BEAMA SECTOR TURNOVER

£12.6 BILLION

BEAMA SECTOR EXPORTS

£4.2 BILLION

NET-ZERO BY DESIGN

Developing a UK market for low carbon technologies

BEAMA industries back the net-zero emissions by 2050 target and agree to take action in meeting the level of ambition required. The industry calls for urgent action and strong leadership from Government to support their commitment.

September 2019

Supporting organisations

Report sponsors

Powering Business Worldwide

Eaton is a power management company with 2018 sales of $21.6 billion.

We provide energy-efficient solutions that help our customers effectively manage electrical, hydraulic and mechanical power more efficiently, safely and sustainably. Eaton is dedicated to improving the quality of life and the environment through the use of power management technologies and services. Eaton has approximately 99,000 employees and sells products to customers in more than 175 countries.

POWERED BY SPECIALISTS

Legrand is the global specialist in electrical and digital building infrastructures, offering high-value-added products and solutions for commercial, residential and industrial buildings.

In the UK the business is organised into six business units: cable management; power distribution; wiring devices; assisted living & healthcare; digital infrastructures; and energy controls. We manufacture approximately 80% of the products we sell in the UK, which means we have local expertise in research and development, design, production and technical support.

Glen Dimplex Heating & Ventilation are dedicated to the design and development of sustainable heating, cooling, ventilation and hot water products and systems for both commercial and residential settings. We believe the future of HVAC lies in product innovation which contributes to a sustainable, zero carbon future, and we are devoted to continual investment in low carbon technologies.

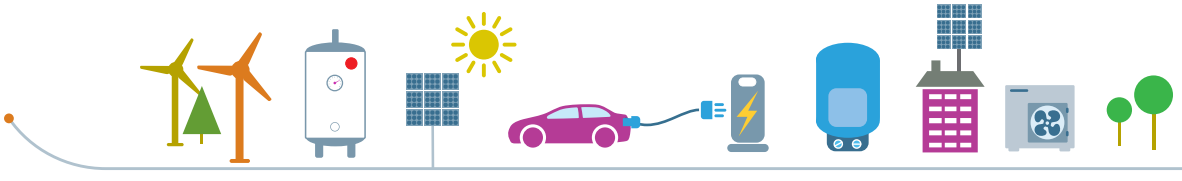
Our extensive product portfolio spans from the Edel Hot Water Heat Pump and Mechanical Ventilation and Heat Recovery, through to the Zeroth Energy System and a range of HVAC emitters that all support comfortable, sustainable living.

Glen Dimplex is an active member of BEAMA and multiple other industry associations across Europe and we are proud to do our part in the creation of a more comfortable, efficient future for everyone.

The Vaillant Group is an international family-owned company with a heritage of more than 141 years in providing customers with energy-saving and easy to operate solutions for heating, cooling and hot water.

The company develops and manufactures its products and services at sites in the United Kingdom as well as Germany, France, Spain, Italy, Slovakia, Turkey and China.

In its core business of heating technologies the company is the second-largest European manufacturer in this sector. The Vaillant Group has a growing focus on products and systems that use renewable energy. There is a growing demand for these products across Europe, and the focus of the Group in this area relates strongly to heat pumps, which utilise the heat from the earth or the ambient air, and solar thermal systems. The development of Hybrid systems which combine renewable energies with heating appliances to create highly efficient and intelligent systems, is also a key focus area for the business.



CONTENTS

ELECTRICAL INDUSTRY COMMITS TO NET-ZERO 2050 EMISSIONS TARGET

This letter sets out the electrical equipment and system manufacturers' commitment to the net-zero 2050 target. Represented by BEAMA, the companies signed up to this commitment agree that urgent action is needed in order to reduce the devastating effects of climate change.

We support the Government's work to regulate for this new target and as domestic and international businesses we commit to reducing our own emissions as well as meeting the needs of the supply chain for the transition to net-zero by 2050. Some BEAMA members have already gone a step further and made the commitment to meet net-zero by 2030 for their global operations.

The technologies required to enable decarbonisation of the building stock, transport and energy system are largely available today; however, the challenge is deployment at scale. Government and industry now need to elevate the level of ambition in order to drive the dramatic step change needed to ensure the net-zero target can be met, through long-term policy and regulatory frameworks and market incentives. This includes the delivery of low carbon heating and hot water, energy storage capacity, a robust and flexible energy system with appropriate market mechanisms, and the development of a national electric vehicle charging infrastructure.

There will be a need for significant investment from industry and Government to achieve these goals. As businesses we have invested and will continue to invest in the necessary R&D to bring suitable technologies and skills to market in the UK and phase out carbon-intensive energy products. This level of market transition needs long-term regulatory and market clarity as it is essential to encourage and ensure private investment into the UK. The current policy and regulatory landscape is not delivering this certainty.

We will work with Government and other important stakeholders to ensure detailed strategic plans for the deployment of low carbon technologies can be developed with appropriate regulatory and financial frameworks. Affordable market access for consumers and businesses will be central to getting the regulatory and market incentives right, and the finance industry needs to be a positive and active player.

Here BEAMA, led by our membership, launch a commitment and views on the necessary steps along the journey to 2050, and through our Senior Sector Council will work with Government to deliver on the joint climate targets.

Dr Howard Porter

CEO, BEAMA

beama

Letter signatures

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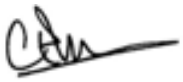

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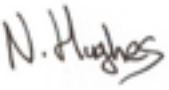

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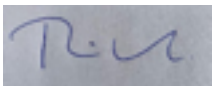

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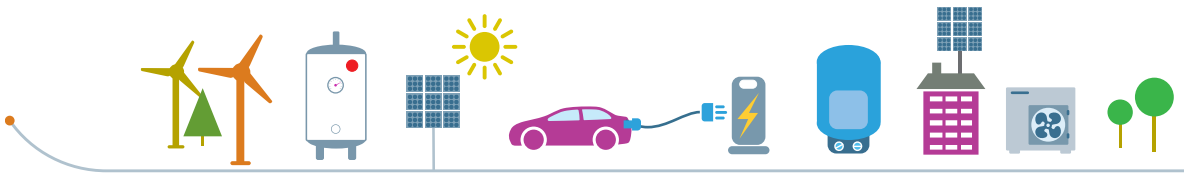

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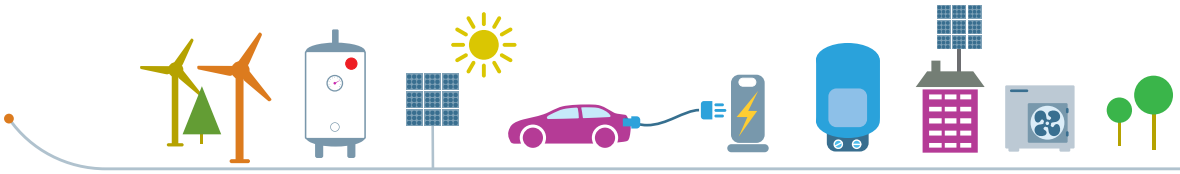


OUR SECTOR

BEAMA is the UK trade association for manufacturers and providers of energy infrastructure and systems.

We represent more than 200 companies, from start-ups and SMEs to large multinationals. Our members provide HVAC products, EV infrastructure, electrical transmission and distribution equipment, energy storage and flexibility assets in networks and the built environment, to support a safe and secure low carbon energy system.

We are a significant part of the UK 'electrical manufacturing' sector and represent an industry:

WITH A TURNOVER OF

£12.6 BILLION

EMPLOYING A WORKFORCE OF

89,500

EXPORTS TO A VALUE OF

£4.2 BILLION

OUR VISION

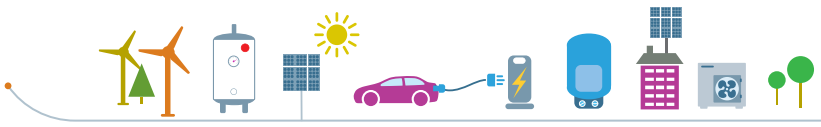
As an industry trade association our vision is to ensure and establish:

- A market for safe, secure and compliant products
- A prosperous export market for our members
- A strong investment environment for new technologies
- A low carbon smart flexible energy system
- A robust market for low carbon heating and storage

OUR TECHNOLOGIES

BEAMA's sector represents a wide range of technologies and sub sectors, including:

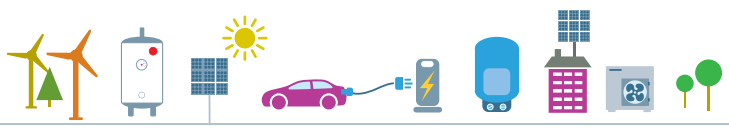
- Transmission and distribution equipment for the electricity grid
- Smart IoT devices for buildings
- Heating, hot water and ventilation products
- Electrical installation products for the built environment
- Storage – thermal, phase change, battery
- Electric vehicle charging infrastructure
- Smart metering



CONTEXT

The nature of the grid and the way people access electricity are changing fundamentally, driven by digital transformation and a trend towards prosumers taking control of their energy choices by generating and trading their own electricity. Acknowledging the need to manage increased demand on the system in coming years from electric vehicles and low carbon electric heating, we need to develop robust, long-term infrastructure plans to help drive investment and ensure the resourcing of the supply chain needed to deliver on the net-zero target. Key to this will be significant investment in low carbon energy solutions and co-location of storage with renewable generation assets, including smaller scale distributed generation. Developing the system's capability for flexibility through technologies such as storage will be essential to decarbonising the system and tackling the volatility that stems from increased levels of renewable energy generation. However, the current regulatory and investment landscape for this market is unlikely to allow the level of uptake needed to enable this transition.

We accept the road to net-zero requires a further and more radical step change in the evolution of the UK energy supply chain. BEAMA is uniquely placed to represent the end-to-end supply chain for electrical products and is working across the sector and with Government to achieve the change necessary.



INTRODUCTION

BEAMA, led by its members, has set a commitment to deliver on the net-zero by 2050 target. The success of this target is dependent on industry and businesses adapting to stable and effective regulation ensuring the appropriate investment signals in the market.

In this report we reflect on existing policy and regulation, and some recommendations for future policy design which will support the supply chain in delivering on the requirements of the net-zero target.

As outlined in the Committee on Climate Change report, **the target is feasible because the technology is available and understood, but changes can only be implemented with strong leadership from Government.** In this report we outline areas where we believe ambition is lacking and there is a need for urgent action – whether that's regulation, policy, standards or market design and incentives.

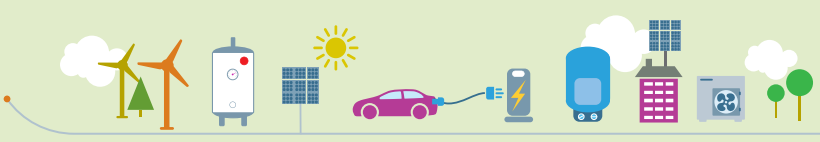
Technology is a key enabler for our low carbon future, and there is great potential for the UK to be seen as a leader in innovation and new technology markets for smart flexible energy systems. As the first major economy in the world to set this target in law, we need to harness the opportunity for growth in the UK economy from this. UK leadership is a significant theme within the Committee on Climate Change recommendations, and we hope this theme will continue to be applied to domestic industries, such as the positive signs in the recent UK Green Finance Strategy[1]. BEAMA sees huge potential for the industry and growth in trade opportunities stemming from the transition to net-zero. In the lead up to COP26 we would like to start work now to gain momentum in the UK market for our transition to net-zero.

