transport, automated energy management in buildings, and demand-side energy management.

We also made recommendations for how Government, Industry, consumers and other stakeholders can work together to enable and maintain the market for smart products and to maximise their benefits to the consumer and to the electricity transmission and distribution networks. This short paper provides some more detail of BEAMA's view of how to realise the benefits of electric vehicles.



A Vision for Smart EV Infrastructure

The BEAMA Electric Vehicle Infrastructure Group exists to give the supply chain a voice in the strategic, policy and technical decisions that will underpin the development and mass rollout of electric vehicle charge points and other associated infrastructure in the coming decades. We also provide group members with updates to policy and technical changes, and help companies respond to and shape these changes with a collective voice. Just as importantly, the Group provides a forum for networking, sharing ideas and meeting with other stakeholders involved in the transition to an electrified transport system. We work closely with standards bodies both in the UK and abroad (particularly Europe), and with other stakeholders to help define and understand the challenges and opportunities of transport electrification in buildings (including building and wiring regulations, BIM, and connections with smart home systems), streets and cities (including air quality considerations, the changing roles of network operators, the smart grid, and energy storage). Among other things we are concerned with market development, finance and the paths to market, the role of the consumer, and in the scalability and management of smart data to enable a flexible, decarbonised energy system.

[1] The report can be found here: http://www.beama.org.uk/resourceLibrary/electrification-by-design-pdf.html

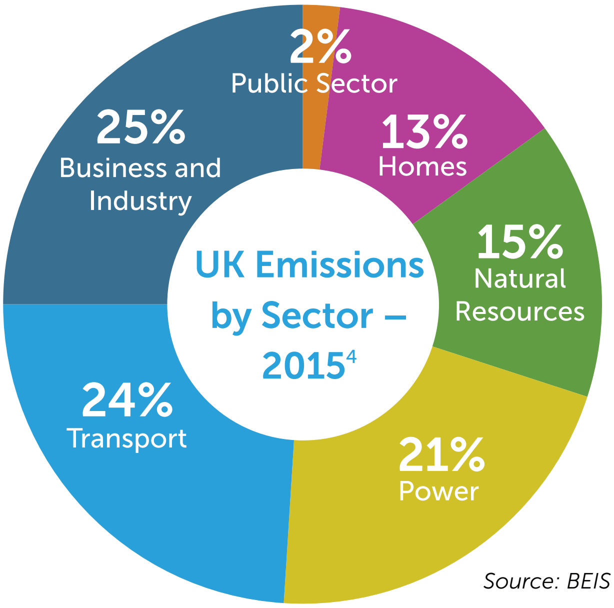
CONTENTS

INTRODUCTION

New registrations of electric cars hit a new record in 2016, with more than 750,000 sales worldwide.[2] The UK Government target is that by 2050 almost all vehicles on Britain's roads will be Ultra Low Emission Vehicles (ULEVs). UK-based transport emissions in 2015 were down 2% compared to 1990, while new cars in the UK are up to 16% more efficient than they were in 2000.[3] Flexible approaches to network management, charging, and consumer offerings, and new solutions and technologies such as smart charging infrastructure, are essential to provide consumers with efficient and cost-effective transport.

With road transport accounting for approximately 24% of UK CO_2 emissions, reducing the use of fossil fuels for transport in favour of cleaner and less carbon intensive fuels is essential. The report will explore how we can do this by combining EVs with low carbon or renewable energy fuel sources.

Ultra Low Emission Vehicles can deliver most transport functions, including buses and even heavy goods vehicles. A significant proportion will be electric, with applications for Hydrogen Fuel Cell Vehicles also being high on the evolving transport agenda.[5]



Source: BEIS

100% = 496 Mt

Greenhouse Gas Emissions by Sector 1990 – 2015[6]

	Emissions (Mt)		
Sector	1990 base year	2015	Percentage change 1990-2015
Business and industry	231	123	-47%
Transport	122	120	-2%
Power	204	104	-49%
Natural resources	152	77	-50%
Homes	80	64	-20%
Public sector	13	8	-40%
Total	**803**	**496**	**-38%**

Source: BEIS

Unlike traditional vehicles, which are almost exclusively refuelled at forecourts, dedicated EV charging infrastructure can be in residential, commercial or office buildings, on streets, in forecourts or even on roads for wireless power transfer (WPT). EVs and electric transportation offer the consumer and business the opportunity to fuel their vehicles conveniently for less and in a more sustainable and cleaner way. EVs are an ever-increasing sight on our roads and streets and in the coming years will become a mainstream choice for individuals and business. How and when these vehicles are charged is crucial to the growth of this market and in delivering objectives. The UK Government has been generally proactive in devising policies to encourage and enable the electrification of the vehicle fleet. The ultimate objective is to cut road transport carbon emissions and deliver on targets enshrined in law by the UK's 2008 Climate Change Act. As a result of concerted development and demonstration activities, technology, culture, and economics are now coalescing to

[2] International Energy Agency (2017) Global EV Outlook 2017 [https://www.iea.org/publications/freepublications/publication/global-ev-outlook-2017.html]
[3] HM Government Clean Growth Strategy (2017) p. 83
[4] HM Government Clean Growth Strategy (2017) p. 9
[5] HM Government Clean Growth Strategy (2017) p. 9
[6] HM Government Clean Growth Strategy (2017) p. 23

provide confidence in the EV market. It is now nearly inevitable that in the coming years EVs will continue to move towards mainstream status.[7]

As the market grows and develops, some technologies will flourish while others will remain niche or disappear altogether. It is important that the industry responds effectively to new products and systems to make the consumer experience simple and stable even while the market changes at pace.[8]

EV Applications and Value Offering

As well as offering consumers a low carbon fuel source, EVs can be less expensive to run than petrol or diesel fuelled vehicles. Furthermore, the purchase prices of EVs are falling and their price-parity with conventionally fuelled vehicles has been expected for some time.[9] When combined with improvements in battery technology to increase range and reduce upfront costs, along with innovative finance models, smart home applications and increasing levels of renewable generation, EVs now provide a solid consumer proposition that is likely to become even more attractive.

Analysis of the cost of Electric Vehicles and petrol or diesel fuelled equivalent via Volkswagen:

MODEL	Golf GTI	Golf GTD	Golf GTE	e Golf
Engine	2.0 TSI	GTD Blue Line 2.0 TDI	1.4 TSI Plug in Hybrid	e-golf
BHP	230	184	204	136
0 – 62 MPH	6.4 seconds	7.4 seconds	7.6 seconds	9.6 seconds
Price From (With Grant)	£28,345	£27,510	£28,160	£27,765
Grant and Scrappage Schemes	Scrappage only	Scrappage only	£2,500 + Scrappage	£4500 + Scrappage
Carbon Emissions	145 g/km	119 g /km	38 – 40 g/km	0 g/km while driving
MPG	44.8 combined	62.8 combined	156.9 – 166.2 combined	186 miles range
Road Tax	£200 per annum	£160 per annum	£0	£0