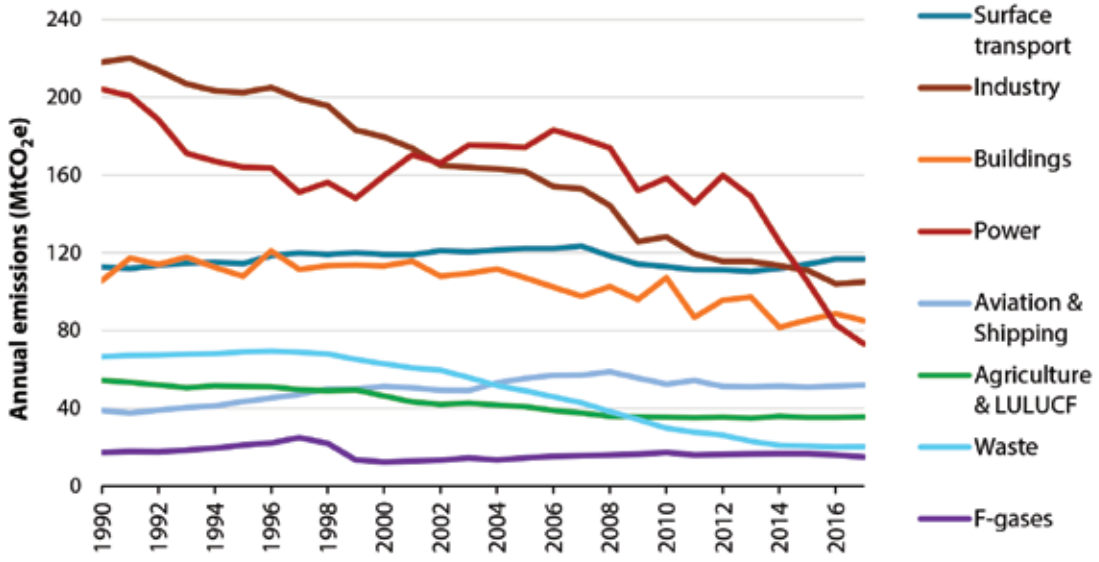
However, the current investment landscape for our sector is wavering at a time when we should be seeing a dramatic increase in the deployment of low carbon technologies. In this report we highlight the limitations today for inward investment and export, how as industry and Government we can tackle this together, and how we can reduce risk for businesses in the UK looking to invest in green, low carbon technologies.

"Reaching net-zero emissions in the UK will require high levels of investment in zero carbon technologies and considerable development and expansion of infrastructure, and innovation to reduce costs and improve the performance of low carbon technologies. Its delivery relies on business being able to invest, which in turn requires that they have confidence that they can earn a reasonable return.

However, a long-term target – even one in legislation – is not sufficient to provide the confidence. It is essential to have clear, strong, effective policies".

Committee on Climate Change, 2019 – Net Zero – The UK's contribution to stopping global warming





Source: BEIS (2019) Final UK greenhouse gas emissions national statistics 1990-2017; CCC analysis

Figure 1 – *Progress reducing emissions in the UK has been imbalanced*

Good progress is being made to decarbonise the electricity and power sector, whereas other key areas have remained stable or seen limited emission reductions in recent years. In this report we focus on the opportunity for emission reductions from heat and hot water within the building sector, associated policy, and how electricity system design and infrastructure can help bolster the decarbonisation of the built environment.

The Committee on Climate Change highlights that the heat and transport sectors have significant potential to decarbonise, and key to this is electrification and a move away from high carbon fossil fuel technologies. Looking closely at the scale of the challenge of electrifying the UK heating and transport systems, we have mapped some of the critical pinch points on the trajectory to 2050 and the regulatory timetable we are currently following. We determine when and how we can introduce new mechanisms to make the changes necessary and ensure the transition to net-zero is commercially viable for UK businesses and consumers.

The Net-Zero by Design report sits alongside the BEAMA *Electrification by Design* series – a comprehensive look at the challenges facing the UK in the electrification of heat and transport, and the market design imperatives to decarbonise through electrification. Published in 2018, the *Electrification by Design* Series introduced many of the principles we raise in this report regarding the transition to Net-Zero by 2050.

THE SCALE OF THE CHALLENGE – IN A SNAPSHOT

Here we look at some of the figures from the Committee on Climate Change and supporting research by Imperial College[2], which assessed the technical and whole-system cost performance of alternative decarbonisation scenarios for low-carbon heating in 2050. This is an attempt to provide insight into what decarbonising heat and upgrading the energy system to reach net zero by 2050 will require.

The Imperial research used three main scenarios to achieve the decarbonisation of heat: an electric scenario, a hydrogen scenario and a hybrid scenario. The overall cost to achieve net-zero in 2050 in these three scenarios is presented in the graph below:

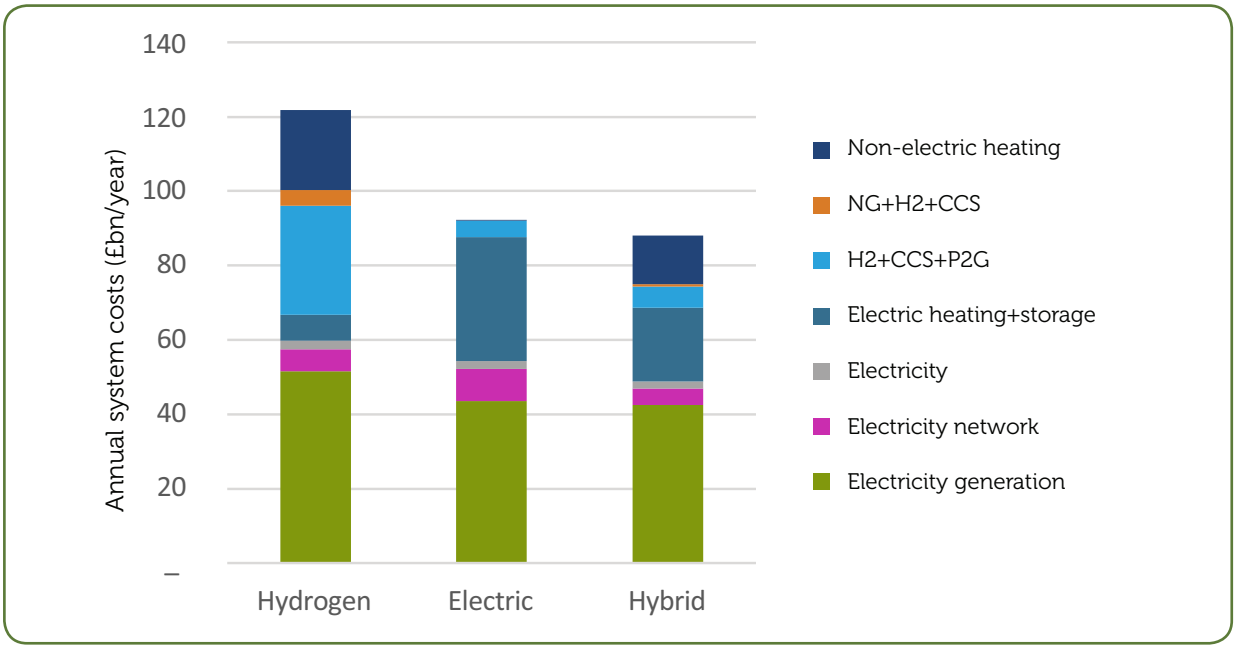


Figure 2 – *Annual system cost of core decarbonisation pathways, as modelled by Imperial College*[3]

Renewables

Below is a breakdown of the renewable generated capacity that is required, according to the modeling work carried out by Imperial, for each scenario, as well as the overall low-carbon generation costs. It is worth noting that, despite general thinking that the cost of generation will be a barrier to electrification, the costs for the electric scenario are the lowest amongst the three scenarios, due to the benefits of flexibility.

	Hybrid Scenario[4]	Electric Scenario	Hydrogen Scenario
PV	103 GW	129 GW	150 GW
Wind	82 GW	74 GW	120 GW
Nuclear	45 GW	43 GW	45 GW
Annualised cost	£41.3 bn/year	£40.9 bn/year	£48.9 bn/year

Table 1 – *Low carbon electricity generation capacity required to achieve decarbonisation of heat by 2050, for a range of scenarios, as modelled by Imperial College*[5]

Network investment and costs

One of the outcomes of the Imperial model is the network investments necessary to facilitate the decarbonisation of heat, according to each scenario. While very similar at a transmission and interconnection level, the distribution network investment will vary significantly depending on the scenario.

	Hybrid Scenario	Electric Scenario	Hydrogen Scenario
Transmission	£0.87 bn/year	£0.87 bn/year	£0.90 bn/year
Interconnection	£1.79 bn/year	£1.79 bn/year	£1.79 bn/year
Distribution	£1.83 bn/year	£5.88 bn/year	£3.32 bn/year

Table 2 – *Network annual investment required to achieve decarbonisation of heat by 2050, for a range of scenarios, as modelled by Imperial College*[6]

Electrification of heat – retrofit

The CCC modeling work has established that large scale deployment of low carbon heating must start before 2030. Estimates imply an annual cost for switching to low carbon heating in the order of £15 billion.

	2030	2050
Heat Pumps	2.3 million homes	17 million homes
Low Carbon Heat Networks	1.5 million homes	5 million homes

Table 3 – *Number of homes with low carbon heating in 2030 and 2050, as modelled in CCC's central scearior*e[9]

This implies that the electrification of heat will rely on retrofitting existing homes to a large extent, given the existing UK residential heatng mix.

Heating system	Percentage UK housing stock
Gas central heating	81.9%
Oil central heating	6.3%
Solid fuel central heating	0.5%
Electric central heating	0.7%
Communal heating	1.7%
Electric storage heaters	5.5%
Gas room heaters	0.5%
Solid fuel/oil room heaters	0.2%
Electric room heaters	2.1%
Heat pumps	0.6%

Table 4 – *UK residential heating mix*[7]

'Energy efficiency retrofit of the 29 million existing homes across the UK should be a national infrastructure priority'

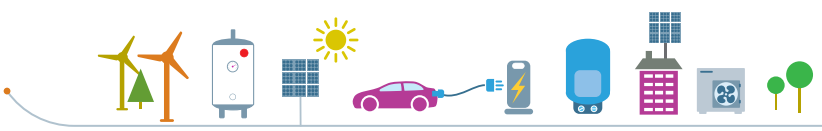
Committee on Climate Change, 2019 – Net Zero – The UK's contribution to stopping global warming

Energy Efficiency – retrofit

The CCC assumed that by 2030 there would be a 17% reduction in energy demand in homes due to energy efficiency measures:

Cavity Wall Insulation	Solid Wall Insulation	Topping up loft insulation
6 million homes	2 million homes	9 million homes

Table 5 – *Number of homes retrofitted with different types of insulation measures by 2030, as modelled in CCC's central scenario.*



GREEN FINANCE – DRIVING INVESTMENT INTO THE UK MARKET

BEAMA has reported to BEIS in recent months the struggling investment landscape for our sector. We must address barriers to investment in the UK to ensure the business opportunities are optimised and we do not pass up the opportunity for growth in UK manufacturing and associated services.

BEAMA welcomes the UK Government Green Finance Strategy which sets out some clear ambition with regards to accelerating the flow of finance into projects and technologies that will help deliver the net-zero target. It is positive to see Green Finance at the heart of Government's approach to enabling the transition to net-zero.

There are some robust actions within the Strategy, but what we call for within this report is further commitments on how Government intends to drive investment into the low carbon sector. This is needed for the creation of mass markets for key technologies we know are necessary in reaching the net-zero target.

The energy sector overall has seen significant levels of investment to date and this has certainly driven innovation and product development in the UK. This includes:

£92 BILLION

TOTAL INVESTED IN ENERGY SINCE 2010[10]

The Clean Growth Strategy commitment and Industrial Strategy Challenge Fund investment are now expected to reach **£3 billion by 2021**, supporting low carbon innovation, and representing the largest increasing public spending on UK science, research and innovation in almost 40 years.

While investment has already been significant, to deliver net-zero by 2050 investment will need to be unprecedented. Despite the levels of investment in the energy sector overall, BEAMA members are still reporting a wavering investment landscape for their market. It is becoming increasingly challenging for them to justify increases in R&D spend for certain low carbon technologies, and to gain investment for projects linked to low carbon generation e.g. large-scale storage[11]. The current picture may not be the same across the whole energy sector, but for BEAMA industries it is becoming increasingly challenging. Evidence suggests this is linked to policy decisions in recent years and months and lack of overall long-term market clarity.

The need for robust long-term policy and regulation to de-risk investment for UK businesses is now very urgent.

We therefore welcome the Government's ongoing Infrastructure Finance Review to explore how infrastructure projects can raise the finance they need, and to inform the 2019 Spending Review. As stated in the Green Finance Strategy, this is especially necessary for new technology markets, where BEAMA industries are experiencing most challenges today. The storage market is a primary example of this investment challenge, and the lack of focused regulatory and market mechanisms is making it increasingly challenging for BEAMA industries to hold onto projects for storage and gain the investment needed.

Within the Green Finance Strategy, Government has made it clear they are working on establishing robust and long-term policy frameworks. BEAMA agrees that setting the Climate Change targets, environment ambition, and accountability in law is not enough alone to deliver what is needed and drive the required levels of investment. While ambitions have been set in Government policy for long term planning, not all are robust enough to de-risk the market for BEAMA members and drive the required investment. We should not restrict ourselves to the use of existing market mechanisms to deliver on these legal commitments (with doubts over the suitability of the current EPC framework and Building Regulations).

£0.5 BILLION

to be attracted through the private rented property EPC E minimum standard for England and Wales

£35-65 BILLION

expected range of investment needed to meet the Clean Growth Strategy aspiration of upgrading as many homes as possible to EPC band C

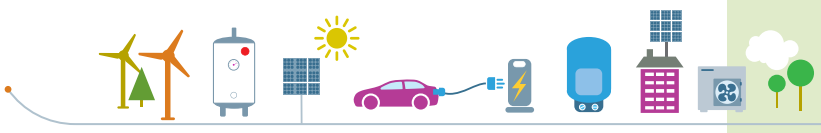
While £92billion of investment has been made in the energy sector, it is believed the distribution of this may not be spread across the full infrastructure supply chain, therefore placing parts of the market at risk. We have seen huge progress in developing the market for offshore wind, and believe a lot can be learnt from policy design, infrastructure planning and financing for the rest of the energy sector as we try and drive more investment into other elements of our UK energy infrastructure. For BEAMA, the most relevant ones are electricity networks (transmission and distribution) and low carbon technologies in the built environment.

Later in this report, we will go into more detail with regards to the investment challenge for driving low carbon technology adoption in buildings, specifically for heat and hot water, and hope this can contribute to the following discussions on how to structure financial mechanisms and robust long-term policy frameworks that enable the net-zero target to be met.

As an industry we feel it would be helpful for an independent authority to audit and monitor investments going forward, to help tackle the distributional issues currently faced in the market and ensure accountability of spend in tackling climate change. This could be a role for the newly formed Green Finance Institute. Transparency at this level will ensure the fair and necessary distribution of investment going forward. This is especially important for the dramatic changes now required for investment in low carbon heat, hot water and building technologies.

Key aspects of the Green Finance strategy BEAMA recognises as a major step forward include:

- The package of measures to mobilise green finance for home energy efficiency and accelerate the flow of finance to projects and technologies essential for the net-zero transition
- The commitment to release £5 million for private sector companies to pilot new financial products that will help drive home improvements, including Green Mortgages
- Continued investigation into further opportunities for simplification of and improvements to the Green Deal framework to support the funding of energy efficiency measures
- Recognition of additional Government support to overcome investment hurdles for some sectors
- Allocation of resources to fund investment in clean energy and natural capital growth to help improve access to finance, leveraging the private sector to achieve the overall level of investment required: e.g. 'The Heat Networks Investment Project, provided as 'gap funding' to grow the market, aims to have a transformative impact on the development of cost-effective carbon savings required to meet our future carbon reduction commitments. In return for a public investment of £320 million, the project is aiming to lever in around £1 billion of private and other capital by 2021.'[12]
- A new clean growth venture capital fund to be launched with a £20 million capital contribution from BEIS, with a view to attracting a matching or potentially greater capital sum from the private sector. In addition to catalysing the Clean Growth equity financing market, this money will be invested on commercial terms in UK companies seeking to commercialise promising technologies.
- £400 million Charging Infrastructure Investment fund for charging infrastructure (£200 million of Government investment plus match funding from private investors).
- The development of an Industrial Energy Transformation Fund, backed by up to £15 million of investment, to support business with high energy use.
- The review of options to increase the size of the Public Sector Energy Efficiency Loan Scheme.



Innovation funding

BEAMA has been pressing for a move away from traditional innovating funding models, whereby small-scale projects or trials are funded with little or no support for transition to commercialisation. In the UK hundreds of millions of pounds have been spent on innovation in the energy sector through regulated innovation funds delivered by the Network Operators (Low Carbon Network Fund, Network Innovation Allowance and Competition), and through the Industrial Strategy Challenge Fund and Innovate UK. BEAMA is keen to move away from the traditional innovation funding models, and supports options for larger scale demonstration projects which transition to business as usual and genuine scale up of technology deployment. This is most relevant for higher Technology Readiness Level products that are relevant to the net-zero objectives (e.g. heat pumps and hot water storage), and something the Energy Systems Catapult is championing with BEAMA. We welcome the acknowledgment of this within the Green Finance Strategy to support new ways of working between private and public sectors.

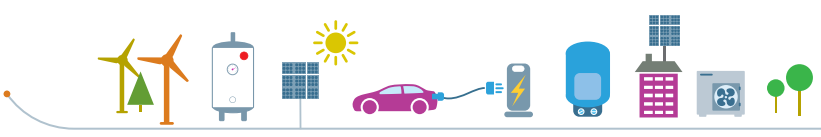
Quality assurance

The net-zero transition will require significant changes and investment in UK homes. The work now underway to plan for this and to introduce retrofit and improvement incentives in the market must be backed by robust quality and safety assurance for consumers. That is why BEAMA has worked with Trustmark on the programme stemming from the Each Home Counts review in 2016. Any future financial incentives placed on the market (whether through mortgage lenders, energy suppliers or direct Government grants) must be based on robust quality standards.

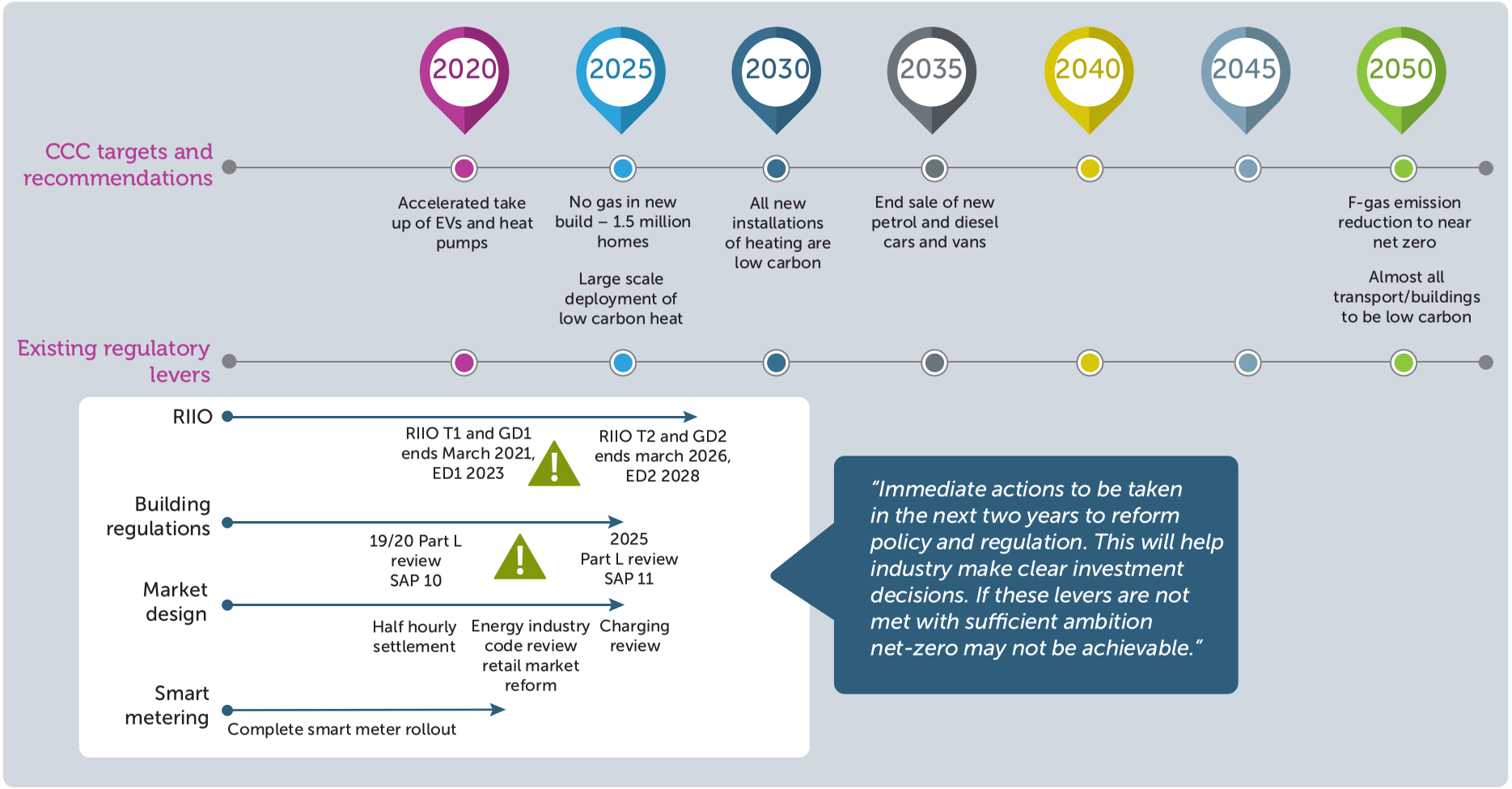
IN CONCLUSION

BEAMA supports the Green Finance Strategy and many key elements of the actions outlined in it will be vital for delivering on the net-zero target. However, specific policy action is needed to de-risk the investment landscape for the energy sector and justify the further investments in resourcing and R&D that are required in order to deliver on the target. The following sections of the report go into more detail for the heat and hot water sector and electricity networks, outlining further the market and the policy levers to drive investment.

Policy development and financial mechanisms in the market should be aimed at de-risking investment for businesses to help drive their R&D and resourcing for UK manufacturing. While significant sums have been invested in the UK energy sector to date, the problem lies with the distribution of finance flowing into the market. We cannot transition to net-zero without the appropriate distribution and scale of investment. More needs to be committed to investment in UK energy infrastructure, beyond what is already outlined in the Green Finance Strategy.



The trajectory to 2050 – critical policy and regulatory timetables and investment triggers



Investment triggers

- Energy white paper
- Roadmap for heat
- Ambitious building regualtion reform and enforcement
- Halve energy use in new build by 2030
- Future Homes standard
- Carbon price for heat
- Regulatory pathway to phase out fossil fuel in off gas homes
- Variable ToU tariffs
- A robust UK market for flexibility services
- Asset planning for network investment
- Replace RHI with a low carbon heat incentive to tackle upfront cost

The regulations, targets and recommendations set out in the graphic are not exhaustive but only those selected most relevant to the scope of this report – Heat, EVs, and network infrastructure.