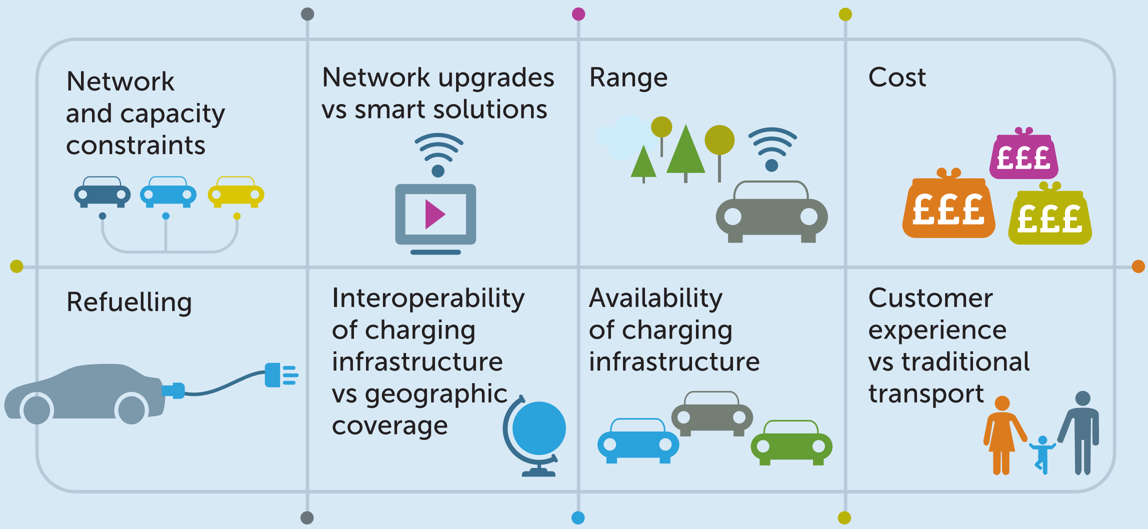
Source: Data only from http://www.volkswagen.co.uk/ (November 2017) Example only and subject to price and data fluctuation

More than half of all new power capacity installed globally is now renewable, and the global market for electric vehicles grew by 60% in the last year. This growth shows no sign of abating, and new applications for EVs such as response services will continue to add additional value. Smart tariffs and charging outside of network peaks or when renewable generation output is high and demand low will reinforce this growth. Although the increasing take-up of EVs will increase total demand for electricity, the ability of EVs to store energy that can be exported to the grid in response to price signals could help to reduce the amount of new generation and network investment that will be needed to meet this increased demand. This will reduce overall system costs.[10]

Innovative new electricity tariffs could encourage EV take-up and make them more accessible via free EV charging models, technology offerings or an annual rebate or reduction on a consumer's electricity bill.[11] This is not to suggest that maintaining an EV would not be a significant proportion of a typical household electricity bill, but the comparison is more relevant to the running cost of a conventionally fuelled vehicle. EVs are a cost-effective proposition from this perspective, even at peak electricity prices. There will be challenges, however, for energy suppliers and network operators to identify appealing packages that stimulate consumer interest, encourage off-peak charging and appropriately incentivise consumer participation in new services and service models.

[7] BEAMA – BEAMA Guide to Electric Vehicle Infrastructure (2015)
[8] BEAMA – BEAMA Guide to Electric Vehicle Infrastructure (2015) p. 26
[9] The Telegraph and UBS – Electric vehicles to cost the same as conventional cars by 2018 (2017)
[10] BEIS – Upgrading our Energy System: Smart Systems and Flexibility Plan (2017) pp. 6 and 15
[11] Utility Week – OVO consumers won't pay for EV driving, pledges CEO (2018) – https://utilityweek.co.uk/ovo-consumers-wont-pay-for-ev-driving-pledges-ceo/

Challenges Summary



At the root of the move to ULEVs is the ambition to reduce emissions of carbon and harmful gases that affect health and air quality. Shifting from traditional fuels to electrically charged vehicles requires a consideration of the wider energy system: electrification won't lead to lower carbon emissions unless the energy generated to charge the EV battery is from low carbon sources. For a truly low carbon system and low carbon transport system, EVs should wherever possible be powered by renewable generation.

The table below presents some scenarios that demonstrate the value and applications on offer to key market participants. All depend on technology solutions that rely on further development of the market for services and systems.

Description	Value to Who?			
	Network Operators	Energy Suppliers	Aggregators	Consumer
Smart Tariffs and Generation matching i.e. charge EVs at a lower cost when renewable generation output is high and demand low	✓	✓		✓
Providing cheaper energy to users who charge or set to automated charge during specific time windows	✓		✓	✓
Smart tariffs to incentivise the consumer to charge outside of peak network times	✓	✓		✓
Interface with local battery storage, smart home controls and on-site generation to maximise use of available energy and reserves for times of high demand, and reduce cost to consumer	✓		✓	✓
Use EVs as aggregated virtual power plants (Nissan recently suggest that 20,000 EVs could offer around 300MW of power)	✓	✓	✓	
Control or temporarily interrupt EV charging cycles when the system frequency is low to provide frequency response services to the system at low cost[12]	✓		✓	
Vehicle to Building	✓			✓
Vehicle to Grid	✓	✓	✓	✓

[12] Poyry and Imperial College – ROADMAP FOR FLEXIBILITY SERVICES TO 2030 [2017]

EVs can play a larger role in the energy system than just driving demand for charging infrastructure and electricity networks. There are a number of solutions and applications already available and others that will be available in the short term; overviews of these are provided below.

CASE STUDY 1

Carbon Tracing (Western Power Distribution)

The project will verify a perception that consumers are increasingly interested in how their energy is generated. WPD suggests that the adoption of solar and wind generation and the resulting ability to tell a consumer what the mix is like at any point in time is deemed valuable. WPD has created an app and website which it will test with local groups before being rolled out across its network, enabling consumers to see their generation mix and allow for their own generation as well.[13]

Smart Charging

Smart charging enables consumers to charge their EVs at beneficial times, for example when excess electricity is being generated and its price is low. This could also apply to the networks, meaning that a network operator is able to notify the consumer and constrain charging at times of high demand on a local level for a short period.

Smart Tariffs and Price Signals

A Smart or Time of Use (ToU) tariffs incentivise consumers to use, store and export electricity at times that are most beneficial or least costly to the system. These tariffs are an intrinsic expression of smart energy network management. For example, offering the consumer low cost energy when generation is high and demand is low or charging a vehicle when energy prices are lower. Further service development in this area could involve consumers opting in to contracts with energy service providers to allow them to make energy decisions on the behalf of the consumer.

Virtual Power Plant

A Virtual Power Plant (VPP) aggregates units of energy i.e. storage devices or EVs across a region under a central control system. Almost all power generation and storage technologies can be part of a VPP including biogas, biomass, combined heat and power (CHP), wind, solar, hydro, diesel and fossil-fired plants.[14]

CASE STUDY 2

Rapid Chargers and Existing Fuel Infrastructure

The Motor Fuel Group (MFG), which operates under brands such as Shell, BP and Texaco, has recently announced plans to install rapid chargers at more than 400 fuel stations. This will be in partnership with the technology provider and installer Charge Point Services and will set a precedent for the mass rollout of EV charging infrastructure. This acknowledges the increasing popularity of EVs and their importance as part of the fuel mix for road vehicles.[15]

Vehicle to Grid

The vehicle to grid technology solution allows owners and users of EVs to use the energy stored in their vehicles' batteries to be sold back to the electricity network at times of peak demand or for other services yet to be defined. This solution could eventually allow the consumer to opt into the provision of network services in return for a reward.