R&D ENSURING RETURN ON INVESTMENT FOR LOW CARBON TECHNOLOGIES

The light bulb moment

The transition from incandescent to energy efficient LED lighting is a great example of a market transitioning from the old to the new. There was a core energy efficiency driver, and the transition was made with policy, regulatory interventions, and market investment at crucial moments. This ensured the appropriate levels of investment and consumer acceptance for the transition.

STEP 1

CERT – Carbon Emissions Reduction Target

STEP 2

CERT provided the signal to industry to invest in LED lighting

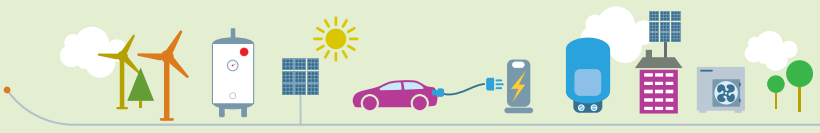
STEP 3

2009- 2012 EU phased ban on the sale of incandescent bulbs.

The higher up-front costs of new LEDs meant the ban was met with criticism, despite the longer-term savings from energy bills. Therefore, the phased ban required Government backing to support communications to consumers and Local Authorities helped to deliver campaigns.

The transition to low carbon heating, such as heat pumps, is more complex than a change to different types of light bulbs, in particular because a consumer needs to engage an installer rather than just choosing a replacement in a shop. There are also very different levels of investment required from consumers to install whole new heating systems. We also know that a heat pump does not directly replace a boiler; they are different technologies that operate in different ways, requiring consumer adaptation and additional system changes such as the introduction of low temperature emitters. For the deployment of many required low carbon technologies in buildings we also need a change to energy markets and pricing for energy bills; consumers can't today just plug in a battery linked to solar and achieve the financial payback that makes for a viable storage market. So it's not as simple as plugging in a new light bulb, and we know the LED bulb transition was still met with resistance, however simple the planned change. But we can learn from the transition process of phased mass market deployment of a new technology, the way in which industry and Government worked together to ensure the market signals were there for investment, and Government support through regulation and communication that helped drive the final take-up of the new technology.

Here we take a close look at R&D investment in specific low carbon technologies we know to be central to the net-zero transition. We look closely at the return on investment so far for industry, what may be limiting take-up, and how can we improve on the current regulatory and policy incentives in the market to drive mass take-up of new technologies.



Low carbon heat and hot water – Light bulb moment

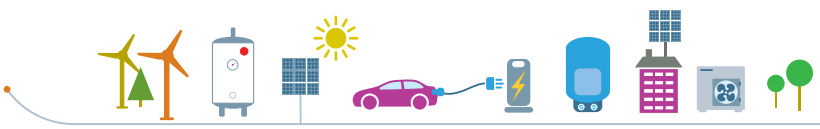
Introduction

> *'Over ten years after the climate Change Act was passed, there is still no serious plan for decarbonising UK heating systems'*[13]

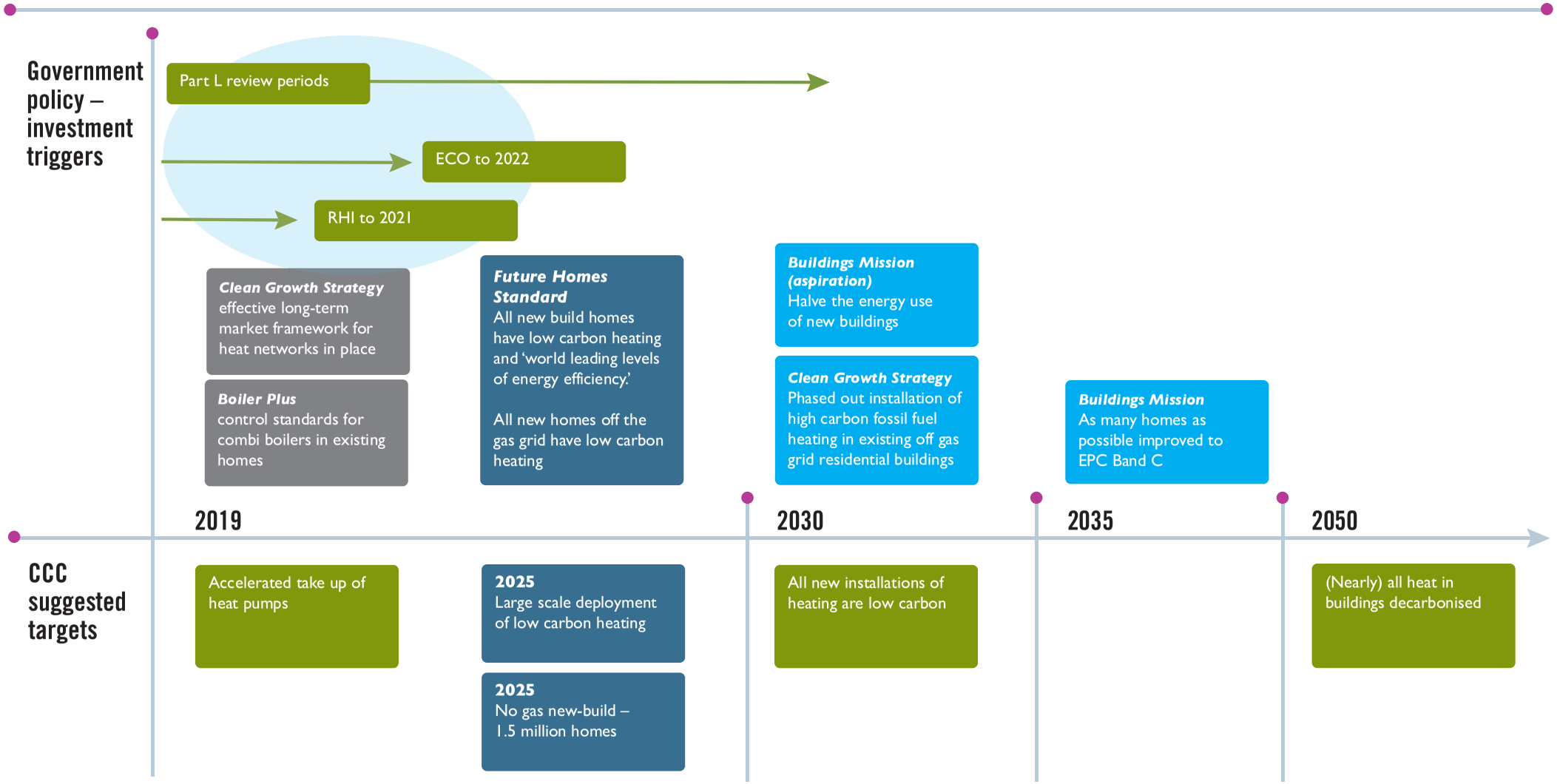
The scale of the challenge for electric heating and hot water is vast, and one that needs careful planning with robust regulatory and policy mechanisms to support the scale-up required. There are critical deadlines in the road to net-zero for the deployment of low carbon heating and hot water systems, and these require significant action within the next 10 years, with significant change to Government policy and regulation needed to drive the investment into the UK market. We hope the points raised in the following section will contribute to the work BEIS are now delivering to set out a robust roadmap for heat during the 2020s.

The Committee makes continuous explicit references to the role of heat pumps in delivering the low carbon heating requirement for net-zero. BEAMA strongly believes heat pumps, including hybrids, have a key role to play and there needs to be a focus on the mechanisms to drive take-up of these technologies. However, BEAMA strongly supports a multi-technology approach to considering the low carbon heating and hot water systems of the future, and the need to determine the best options for buildings based on financial and practical factors, both at the building level and within wider decarbonisation priorities. Furthermore, while in Government policy and the Committee's recommendation much attention is drawn to space heating, it must be acknowledged that much energy use and emissions are generated from households' hot water demand, and this is the dominant load in newer buildings. Therefore, hot water must be factored into any future roadmap and Government policy, alongside space heating. Smart electric thermal storage heaters, direct acting panel and underfloor heating, effective controls and hot water storage will be crucial in this transition, and offer accessible and affordable low carbon alternatives for consumers.[14]

Heat is about people and places, so policy and market frameworks must be structured to support well targeted solutions that consider the variation in housing stock and customer types (e.g. large families, fuel poor, vulnerable consumers). The range of technology solutions means there are systems that can meet the needs of a wide range of housing types and customers, but today our policy and regulatory environment does not facilitate the suitable matching of solutions with customer needs. In this section, we consider this in more detail with regards to specific technologies.



The heat trajectory to 2050 – critical regulatory and policy timetables and investment triggers



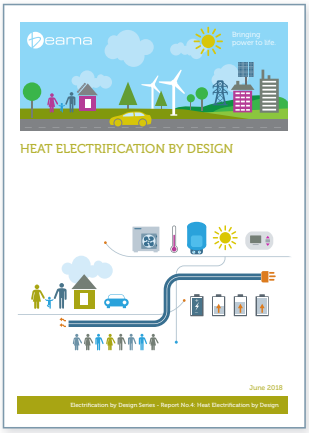
THE CURRENT MARKET STATUS FOR LOW CARBON HEAT AND HOT WATER

BEAMA members comprise leading UK manufacturers[5] in the heat pump, water treatment, heating controls, underfloor heating, water cylinder and electric storage heating markets. This section reflects their experience in the last 10 years, and their views on how future policy could help to drive the uptake of these low carbon technologies.

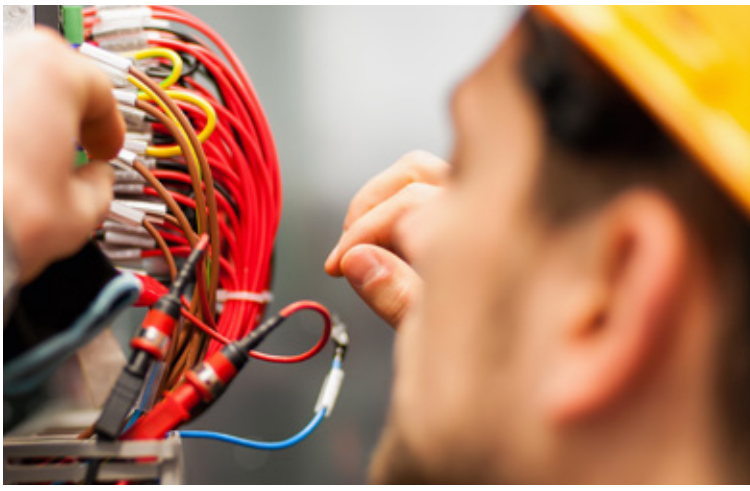
We conducted interviews with member companies, asking about their levels of investment in R&D for heat pumps and electric storage heating products, what drove this investment, and whether return met expectations.

To drive investment into the UK manufacturing sector for low carbon technologies, and to design a future roadmap and policy mechanisms for the market, Government needs to understand how UK businesses make investment decisions. There have been a number of policy and regulatory mechanisms for the heating sector in recent years (RHI, Green Deal, ECO, SAP, Code for Sustainable Homes) and how effective they have or have not been in the market must be analysed to design robust future market incentives.

While we focus here on specific technologies, BEAMA supports the need to keep the market open to the full range of low carbon solutions and technologies. Bias towards certain technologies should be primarily driven by carbon and efficiency. We focus our attention here on specific products to highlight key examples of market barriers and investment drivers.



For more information on the full range of technologies in scope of our transition to net-zero download the BEAMA Heat by Design report here.



Drivers for R&D investment and market status

Drivers for investment in R&D in the last 15 years are twofold:

- **Market demand** – driven by incentive schemes or energy price (e.g. RHI), or by simply changing consumer preferences (e.g. smart controls)
- **Regulation** – predominantly energy efficiency product regulations (e.g. EcoDesign) and Building Regulations

Here we take a closer look at specific products to understand the drivers for R&D investment and what market barriers exist today.

Heat pumps

For **Heat Pumps** the announcement of the Renewable Heat Incentive (RHI) in 2008 drove a lot of investment into the UK initially (R&D and scaling up manufacturing). However, evidence has shown that given the slow market uptake of heat pumps compared to original Government targets, R&D investment has reduced and, in some cases, manufacturing has moved out of the UK as a result. Other markets in the EU are much greater for heat pumps today and demonstrate examples of effective market incentives. France has one of the largest heat pump markets in the EU due to lower electricity prices, making the investment more viable for consumers. In Germany, the heat pump market is growing and has already surpassed gas boiler sales in new residential buildings, due to market incentives offering lower electricity tariffs for customers with a heat pump, and low-interest loans with grant repayment support to help with the upfront cost of installation, as part of the Market Incentive Programme (MAP).[16]

What are the market barriers?

While the UK's main heat decarbonisation programme has enabled some uptake of heat pumps, the RHI is an Opex solution to a Capex problem, and feedback from our members suggests that the current incentive rates, resulting in a 6-8 year payback, are still unreasonable for many customers and has limited the heat pump market from expanding, unlike the FITS scheme for solar PV.

The real barrier for the heat pump market is the **upfront cost** at point of installation. Any future incentive should either look at a more favourable tariff payment over a shorter period of time or an upfront grant or financial incentive to help cover installation costs, certainly while the market is still niche for the majority of able-to-pay customers. Reducing the primary energy factor within the Building Regulations as our electricity system decarbonises will make the case for electric heating more favourable over time in the new-build market. This, matched with more favourable tariffs and electricity prices, could help increase heat pump take-up in the UK. Heat pumps and other low carbon heating and hot water products can offer flexibility to the system. Today we believe the payments for flexibility services would not incentivise take-up alone, so in the near-term solutions have to be provided in alleviating up front costs, and over time introduce more favourable financial incentives for flexibility and payback for customers.

Issues related to the **installation** of heat pumps is one of the biggest barriers to market growth. This includes the overall upfront cost of the installation and the lack of a skilled network of installers. Furthermore, there are issues in connecting heat pumps to the distribution network in specific cases and certain areas of the country, where network reinforcement is sometimes required, and costs are directly passed on to the consumer. While some allowances have been made in the past (e.g. DCUSA) to socialise the reinforcement costs for heat pump customers (i.e. fuse upgrades), there are still some cases where customers may be faced with a connection bill from the network operator to cover upstream reinforcement works (e.g. cable in the street or transformer upgrade). If we are to drive the uptake of this technology, longer term solutions must be developed to tackle this barrier. The rollout of EVs will also require network reinforcement in certain areas and this could facilitate electric heating at the same time. Therefore, taking a regional approach to addressing network capacity and reinforcement for EVs and electric heating together would be beneficial to market uptake.

Evidence from BEAMA members shows that one of the most significant contributing factors to technology costs is product **certification**. The current lack of recognition in the UK of the different certification schemes across the EU make this even more so. Progress has been made recently with the Microgeneration Certification Scheme (the required product and installer certification body to access the RHI) announcing the acceptance of European schemes Heat Pump Keymark and Certita Eurovent for the purposes of MCS product certification (expected from later this year). But it is also a consideration of the implication Brexit may incur with regards to product costs in the UK.

The UK market is already relatively niche in terms of wider EU applicability of heat pump products, so efforts to align product markets with the EU are necessary to ensure costs can be kept down for consumers.

Overall the slow take-up of heat pumps in the UK market can be linked to a number of factors including existing and previous Government incentives, but speaking to our members it is clear that as an industry we were perhaps naive in assuming how fast this market could potentially grow in the UK. The challenges in building a UK supply chain of trained installers and building consumer confidence in the technology was perhaps underestimated and this should be the core focus going forward.

How to trigger investment

Long term market drivers for investment decisions in the UK will stem from **Building Regulations** for the **new-build** market, **financial incentives** for the replacement market and **electricity prices and tariffs**. The cost of gas compared to electricity in the UK is currently a significant inhibiting factor for low carbon electric heating and hot water.

The new-build sector is often seen as an easy-to-decarbonise sector, due to the lower installation costs of a heating system, the better insulation levels (which reduces the size and cost of the heat pump) and the lack of disruption to the building. However, members have stressed that the current lack of enforcement of Building Regulations (or lack of penalties for non-compliance) is a big barrier to actual progress in this sector. In addition, issues derived from transitional arrangements provisions (i.e. "breaking ground"), where buildings, once construction has begun, do not need to comply with the latest set of requirements for an unrestricted amount of time, is also a big factor in slowing down the progress achieved in legislation. Government has already recognised the need in the construction process for better transparency and compliance, proposing a 'Golden Thread' of information as part of a wider 'Culture Change'.[17] While proposed as part of the Building Safety Programme, a similar approach could tackle issues including the 'breaking ground' problem and help to ensure that the purpose and spirit of regulations are met.

The heat pump market in the UK has done well in recent years in social housing, and the focus today is more on the new build market. However, this still represents a very low proportion of the UK housing stock and mass market lies in the more than 20 million homes in the UK that are viable for heat pumps or other low carbon heating alternatives. Our members view current penetration in this part of the market to still be very niche in the UK.

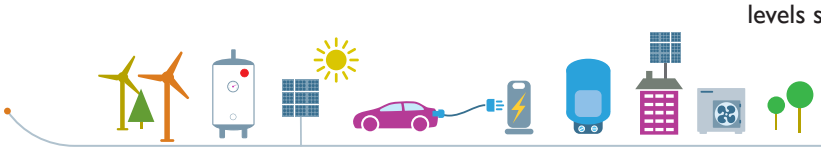
We can trace R&D investment for heat pump product development back to the 1970s, demonstrating this is a well-advanced technology. Overall, we can see key triggers for R&D investment over the last 15 years linking to key incentive schemes in several EU countries, including the RHI. Consensus from manufacturers reveals that, in the UK, the return on this investment has not met expectations. BEAMA members see a great opportunity for this product and continue to invest in R&D, though at a reduced pace on average of below 5-10% of turnover, as compared to 10-15% in previous years.

R&D spend is now focusing more and more on the connectivity element of the technology and application for flexibility markets, as we move to more integrated and connected heating and hot water systems in the home with connected devices. There are cases where tens of millions of pounds have also been spent in the UK market for the tooling up for manufacturing facilities for heat pumps and other low carbon heating technologies.

All companies agree that long-term policy and market signals need to be put in place before being able to justify further investment in the UK market for this product.

Water cylinders

Hot water is required 365 days a year and is therefore well placed to provide storage capacity and flexibility services to the energy system. There has been a dramatic change in the efficiency and design of **water cylinders** in recent years and investment in R&D can be clearly tracked to the introduction of Lot 2 under Ecodesign.[18] This European regulatory framework has driven the supply chain of inefficient products in the market. From September 2017 anything below a C efficiency rating was no longer marketable in the EU. In turn this has driven improvements in smart control in order to reach the minimum efficiency levels set within the legislation (DSR).



R&D investment is now focused more on advancing the control element of the products and specifically on applications for the integration of water storage with renewables and other systems within the building to enable Demand Side Response.

What are the market barriers?

The challenge for water heaters and storage today is the negative impact of electricity in trying to meet the energy efficiency requirements of UK Building Regulations, due to outdated carbon and primary energy factors. Proposed factors for the next Part L would be significantly more favourable for electricity and therefore electrical products, even more than at a European level (see extract on SAP and primary energy factors). However, the market is still low due to the cost of electricity and other market incentives for cylinder replacement and installation. The **new build** market is increasingly challenging due to restrictions on space, and is also driven by a recent reduction in minimum standards for flow rates set by the National House Builders Council (NHBC), and the corresponding growth in more powerful combi boilers being installed. We are also seeing the **steady replacement of hot water tanks in existing properties with combi boilers.** These factors are likely to be the cause of a gradual market decline in sales for water cylinders in recent years, despite their suitability for DSR, building efficiency and overall carbon reduction on the system.

How to trigger investment

Despite these challenges, BEAMA members see a positive future for this technology, as storage capacity within domestic buildings needs to increase in order to manage the fluctuating load from distributed renewable generation on the system and help alleviate peak loads. So companies continue to invest in R&D, although the market has been declining in recent years. They agree that for further investment clarity needs to be provided on the longer-term price and carbon factors in the market.

Government data[19] showed that by 2011 the number of boilers with a hot water tank had declined to 43% due to the growth in combination boilers (including incentivisation under ECO), and this number has continued to fall. BEAMA estimate a 1% annual decline in the number of hot water storage tanks in homes across the UK, thus significantly reducing our capacity for DSR in the future.

11%
decline from a peak in 2015 for conventionally heated cylinders.[20]

44%
decline in the last 6 years for renewable cylinders.[20]

Thermal Energy Storage is key for net-zero

Modelling carried out by Imperial College demonstrates that in the absence of thermal energy storage (TES) and other forms of flexibility, there would be a need for more than 55 GW new electricity storage[21] in the Electric scenario. However, if 58 GWth of TES (1.7 kWth/household) and preheating (more than 100 GWth) are available, the need for new electricity storage reduces to below 10 GW, since the cost of thermal storage (e.g. hot water tank, oil or phase-change-material based thermal storage) is considerably lower than the cost of electricity storage while the preheating is assumed to be applied at low cost.

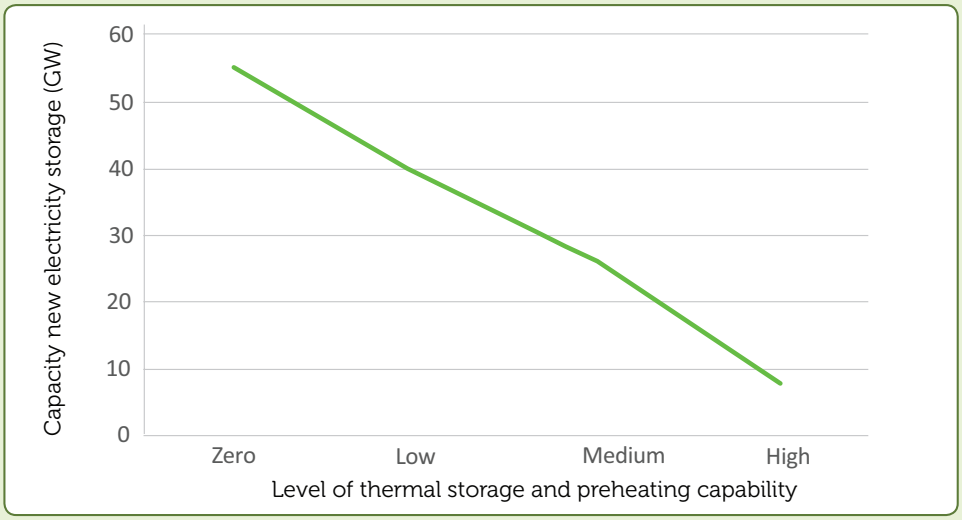


Figure 3 – *Variation in the level of new electricity storage depending on the level of thermal storage and preheating capability available at a building level.*[22]

Standard Assessment Procedure (SAP) for energy assessment in dwellings – the role of Primary Energy Factors

SAP is the national calculation methodology used to assess compliance of new buildings with the minimum energy efficiency requirements set out in Part L of the UK building regulations and is viewed as a key mechanism for decarbonising the UK housing stock. SAP calculates the associated carbon emissions and primary energy use of a home, which need to be below the target set out in Part L. Therefore, differences between the carbon and primary energy factors in SAP for different fuels (e.g. gas, oil, electricity) will influence the type of heating technologies installed in order to comply with building regulations. It is therefore a key regulatory tool and will be used to drive the transition to low carbon technologies. In implementing the recast Energy Performance of Buildings Directive the UK will move to using primary energy as the key metric for ensuring compliance rather than carbon emissions, so primary energy factors are now of high importance. It is therefore a key regulatory tool and will be used to drive the transition to low carbon technologies.