Vehicle to Building

There is the potential for an EV to provide energy to the home for short to medium durations or at times of high network demand. Smart home and load management controls could act as the interface between connected loads and the networks to fulfil pre-agreed actions and service requirements.

Inductive Charging

Inductive Charging, or wireless power transfer, allows vehicles to charge wirelessly without cables or leads. General applications include charging for buses and centralised transport. Inductive charging technology could be located at bus stops, traffic lights or taxi ranks, allowing vehicles to charge or top up their batteries for short durations or during driver breaks. It may also be technically and economically feasible for EVs to charge wirelessly while moving, possibly even at motorway speeds.

Flash Battery Technology

Charging time is one of the main barriers to take-up of EVs, but new technology designed to reduce charging time is in development. Rapid chargers can currently charge a car in around 30 minutes, but flash technology could see this reduced significantly. Mercedes's parent company, Daimler, is one company with large investments into this development.[16] Flash battery technology and other rapid battery technologies aim to reduce the charging time of vehicles towards parity with traditional petrol or diesel refuelling.

[13] Western Power Distribution – Carbon Tracing (2017) – [http://www.smarternetworks.org/Project.aspx?ProjectID=1960]
[14] ABB – Virtual Power Plants Overview (2017) – [http://new.abb.com/abb-ability/utilities/virtual-power-plants]
[15] Utility Week – Rapid EV chargers to be rolled out to petrol stations nationwide (2017) – [http://utilityweek.co.uk/news/rapid-ev-chargers-to-be-rolled-out-to-petrol-stations-nationwide/1311002#.WfitJWi0PD6]
[16] The Express – Mercedes invest in radical electric car technology which could revolutionise the industry (2017) – [http://www.express.co.uk/life-style/cars/854560/Mercedes-electric-car-battery-charging-technology-Daimler]

MARKET DEVELOPMENT

State of Play for EVs

In 2017 there were approximately **113,00** EVs on the road in the UK, comprising **64,000** non plug in hybrids, **29,000** plug in hybrids and **20,000** battery electric cars.

During 2017, more than **53,000** new ULEVs were registered in the UK, an increase of **27%** on 2016. New registrations of ULEVs have been rapidly increasing since 2014.[17]

From July to September 2017, **14,600** new ULEVs were registered in the UK, an increase of **33%** of the same period in 2016. Most of this increase has been vehicles eligible for plug-in car and van grants. New registrations in 2017 included **46,058** cars and **1,241** LGVs of models that were eligible for these grants, which was **89%** of all ULEVs registered for the first time. The generic models of ULEV most registered for the first time in 2017 were the **Mitsubishi Outlander (7,408)**, followed by the **BMW 3 Series (5,871)** and the **Nissan Leaf (5,665)**.

The majority of ULEVs are hybrid electric or pure electric. At the end of 2017, 64% of licensed ULEV cars in the UK were petrol hybrid and 35% were pure electric. The remaining 1% were diesel hybrid or used other technologies.[18]

The UK has more than 12,500 public charge points, and its network of more than 900 rapid charge points is the largest in Europe. More than 89,000 domestic charge points have been installed under the Electric Vehicle Homecharge Scheme (EVHS) and predecessor schemes. This is in addition to workplace charging schemes, to which more than 360 private and public organisations have applied. More than 1,300 sockets have been approved and more than 500 have been installed since the scheme launched in November 2016.[19]

Public charge points are generally aggregated in densely populated urban areas. In April 2016 the longest drive from a public road to a public charging points was 47 miles (76km), in North Devon, and distances between charge points varied widely; the average distance between charging point was 3.8 miles (6km).[20] Large numbers of charging points have been installed since then, as consumer take-up of EVs continues to be backed by policy and infrastructure investment., Zap Map provides comprehensive but not exhaustive locational data of charge points for EV owners, and to highlight the improvement in deployment of charging infrastructure in 18 months, a search in North Devon shows that the furthest charge point between Bishops Nympton (highlighted) and Tiverton or Exford is now approximately 15-17 miles (24-27km).[21]

EVs and Network Infrastructure

National Grid's 2017 Future Energy Scenarios suggested that if the rate of consumer take-up of EVs were to continue, large increases in peak demand could result. When considered in parallel with increases in heat demand and heat electrification, whole system coordinated approaches will be required and investment in smart technologies as well as distribution and transmission infrastructure. This will be supported by solutions and new commercial arrangements that deliver value to consumers.[22] The anticipated impact on demand emphasises the need for coordinated approaches as challenges will be faced across all industry sectors, by multiple market participants.

National Grid's projections suggested that electricity peak demand could be as high as 85GW in 2050, compared to around 60GW today. This would be driven by many new technologies and solutions such as the electrification of heat, cooling and transport, which could create an additional 8GW of demand at peak times. In addition, increased use of air conditioning due to changing weather patterns could raise the summer peak demand to a level similar to winter peak demand.[23]

At a local network level, Scottish and Southern Energy Network's (SSEN) My Electric Avenue project found that across Britain 32% of local electricity networks (312,000 circuits) will

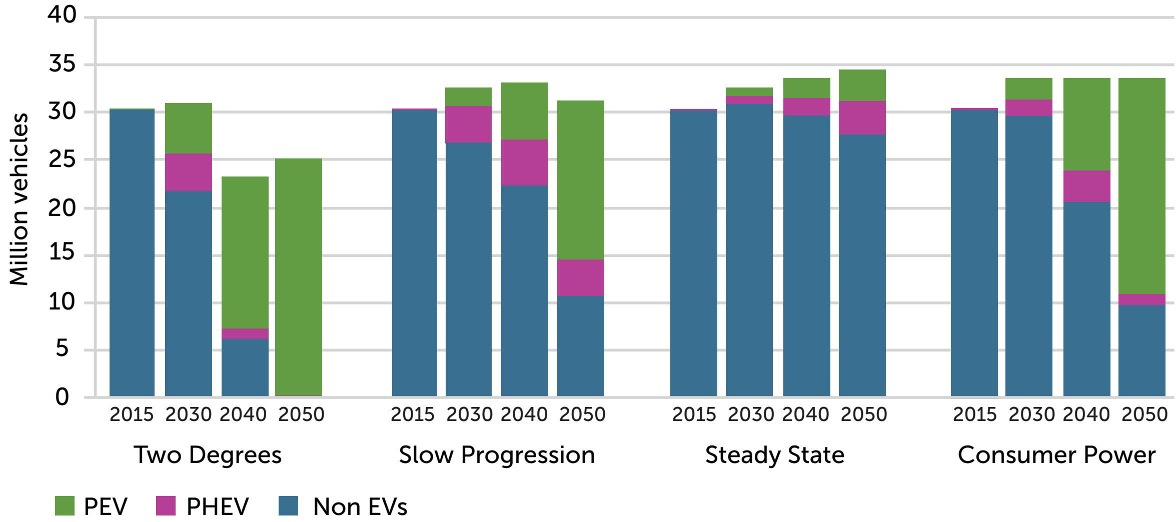
[17] Department for Transport – EV Statistics (2018)
[18] Department for Transport – Vehicle Licensing Statistics: Quarter 1 (Jan – Mar) 2017 – [https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/620223/vehicle-licensing-january-to-march-2017.pdf]
[19] Office for Low Emission Vehicles – Chargepoint Data (2017) – Statistics requested to end of September 2017
[20] BBC – Electric cars: Longest distances to charging points revealed (2016) – [http://www.bbc.co.uk/news/uk-england-36102259]
[21] Zap Map – Search on EV Chargepoint Proliferation in North Devon 5th October 2017 – [https://www.zap-map.com/live/]
[22] National Grid – Future Energy Scenarios (2017) p. 03 © National Grid plc, all rights reserved
[23] National Grid – Future Energy Scenarios (2017) p. 5 © National Grid plc, all rights reserved

require intervention when 40%-70% of consumers have EVs, and that new technology and smart solutions could reduce the cost by around £2.2 billion by 2050.[24]

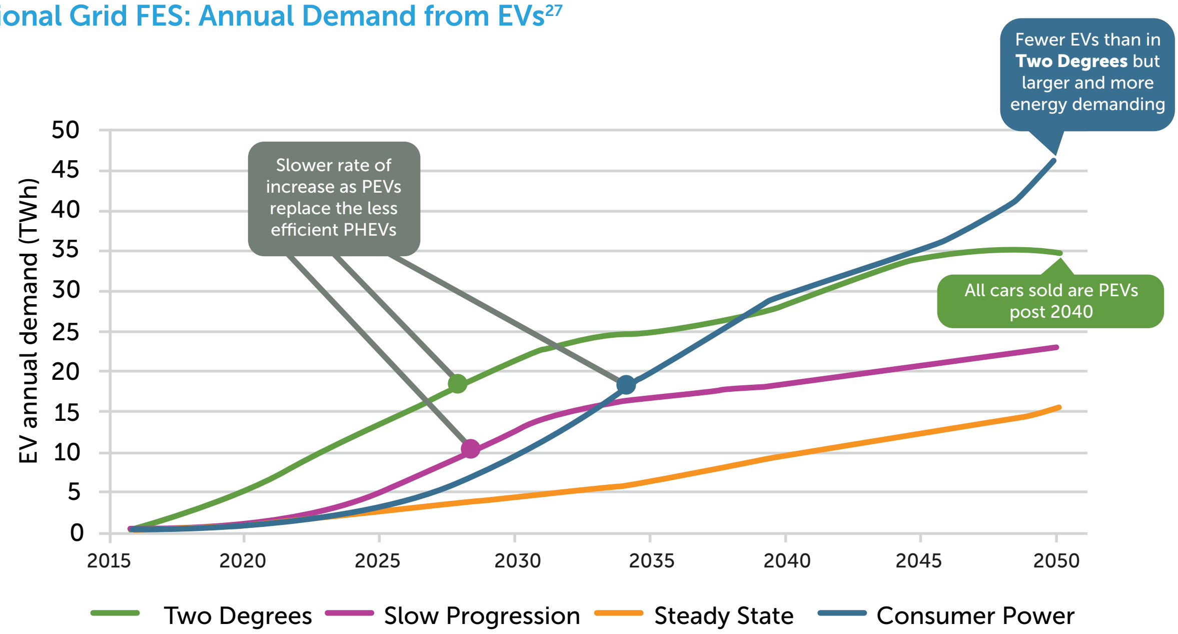
There has been some uncertainty around the infrastructure costs of EVs, due to vehicle charging requirements and the effects of vehicle clusters on the local electricity networks. Some sources have suggested that the cost of network reinforcement would outstrip the cost benefit case on offer for the move to EV and that a number of new nuclear power stations would be required to meet charging demand alone. National Grid in 2017 moved to clarify these suggestions; its Two Degrees Scenario showed that peak demand from EVs would equate to approximately 5GW, or an approximate 8% increase on today's peak demand.[25]

The graphs below describe four scenarios for the growth of electric vehicles and the growth impact on annual demand, taken from National Grid's Future Energy Scenarios. The first graph covers Pure Electric Vehicles (PEV), Plug in Hybrid Electric Vehicles (PHEV) and non-Electric Vehicles, projecting average growth to 2030, 2040 and 2050 across the four scenarios.

National Grid FES: The Growth of EVs[26]



National Grid FES: Annual Demand from EVs[27]



[24] Western Power Distribution – Electric Nation: The Need for the Project (2017) – [https://www.electricnation.org.uk/about/the-project/]
[25] National Grid – Our Energy Insights – Electric vehicle announcement and what the papers say (2017) © National Grid plc, all rights reserved [http://fes.nationalgrid.com/media/1264/ev-myth-buster-v032.pdf]
[26] National Grid – Future Energy Scenarios (2017) p. 41 © National Grid plc, all rights reserved
[27] National Grid – Future Energy Scenarios (2017) p. 42 © National Grid plc, all rights reserved

CASE STUDY 3

Transport for London

In April 2017 Transport for London (TfL), the Transport Authority for the City of London, announced £18m in funding, which includes funding for rapid charge points that are capable of charging EVs in 30 minutes. This investment includes measures for dedicated charge points for taxis, plans to encourage drivers of the most polluting vehicles to go electric and consumer friendly payment models. The initial aim for some of this investment is to see 75 charge points in the ground by the end of 2017, with the network growing to 150 by the end of 2018 and 300 fully functioning by 2020. This is backed by partners who include network providers and charge point manufacturers and installers. The TfL strategy acknowledges that an extensive network of rapid chargers is essential to facilitating the move for consumers from diesel and petrol to electric.[28]

CASE STUDY 4

Electric Nation (Western Power Distribution, Lucy Electric and partners)

The Electric Nation project is being hosted by Western Power Distribution. It is being delivered by a partnership of EA Technology, DriveElectric and Lucy Electric Gridkey. The project, funded by Ofgem through its Network Innovation Allowance scheme, aims to provide local electricity network operators with the tools to ensure that their networks can cope with the challenge of transport electrification, while avoiding replacing cables and substations.

CASE STUDY 5

Management of Plug-In Vehicle Uptake on Distribution Networks (Scottish and Southern Electricity Networks)

This project will seek to inform an ENA Engineering Recommendation (or equivalent) for the connection, charging and control of new, large, plug-in vehicle loads to domestic properties. The project focuses on the collaborative approach required to support controlled PIV charging. It aims to enable significantly larger numbers of PIV charging on today's local electricity distribution networks, with sizeable reductions in reinforcement costs and consumer bills or disruption.[29]

BEAMA's involvement in this project and initial discussions indicate the preference for a constrained charging function for EV charge points to manage demand at local network level. It is suggested that interventions from the network operator will be infrequent and will not stop a consumer from charging. Instead of an on/off switch, there could be a reduction in the charging capacity of charge points connected to the local network. BEAMA is working with SSEN and EA Technology to avoid limiting the penetration of future technologies, solutions and applications. BEAMA will continue to work collaboratively with network operators to help ensure the best solution for the consumer and the wider energy system and continue to advocate market, technological and service solutions that avoid unnecessary interventions.