Once perceived as a high carbon fuel, electricity has been on a decarbonisation journey that has seen the carbon factor of electricity plummet from around 0.519kgCO_2/KWh in SAP 2012 to 0.233 kgCO_2/kWh in the new SAP 10.0. Therefore, the availability of low carbon electricity is offering the opportunity to decarbonise heat to a large extent through electric heating in the lead up to the 2030s, as required by the CCC modelling.

BEAMA has undertaken some analysis to understand what the new carbon and primary energy factors under SAP 10 will mean for the take-up of low carbon technologies and understand the impact to different heating technologies. We have produced a SAP model for a house and an apartment. Comparisons can then be made by changing a parameter within the model, usually the heating technology, and looking at the impact that makes on the Dwelling Emissions Rate (CO_2 emissions) and Primary Energy consumption. A high-level summary of the results is being made available for BEAMA members and Government.

BEAMA continue to work with BEIS to ensure the effective delivery of SAP 10 under the new building regulations. Furthermore, we are already supporting the review of SAP 11 for the next round of building regulation review as a means to ensure SAP can in the future take account of flexibility and smart control. SAP 10 and SAP 11 as progressive measures in the building regulations will be essential for net-zero.

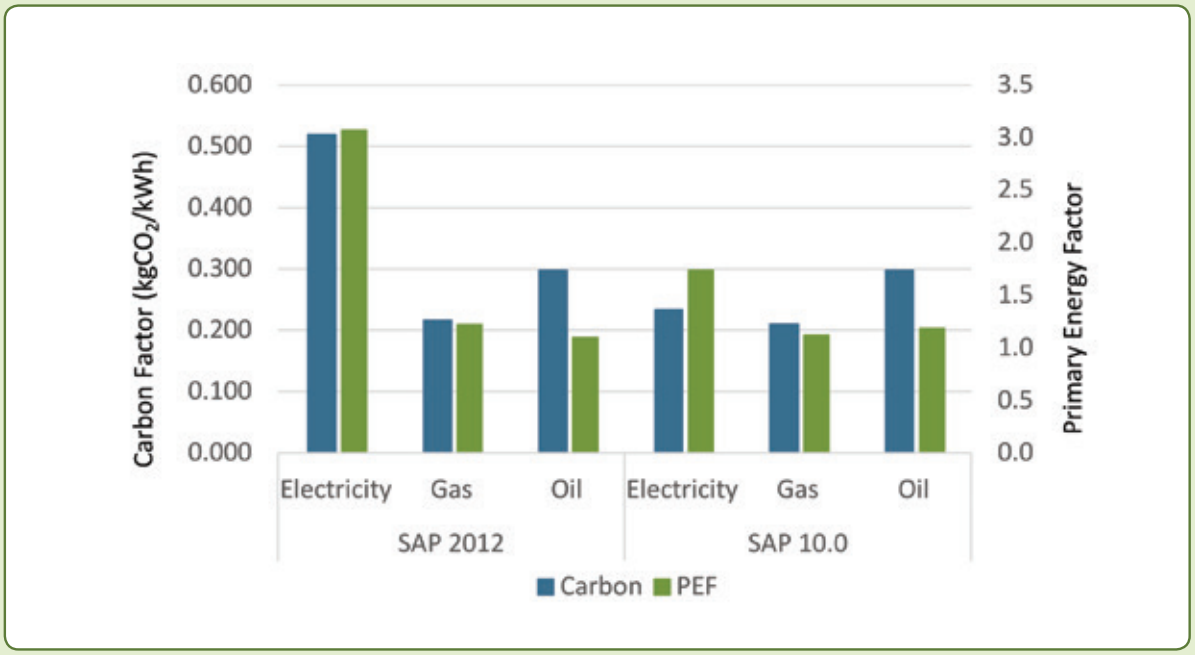


Figure 4 – *Comparison of carbon and primary energy factors for a range of fuels, in SAP 2012 and SAP 2010*

How to get to 2050

BEAMA members have identified three key factors to ensure that a robust market for low carbon heating and hot water can be created in the UK to meet the net-zero target.

1. **Create a proposition for the consumer:**
   The current heating market for existing homes is largely based on millions of individual consumer decisions, so there is a need to overcome the barriers of upfront cost and energy prices to change the retrofit market for existing housing towards low carbon alternatives as we progress towards 2050.

   Customer incentives need to be put in place that address the core barriers to market (e.g. a Capex solution to a Capex problem). We have seen in the past how product regulation has driven out inefficient products from the market, and Government may need to take decisions to set a trajectory for removing fossil fuel technologies from the UK market. This 'choice editing' combined with a clear trajectory on energy price and carbon factors will drive customer demand.

   Knowing some barriers to consumer uptake are upfront costs associated with replacing existing heating and hot water system with new low carbon solutions, we must be open to new models for energy services and financing (e.g. energy as a service and green mortgages).

2. **Guarantee a rate of return:**
   Setting out a long-term trajectory for subsidies in the market will ensure a business case for all low carbon solutions can be understood by consumers and businesses. Pricing options including variable Time of Use Tariffs will be key to driving uptake of these technologies and ensuring the move to electric heating and hot water is economical. This combined with a steady reduction in the cost of electricity as compared to gas will enable market uptake. Therefore, we have to consider a carbon price for heat as the price of electricity needs to reflect the carbon content of the fuel mix, which is not the case for households currently using fossil fuel-based heating systems.[23]

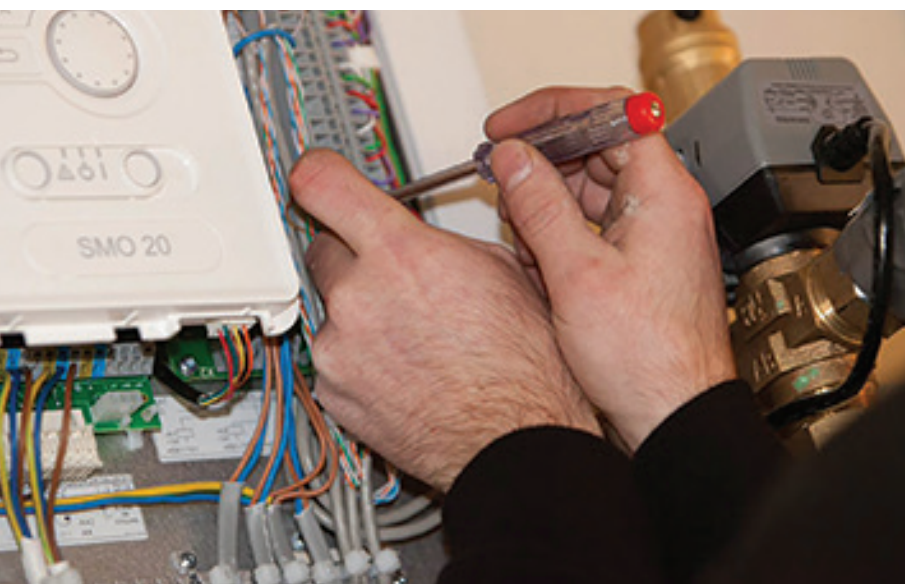
   New market models, including 'energy as a service', will also help to guarantee rate of return for businesses and consumers.

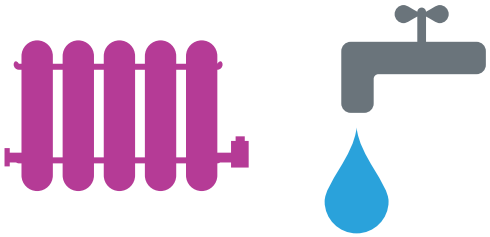
3. **Incentivise a labour force:**
   Mass rollout of new technology requires new skills and trained installers in the market. Installers will be key to the delivery of new heating and hot water systems, especially for the retrofit of existing homes, and we know this to be a significant barrier today. Ensuring installers are equipped with the skills, information and motivation to sell appropriate technologies to customers is vital. In many cases it is easier to replace like for like, and installers often focus on the most profitable installations, which is not always consistent with working towards the net-zero target. We need to make low carbon profitable for installers and incentivise them to move away from fossil fuel technologies.

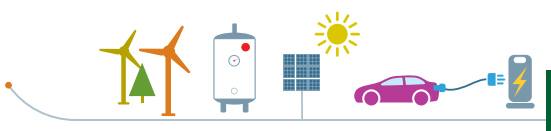
The future development of the market should be seen in a 2-staged approach:

1. Create a future market that is viable for all (consumers and businesses) through ensuring running costs, VAT and carbon factors are cost reflective and create the market demand. This won't happen overnight and a long-term trajectory for these needs to be set in regulation. In the meantime:

2. The market gaps need filling, and as a number of these factors align over time the market may need a number of additional mechanisms to ensure the market continues on the pathway. E.g. RHI was intended to provide momentum but was not effective in maintaining a pathway for the market; we need to consider what these policy instruments are in the future.



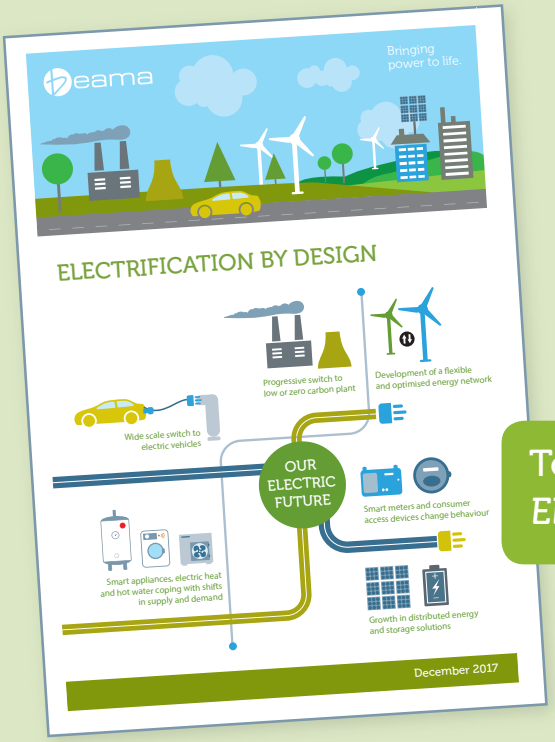




Electrification by Design – Success lies in regional structures

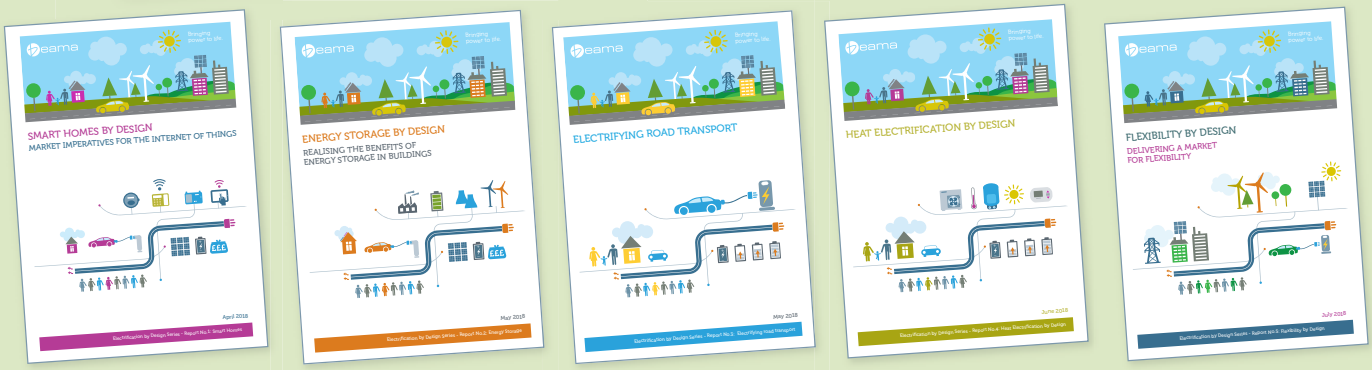
BEAMA has long advocated for a regional approach to delivering mass rollout of low carbon heating and hot water systems. This ensures technology rollout can be matched with regional energy system characteristics, building type and customer base, as well as helping to stimulate local supply chains for installers, services and provision of technologies.