[29] SSEN – Management of Plug-In Vehicle Uptake on Distribution Networks (2017) – [http://www.smarternetworks.org/Project.aspx?ProjectID=1883]

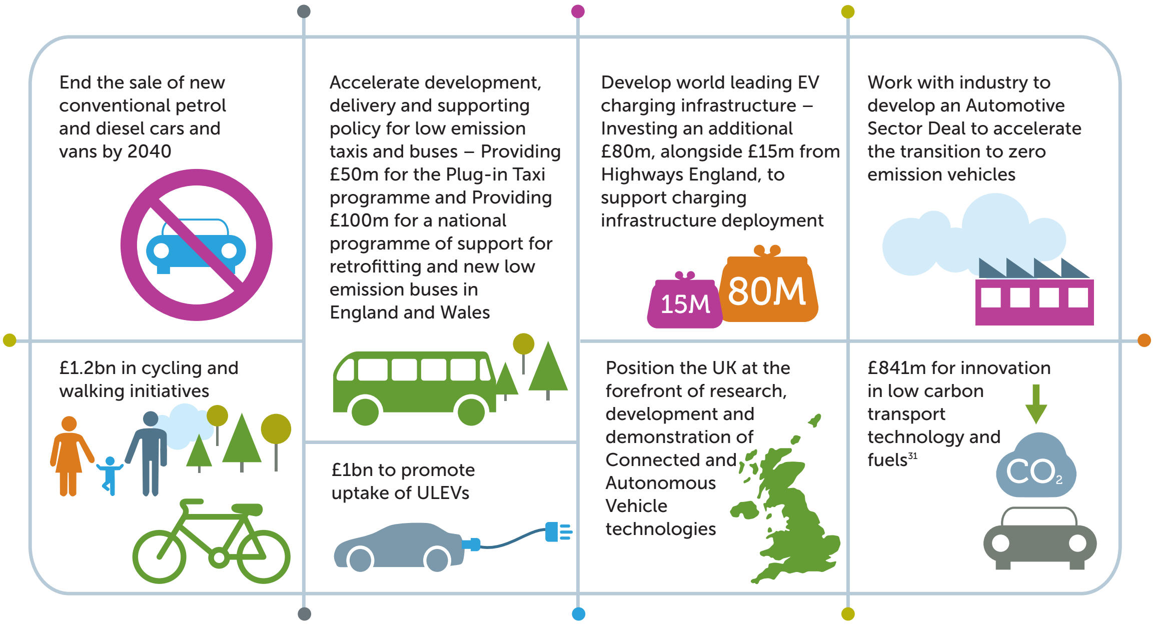
POLICY HIGHLIGHTS

In 2017 The UK Government committed to ban the sale of all diesel and petrol cars and vans by 2040 and require all newly registered vehicles to be zero emissions. This is a defining move for the future of road transport. Whilst the main driver for this change was to improve air quality, the benefit is twofold as the take-up of ULEVs will help to decarbonise transport.

A trajectory has now been established that will deliver a move away from traditionally fuelled vehicles. This forms part of a £3bn Government programme to improve air quality and reduce emissions from vehicles, alongside Government promises to publish a Clean Air Strategy for 2018. Whether this results in the move to an EV majority or another alternative clean fuel source in the coming decades remains to be seen, but the business models of the vehicle manufacturers all suggest that EVs are likely to be the largest market.

In July 2017 the Government announced that was "taking bold action and want[s] nearly every car and van on UK roads to be zero emission by 2050, which is why the Government committed to investing more than £600m in the development, manufacture and use of ultra-low emission vehicles by 2020."[30]

The Clean Growth Strategy (2017) identifies the key enablers and requirements of the shift to low carbon transport and a low carbon economy. The Strategy sets out a comprehensive set of policies and proposals that aim to accelerate the pace of "clean growth", which is increased economic growth and reduced emissions. The strategy covers transport, power, cross-sector, smart systems, homes, business and industry, land use and waste sectors. A breakdown of the Clean Growth Strategy funding dedicated to the transport and transport emissions sectors is below:



The Automated Electric Vehicles Bill was announced as part of the Queen's speech in 2017. This is an infrastructure focussed Bill designed to improve infrastructure for EV charging and hydrogen refuelling. The ambition is to establish a level of commonality and standardisation at key locations off motorways and at large re-fuelling stations. Common technical and operational infrastructure will be installed to be simpler and more accessible to consumers. It is hoped that the ensuing operational and technical standards will facilitate new applications and solutions such as Demand Side Response (DSR) and Vehicle to Grid (V2G). The involvement of EVs in providing DSR and storage will reduce the amount of new generation and network investment that will be needed, lowering overall system costs.[32] This Government commitment to addressing key infrastructure challenges in this way clearly show an ambition to move to a smarter system.

CASE STUDY 6

Norwegian EV Policy

Norway has the highest penetration of EVs in the world, with about 30% of registered cars running on electricity. Most of this is renewable energy: with more than 99% of electricity being generated by hydro. Its ambition is that 100% of vehicles will be fuelled by low or zero carbon energy by 2025, with most of them electrically powered.[33] Such progressive and radical policy combined with government ambition can have a significant impact on the environment and the energy sector.

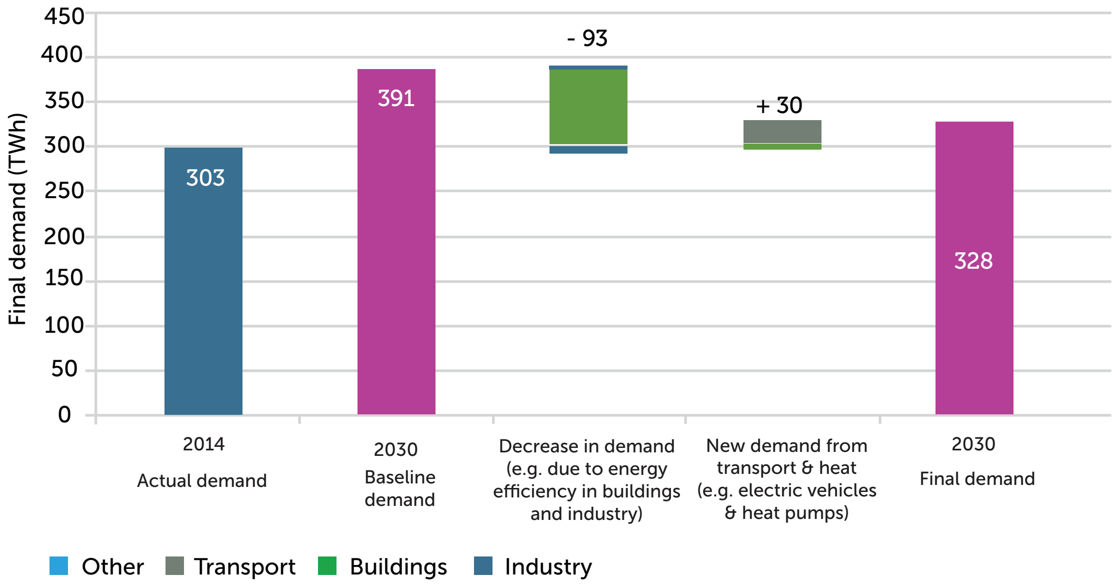
30 DEFRA – Plan for roadside NO2 concentrations published (2017) – [https://www.gov.uk/government/news/plan-for-roadside-no2-concentrations-published]
31 HM Government Clean Growth Strategy (2017) pp. 14 and 15
32 BEIS – Upgrading our Energy System: Smart Systems and Flexibility Plan (2017) pp.13 and 15
33 The Independent – Norway to 'completely ban petrol powered cars by 2025 (2016)

THE TRANSITION TO ELECTRIFICATION OF TRANSPORT

The electrification of transport brings with it inherent challenges, although these may be outweighed by the long-term value, carbon reductions and flexibility on offer.