This encourages B2B relationships and the targeted approach required for electrification. The pathway to low carbon heating and hot water requires collaborative working that can help build a supply chain capable to deliver our needs. With this comes quality assurance, relevant and consistent marketing campaigns and integrated finance offers. Most importantly of all, with local authority involvement as a trusted access route to data and local demographics, strategies can be developed and implemented that promote finer targeting and essential B2B derived technology and service offering to develop local strategies.



This matches some of the proposals outlined in the Green Finance Strategy and by the CCC.

To read more download the BEAMA *Electrification by Design* Series



Where is the replacement opportunity?

The installer will be the primary target to drive the decarbonisation of heat and hot water in the UK. Incentivising installers will be an important task in the coming years and to do this we need to understand the replacement opportunity for heating and hot water systems. For heat pumps BEAMA members are noting the reduction in current MCS installers, and believe ensuring trust and reliability in installation services for all new technologies is absolutely central to the net-zero transition.

Heating systems are predominantly on a 15-20-year cycle of replacement therefore necessitating the urgency of action now to target installers to drive the retrofit of existing homes. In many cases the replacement is an emergency job when an old boiler or heating product fails and reaches the end of its life. In this situation the broken product is commonly replaced, like for like. Arguably it would therefore be more effective to place an incentive in the market that targets the replacement of these systems before they fail. This could be targeted through energy suppliers and annual boiler servicing and gas safety checks for example.

There is a general lack of consumer awareness of the options for heat and hot water. Arguably too much reliance may be placed on the installer and we must consider how we offer guidance for both parties as the market changes.

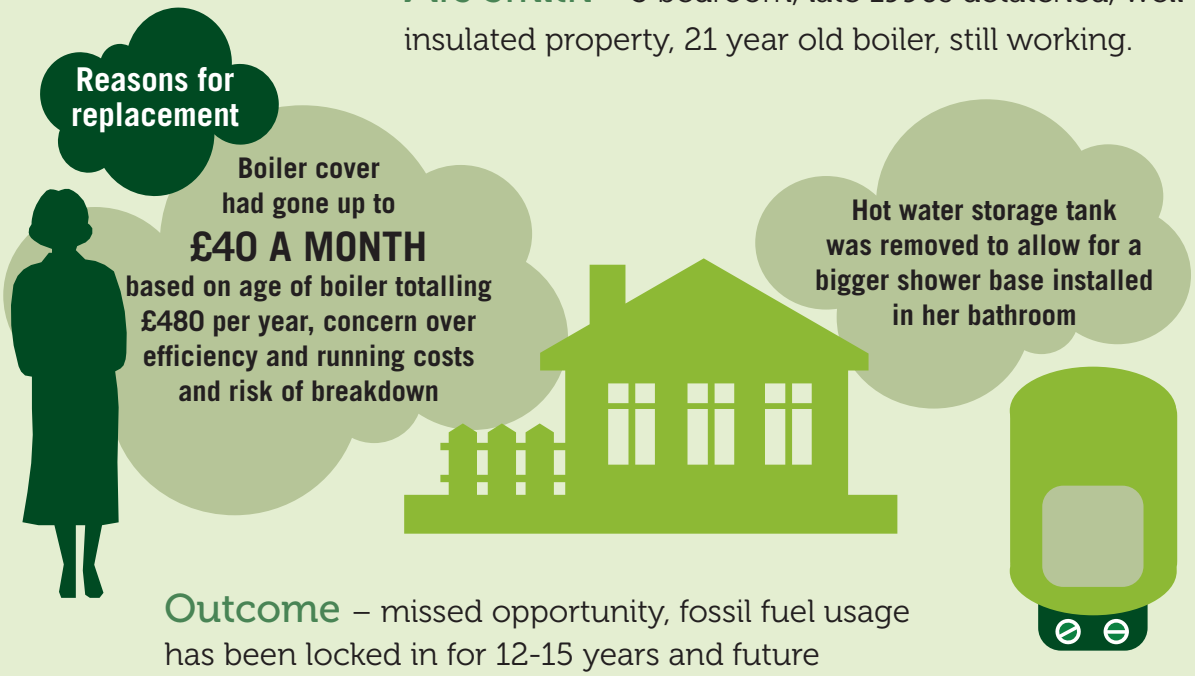
With the technologies now available on the market and our ability to better understand customer energy use in buildings (e.g. through smart metering and provision of energy use data), it is possible to specify system design in properties that not only better suits the needs of the customer and building type, but also further improves building efficiency and emission reductions. System design extends to room by room zones within properties, but is absolutely essential in our move to net-zero and to optimise the efficiency of heating and hot water systems in buildings. Effective system design avoids over-specifying solutions for properties that are fitted as part of a blanket approach to all customers, and can reduce cost and improve comfort in the home. Creating the right market mechanisms for installers to adopt proper system design practices will also ensure customer confidence and aid the transition to net-zero through the adoption of next generation heating systems including hybrids.

1.6 MILLION
BOILERS ARE REPLACED EVERY YEAR

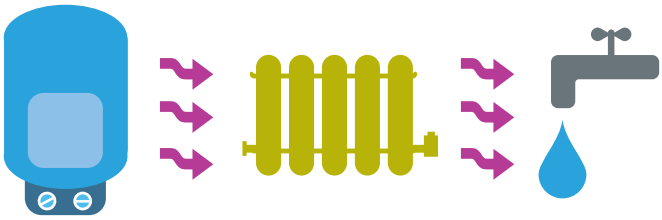
1%
HOT WATER STORAGE TANKS ARE BEING REMOVED EVERY YEAR

CASE STUDY 1

Mrs Smith – 3 bedroom, late 1990s detatched, well insulated property, 21 year old boiler, still working.



Outcome – missed opportunity, fossil fuel usage has been locked in for 12-15 years and future flexibility benefits missed.



Policy and market levers for low carbon heat and hot water take-up

From our review of the current regulatory mechanisms in the market (page 19) it is evident that we are approaching a critical point in the existing regulatory timetable which provides the opportunity to set clear market signals for the industry, as part of Government's longer-term plans to set out a roadmap for heat and hot water. This includes the next Part L review expected in 2019. Our members are clear that the Building Regulations are essential in determining the market demand for low carbon heat and hot water. This is not just new build homes.

BEAMA will be publishing a more comprehensive review of all key elements of the Building Regulations later this autumn, but some of the top level recommendations for these regulations are included within the policy recommendations below.

Around 8 million boiler replacements are expected to take place in the five year period covered by the next round of the Building Regulations, all of which should be installed in accordance with those Regulations.

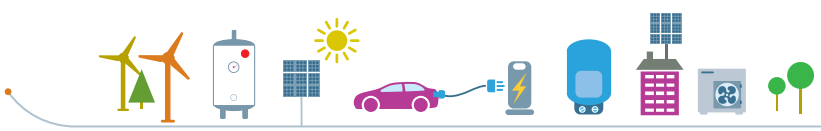
It is our strong belief that if we do not elevate ambition in this round of the Building Regulation review, we will not meet the expected levels of take-up for low carbon heat and hot water during the 2020s. If we defer action to later reviews we may not see implementation of new requirements until 2030 given the time lag in breaking ground for new build and the pace of retrofit for existing housing.

Current Government action on electrification of heat

- Government is committed to supporting the growth of the UK heat pump industry, and through the Renewable Heat Incentive, £2.8 billion will be made available between 2018/19 and 2020/21 to support low carbon heating technologies in homes and businesses, including heat pumps.
- BEIS is currently considering future policy framework for supporting electrification of heat while also ensuring Building Regulations are appropriate to drive uptake in low carbon heating.
- Furthermore, Government is providing up to £16.5m to deliver an Electrification of Heat Demonstration Project, which seeks to demonstrate the feasibility of a large-scale transition to electrification of heat in Great Britain by installing heat pumps in a representative range of homes, alongside new products and services designed to overcome the barriers to deployment.

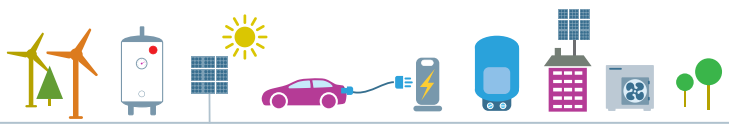
What is the electrification of heat demonstration project?

- It is expected that around 1,800 homes will undergo suitability surveys and 750 heat pumps will be installed and monitored as part of the Electrification of Heat Demonstration Project, with the majority on the gas grid. Heat pumps will be free at the point of use to participants, and include insulation upgrades (where appropriate) and innovations aimed at improving the consumer proposition.



Policy Recommendations

- We need to maintain and enhance financial incentives through reduced VAT rates for key low carbon technologies. Currently UK Government is removing reduced VAT rates for solar and battery storage which seems counter-productive to the need to help facilitate market uptake for these technologies.
- Replace RHI with a low carbon heat incentive to tackle upfront costs.
- Introduce electricity tariffs for heat pump consumers ensuring the running of a heat pump is economical versus fossil fuel alternatives. This could be introduced for a fixed time at the start of a longer-term trajectory to phase out fossil fuel technologies and a rebalancing of subsidy and tax for fuel types based on carbon, therefore ensuring energy prices are reflective of carbon, as recommended by Imperial College.[24]
- Align certification schemes in the UK with the EU to keep costs down.
- Adjust the Energy Company Obligation (ECO) to reduce the rate of replacement of water tanks with combi systems. This programme currently has Government support beyond 2022 with the current level of funding £640m per annum and applied up to 2028. With this support in place this is a vital mechanism for the decarbonisation of heat and hot water.[25]
- Improvements to the SAP 10 calculation methodology are moving in the right direction to more accurately reflect the carbon content of the electricity grid to allow effective decision making for low carbon technologies. The next iteration of the methodology, SAP 11, will need to accurately reflect the next generation of heating and hot water technologies, in particular hybrids, and to accommodate measures for flexibility.
- As the relative importance of hot water demand grows in new build homes relative to space heating, consideration should be given to requiring hot water storage in new build homes. This would allow better sizing of heating systems and accommodate renewable generation and storage. The space requirement could also be seen as a beneficial way of futureproofing new homes for other forms of thermal or electrical storage in the future.
- Improvements in energy efficiency standards in buildings goes hand in hand with the scaling up of heat pump deployment. A more efficient property requires a smaller heat pump (e.g. 3-4kW). This will avoid unnecessary oversizing of systems in properties and bring the costs down for consumers, helping to produce economies of scale for the heat pump market. Energy efficiency drivers for UK homes should consider this alongside heat pump deployment. This is another justification for a regional model for local retrofit schemes.
- Ensure that policies for heat decarbonisation are consistent with the need, as laid out in the revised EPBD, to ensure that improved energy performance does not impact negatively on indoor environment quality and the health of occupants.
- Increase enforcement of and compliance with the Building Regulations, and introduce adequate penalties. The current building safety review is going a long way to ensure a new model in the UK for compliance and enforcement. We need to improve on existing levels of enforcement for energy efficiency and decarbonisation to ensure we are going to meet the net-zero target.
- Close the loopholes that allow new homes to be built to outdated Building Regulations standards and implement higher standards as soon as possible. We support the recent recommendations of the House of Commons Business, Energy and Industrial Strategy Committee[26] in this regard, where they report large housebuilders telling the Committee that up to 62 per cent of their homes built in 2018 were built to standards that pre-date the 2013 regulations.
- Government should undertake a review of the existing Energy Performance Certificate and associated methodology to ensure targets set for minimum efficiency standards in buildings do not act to disincentivise low carbon heating and hot water systems. While this measure has driven progress in improving the energy efficiency of buildings in the UK, the new requirements on homeowners and landlords to meet minimum levels could work against our net-zero ambitions. The current reliance on running costs as a metric means installers and homeowners will defer to fossil fuel alternatives to meet the minimum ratings for energy performance certification. Carbon and storage capacity are metrics that now need to be considered in determining the long-term efficiency and carbon intensity of a building. BEAMA will be presenting options for this to MHCLG in response to their review of the Smart Readiness Indicator model, as proposed under the new EU Energy Performance in Building Directive.
- Introduce variable tariffs to ensure viable demand side services can be created, specifically helping to incentivise storage capacity within homes.