The Cost of Energy Review (2017) highlights the importance of energy efficiency in buildings to play a part in demand reduction, whilst acknowledging that electrification of transport and increasing electrification of heat that will serve to increase electrical loads, reducing demand in other areas and improving energy efficiency is essential. This is highlighted in the graph below which is taken from the review and via The Committee on Climate Change – Advice on the fifth Carbon Budget (2015) paper.[34]

Demand vs Projected 2030 Demand[35]



Source: Committee on Climate Change (2015), Advice on the Fifth Carbon Budget.
Notes: OCGT, open-cycle gas turbine; CCGT, closed-cycle gas turbine.

The electrification of transport will bring a wholesale change in the way that the electricity system is used, so appropriate policy and regulatory support is required to ensure that the network is fit for purpose. Network Operators face the challenge of ensuring that the network can handle the increased requirements, and consumers will need to be assured that charge points will be connected in a straightforward and standardised way across all network operators' geographic licence areas.

Network Operators can benefit from energy efficiency as a reduction in demand, or more effective management of demand through demand side response and storage, can in some instances delay or entirely offset the need to invest in making upgrades to the network such as the replacement of substations.[36] Inevitably there will be a need for targeted reinforcement in areas where the network is being stressed with a combination of smart solutions to reduce or manage demand, there is no one size fits all solution and therefore targeted approaches consisting of reinforcement and smart solutions typically based on demand and are recommended.

Smart Charging of EVs and studies of their impacts have been undertaken to seek innovative solutions in handling the shift numbers are currently low and more manageable. The point at which EV proliferation becomes a more fundamental network issue is foreseeable and innovative ways of handling connection to the networks combined with flexibility approaches such as DSR and any smart charging. These options should be managed in a way that does not dilute the consumer offering to such an extent that charging a vehicle becomes complex and subject to frequent interruptions.

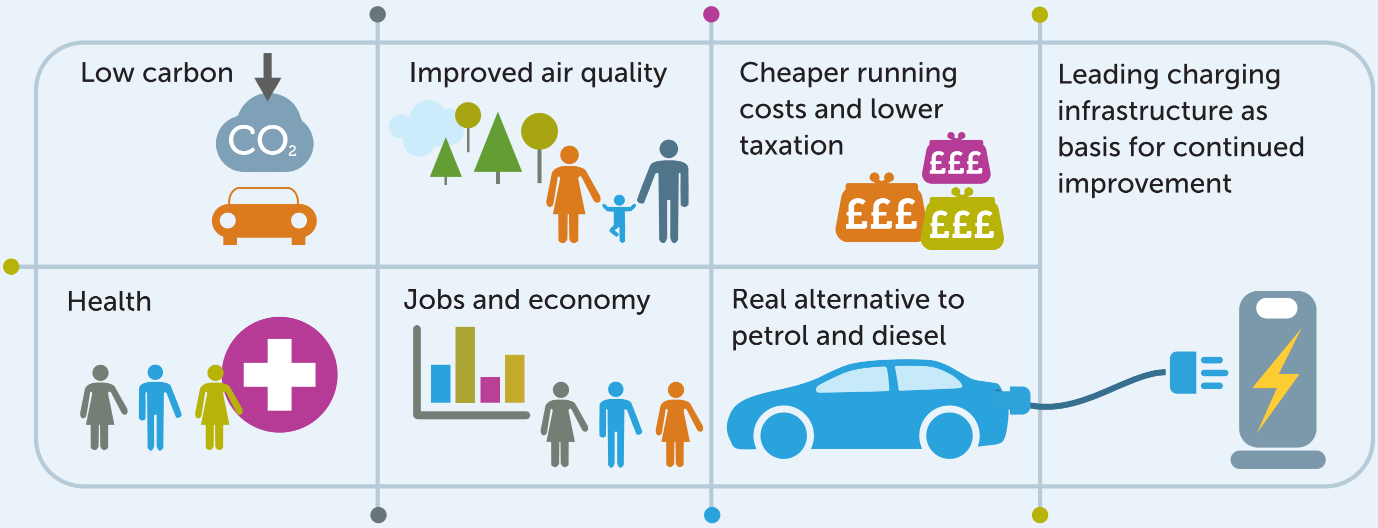
How EVs will aggregate geographically is an important consideration, it is expected that clusters of EVs will develop in urban areas, cities and suburbs, greater investment and infrastructure spending and greater policy focus on EVs and their associated benefits such as air quality regulation. Current technology focussed concerns around cost and range, refuelling and cost will not be prevalent long term, advances in batteries and cost, infrastructure and vehicle technology will serve to increase consumer trust and alleviate concerns around vehicle range, upfront investment and add to the known benefits.

34 BEIS – Cost of Energy Review (2017)
35 Committee on Climate Change (2015) – Advice on the Fifth Carbon Budget
36 UK Power Networks – Vulnerable Consumers and Energy Efficiency (2013) – [http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Energywise/Project-Documents/VCEE+Bid+Submission+2013.pdf]

Consumer Charging Habits Explored

The My Electric Avenue Low Carbon Networks Fund (LCNF) project undertaken by SSEN in partnership with EA Technology looked to explore the impacts on charging EVs at peak times and how any impact could be effectively managed and/or mitigated by network operators. The project successfully recruited successfully recruited over 100 people in different clusters (10 or more people using EVs) around Great Britain. The trial found that some of the local network will require reinforcement with the increased demand brought about by consumers opting for EVs. It is noted that this study focussed on 3.5 kW charging and advances in charging capacities and batter technology have been witnessed since the trial closed. The project also explored charging habits and found that those in the EV clusters studies were more likely to charge before and after work. Approximately 70% of EVs are charged only once a day, with more than 65% being charged until the battery is full.[37]

Benefits



This charging behaviour is in line with current EV charging patterns, with peak demand in the morning and evening. But this also presents an opportunity, suggesting that if behaviour is predictable then it may be easier to influence with the appropriate new services and business models.

A Road Map for Flexibility

The Roadmap for Flexibility Services to 2030 and the paper's modelling assumes that up to 80% of EV demand could be shifted away from a given hour to other times of day, and that this is a realistic scenario. It is also suggested that the interruptible charging could be used as a low cost and easily accessible form of frequency response and control without substantially infringing on the consumers charging of their electric vehicle[38] These findings suggest that whilst integration of EVs into the networks is a challenge the toolkit exists to manage and mitigate any negative impacts of EVs.

Charge points that facilitate smart charging, and the wider standardisation process is well underway through BEAMA, BSI and European agencies. The primary issue for them is not technical but one of demand and cost. The UK market is extremely price-driven at present and does not readily sustain products of higher quality with good support and features to ensure longevity. To create market demand for these more sophisticated products, the electricity pricing regime must be right but we also need to change the purchaser's valuation criteria.

Whilst remaining very cautious about standardisation and legislation, there is recognition that there are calls to mandate certain functionality within charging equipment e.g. the capacity to perform smart charging. This offers an interim solution for Networks Operators to manage demand on the networks and ensure quality of supply and minimise interruptions, however any smart charging solution must not be exclusive and allow capability for other smart home functions and technology to interface as required.

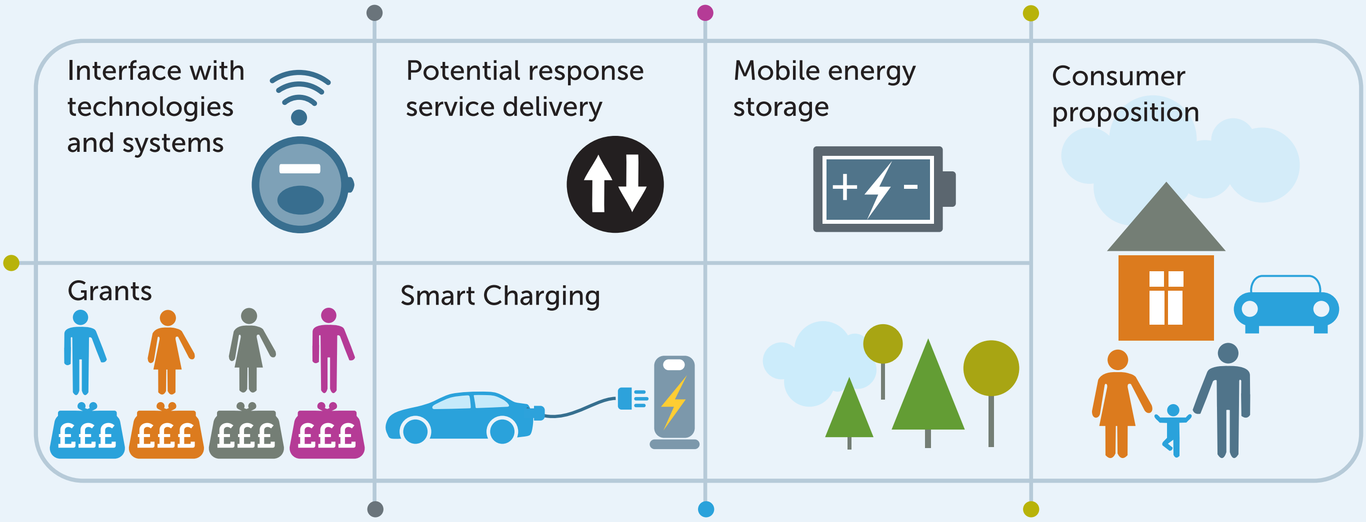
The EV market is dynamic and as such it is affected by developments in technology, public and media attitudes, government policy and many other outside influences. However unpredictable the market, most stakeholders do agree that sustainable levels of growth are achievable given the right conditions. Many standards have been developed over the last few years and we are starting to see a level of standardisation in this area although it continues to be

37 EA Technology – My Electric Avenue: This is What We've Learnt (2016) pp. 4,6 and 7
38 Poyry and Imperial College – ROADMAP FOR FLEXIBILITY SERVICES TO 2030 [2017]

important to proactively identify needs and respond accordingly. There are also challenges ahead for interoperability, reliability, and safety as equipment is produced outside of agreed standards and certification norms.[39]

Whilst cost and range concerns are have been prominent in initial years, this has done little to deter consumer interests and uptake with over 100,000 electric vehicles now registered. Technology has demonstrated that it can rapidly improve in regard to charging and EV batteries whilst at the same time EVs are reducing in price. At the current trajectory and with costs decreasing and technology improving the proposition to the consumers continues to grow in appeal

Opportunities

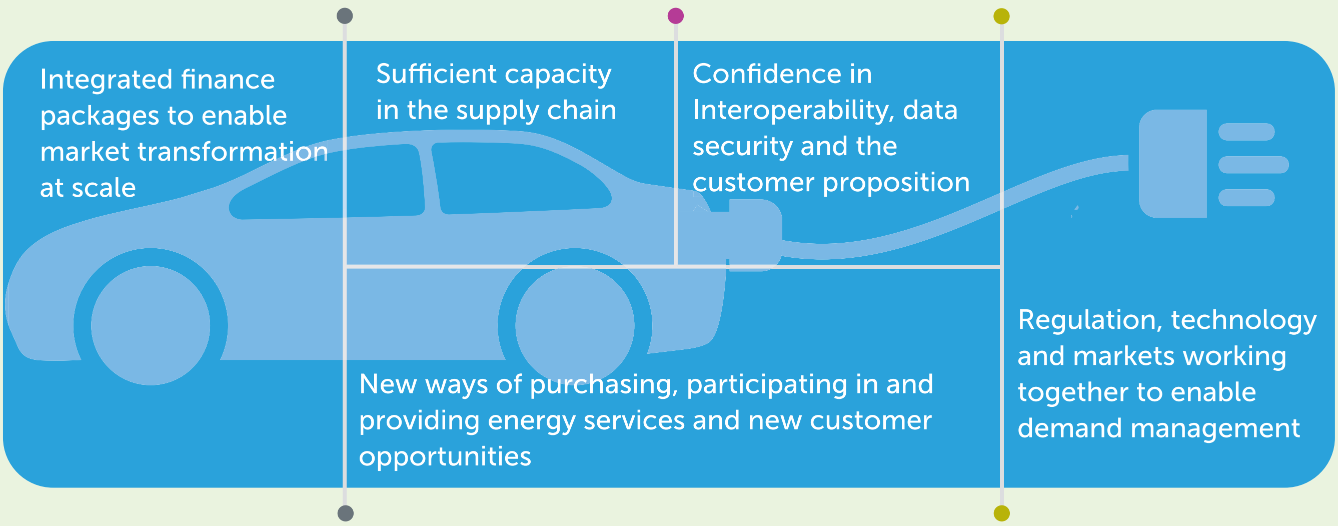


RECOMMENDATIONS

Routes to Market and Market Imperatives

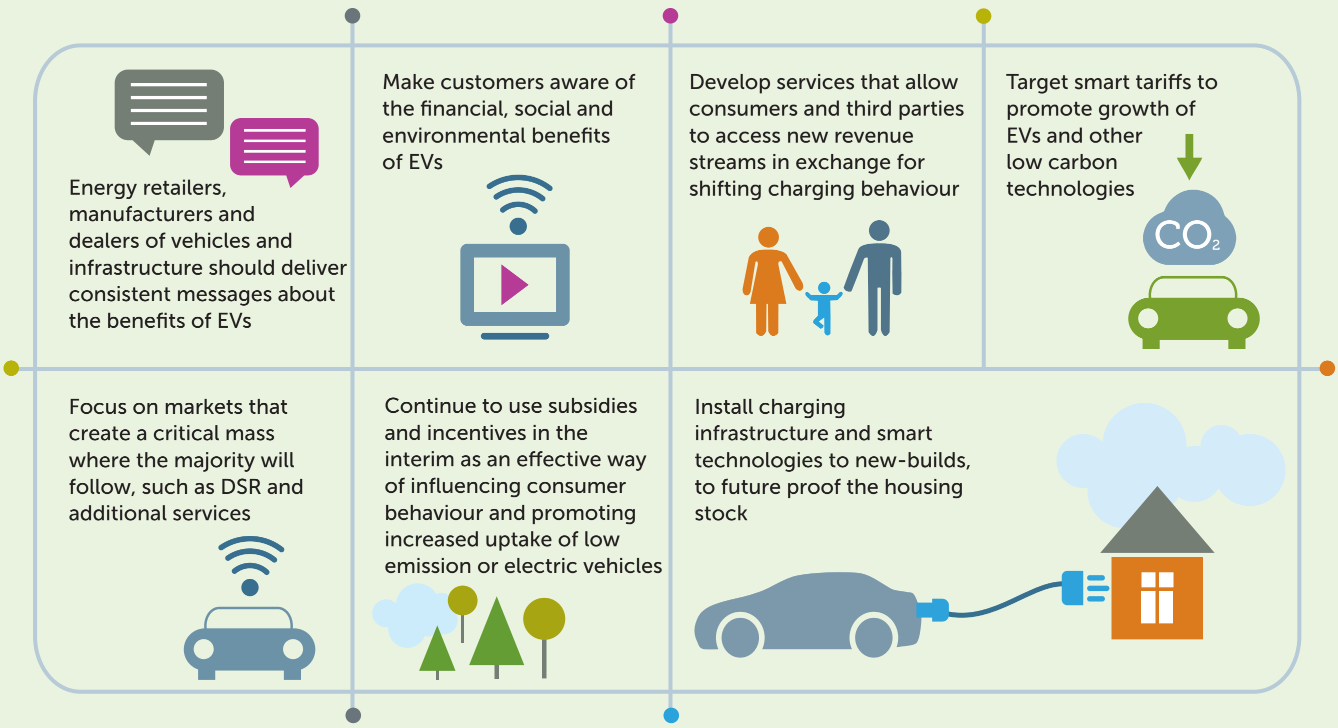
As the market expands, the cost of smart home products will fall and interactive services and demand-side price signals will bring new value to consumers. It is essential that consumers retain confidence in the value for money of smart controls, and that the upstream beneficiaries of smart data management pass on savings in an equitable and transparent fashion. This will naturally lead to new and more complex ways of buying or leasing devices and energy services, and the increasing complexity of the market will have far-reaching consequences for how we think about competition and consumer protection.[40]

Market Imperatives



39 BEAMA - BEAMA Guide to Electric Vehicle Infrastructure (2015)

40 BEAMA Electrification by Design Series – Smart Homes by Design: Market Imperatives for the Internet of Things (2018) - http://www.beama.org.uk /news/beama-publishes-its-firsts-report-in-the-electrification-by-design-series.html

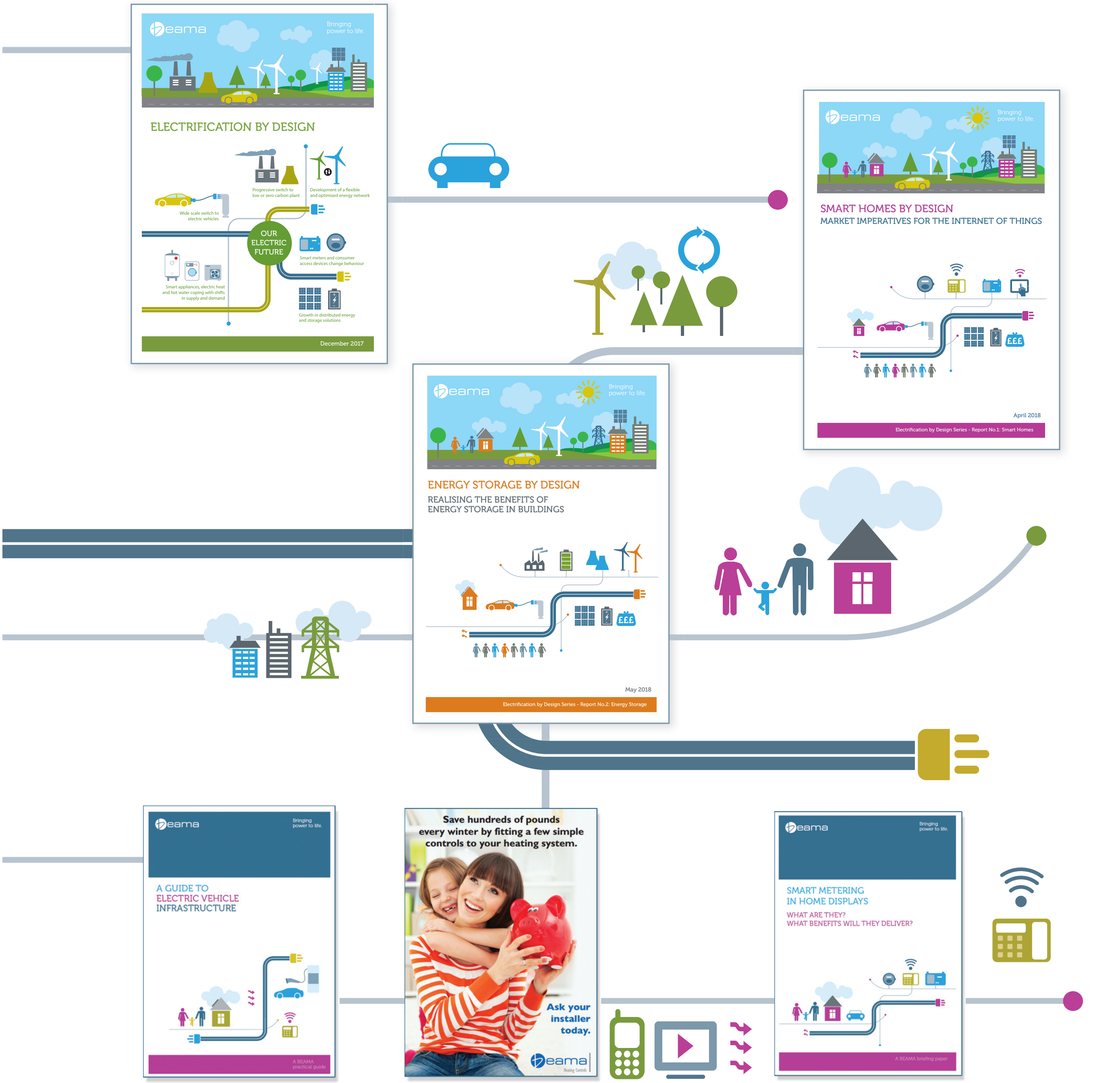


CONCLUSIONS

The electrification of road transport is a critical aspect of the broad, nationwide changes that will occur over the coming decades as we transition to a low-carbon economy with smart, responsive and flexible energy systems. The rollout of EV charge points to buildings, streets and forecourts, and the related investment in supporting infrastructure, will be a task greater even in scope, importance and complexity than smart metering, with an even greater impact on the way we use and manage energy. It poses challenges for planners, with new implications for building regulations and demands on land for public charge points; for Government, market regulators and the organisations that manage the networks; and for the markets themselves, as innovative market models emerge that will engage consumers in new ways.

There are technical, financial and policy issues to overcome. But transport electrification also presents a huge and exciting opportunity for the supply chain, including manufacturers and service providers, to find new ways of engaging with their customers. BEAMA is committed to taking a central role in these changes, just as it has for the smart metering programme, by representing the views of the supply chain and helping its members understand the implications of the rapidly changing market and policy landscape.

For further reading on the subject of electrification, visit www.beama.org.uk and download one of our associated publications



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