'Reducing heating emissions to close to net-zero looks likely to remain more expensive than burning natural gas in boilers. Low carbon heating systems (including household conversion) add up to £10billion a year to annual heating costs in CCC scenarios. Whilst installing energy efficiency measures costs up to £7billion annually results in annual fuel savings of £5 billion. Aggregate impact of these changes would be broadly neutral by 2050.' [27]

Conclusion

Overall BEAMA supports the Government's move to develop a roadmap for clean heat in the UK, and this should be the mechanism to set the longer term market signals for the sector. We ask that this also includes a strategy for low carbon hot water systems, as we strongly believe the two must be planned together. We will ensure continued support for this work as this is a key step outlined by our members in ensuring they can justify increased investment into the UK market.

Looking at the replacement timescales for heating and hot water systems we can assume two generations and phases of system design in our transition to net-zero. The first will include a combination of hybrid solutions and a move to electric, aiding the transition to second generation by 2040-2050 for dominant pure electric systems, hydrogen and other low carbon alternatives. So while Government can start work now to set the future long-term trajectory for key market factors (including energy price, carbon and fuel factors and VAT), the majority of the recommendations highlighted above can be delivered in the next two years to progress us into the first generation of net-zero heating and hot water system design while the additional factors align in coming years.

Government needs to continue to take a balanced view on technologies, as the variation in build types warrants different solutions and system design. Hybrid technologies are likely to become more prevalent and a key element of the transition to net-zero. The new era for heating and hot water we are now entering into presents opportunities to improve consumer experience of heat and hot water, and arguably today systems are not designed and sized appropriately for the building type and customer needs. Improving this customer experience will ultimately drive decarbonisation.

In developing the right policy instruments it must be considered that manufacturers may spend a long time developing a product to tackle the Capex barrier to deployment, when the policy changes influence the Opex of the product. They may have then developed a product not suitable for the market – so the direction of travel as to how policy will affect Capex Vs Opex is absolutely vital.

Carbon factors and electricity price will be key long-term mechanisms to drive decarbonisation, and setting a trajectory for these will drive investment into the UK heating and hot water market.

'Strong, clear long-term policy signals and legislation are key drivers for our business – Government needs to limit business risk and in doing so, investment will move into the UK market. As of today, the UK Government is not reducing that risk and this does not warrant a significant shift in resources.'

Mitsubishi Electric UK, Marc Overson

CATAPULT
Energy Systems

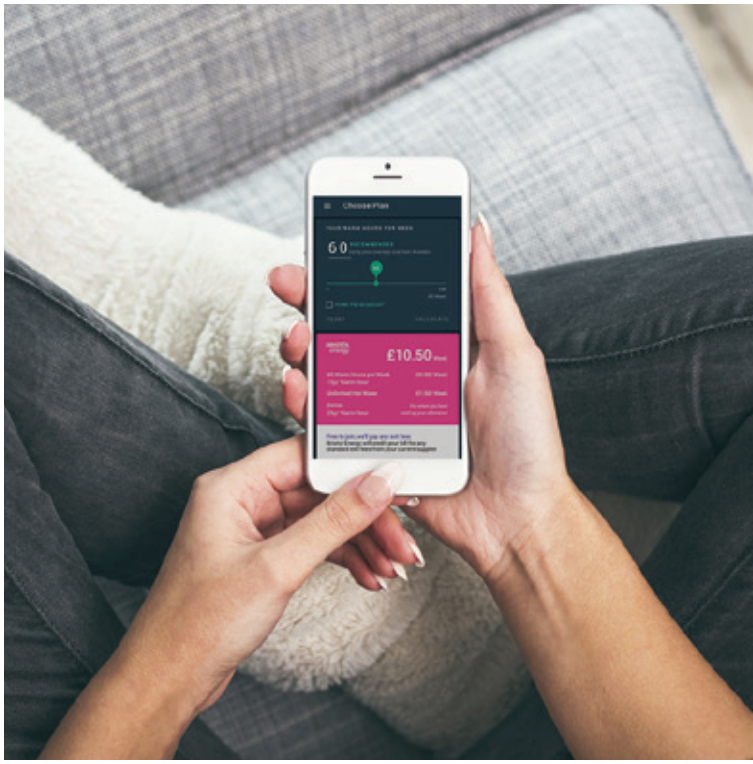
Perhaps the toughest Net Zero challenge is persuading consumers to improve the energy efficiency of their homes and replace existing heating systems with low carbon alternatives. They would be more open to the change if low carbon heating was as good as, or ideally better than, what they already have. After all, in the 1970s only one quarter of homes had central heating. Consumers paid to install it and endured the disruption because it was better than what they had. Energy Systems Catapult has spent years researching the potential for innovation to accelerate the uptake of low carbon heat.

Heat as a Service

Our research has shown that most people care more about their heat experience than what technology delivers it. We wondered if they would buy a "warm home", rather a heating system and units of fuel. We reasoned that as long as they could get the comfort they wanted they wouldn't care whether they got this from a low carbon alternative to their existing heating system. After all, if you enjoy your meal you don't care what oven it was cooked in.

To find out, we created a 'Living Lab' of 100 smart homes then used AI and data science to offer consumers an energy service called a Heat Plan, where they could buy 'warm hours' instead of kilowatt hours. A warm hour was any hour their rooms were warmed to the temperature they wanted. Around half chose to try out a Heat Plan, far more than we expected for something so new. Here's some of what we learnt:

- **Data is vital:** We used data from consumers heating controls to offer them Heat Plans with the number of hours and temperatures we knew they would enjoy.
- **Find out what consumers want:** We offered consumers different types of Heat Plan at different prices so that their choice revealed how much they valued their heating. Some wanted to save money with a no-frills package, others wanted to pay more for top quality.
- **Pricing:** We used data about the cost of heating their home to price their service and discovered that many were willing to pay more for a service than they were previously paying for their energy.
- **Loyalty:** Two thirds said they would recommend their supplier if they offered Heat Plans.



Energy services may open a new route to low carbon heat

We explored if energy service providers could convince consumers to improve the energy efficiency of their home and upgrade to low carbon heating when replacing their boilers and, Here's some of what we learnt:

- **More open to low carbon heating:** 85% were open to replacing their boiler with a low carbon alternative if their providers guaranteed they would get the comfort they wanted for a price they were willing to pay. This compares with around 33% of the general population.
- **Better low carbon systems:** Manufacturers could use data about how consumers use their heating to design more appealing low carbon products.

- **Tailored retrofits appealed:** Most households put up with drafts, damp, overheating, or other heat-related problems. Consumers were enthusiastic about service providers using their own data to help tackle these problems by renovating to improve the thermal performance of their home.
- **Spreading costs:** Consumers liked the idea of adding the cost of these energy performance improvements and new heating systems to their service contract so they could repay them over time.
- **Value-adding features:** Consumers underestimated how much they enjoyed using their heating for other things, like drying their laundry. Service providers could use these insights to add new features that enhance consumers' heating experiences. For instance, we created a 'laundry dry' setting consumers could use to make a radiator hot for a period of time to dry clothing.

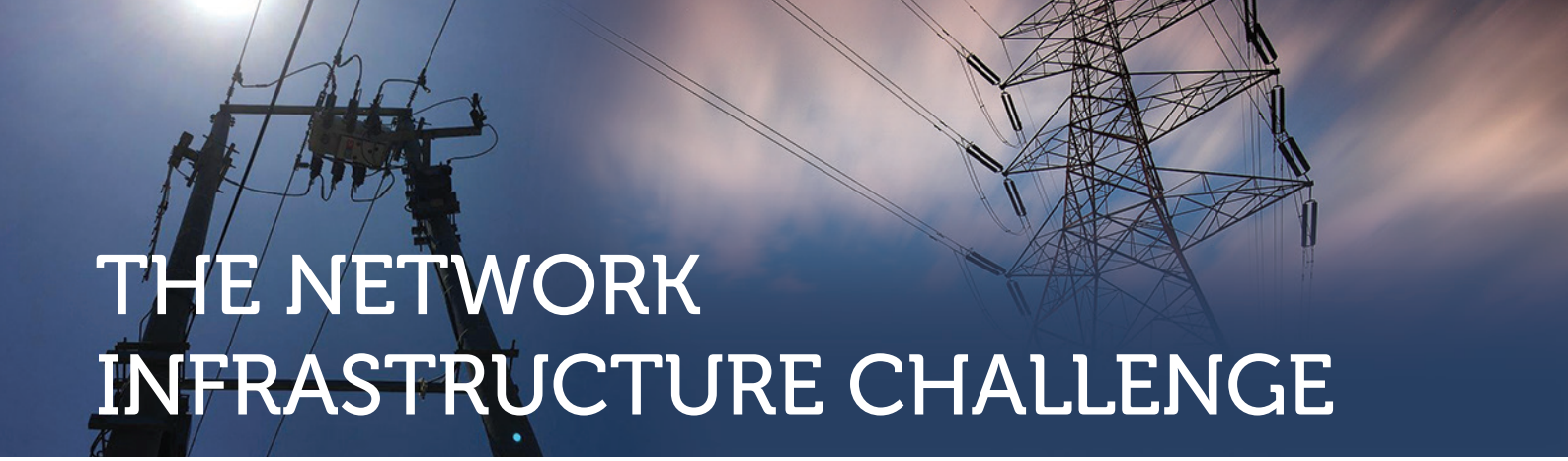
CATAPULT
Energy Systems

Supporting innovation

Most households will need to improve the energy efficiency of their homes and replace their heating systems if we are to get to Net Zero, so these results are promising. Businesses who can apply the principle of the circular economy to offer their customers more efficient services could reap huge rewards. Business model innovation, for instance selling energy as a service, could hold real potential even in today's market.

Of course, Heat Plans are just a starter for ten. Energy services will need to include hot water and could soon include other services like charging for electric cars and discounts for providing grid services. Yet more is needed. Each local area will need to use information about the state of their housing stock and the capacity of their power and gas grids to choose between different options (hydrogen, district heat, heat pumps etc.) to decarbonise their locality.

A joined-up approach will help keep the costs down. None of this will be easy. That's why government set up the Energy Systems Catapult. We're here to help us work together to build the sort of Net Zero future we can all enjoy living in.



THE NETWORK INFRASTRUCTURE CHALLENGE

Overview

A flexible, decarbonised and optimised energy system will balance the introduction of new technologies into buildings with the challenges these new loads will place on the network. This is particularly relevant for the anticipated sharp increase in electric vehicle charging infrastructure and shift to heat electrification. Wind and solar generation are intermittent by their nature and the way the energy system operates must change to accommodate and balance this generation at a system level. To maximise the value and usage of an increasingly dynamic generation mix, we need greater flexibility and significant changes to our energy infrastructure. While network operators are working to maximise capacity through active network management, response services and other innovative solutions, as we transition to a smarter more flexible system, effective planning, investment and coordination are critical.

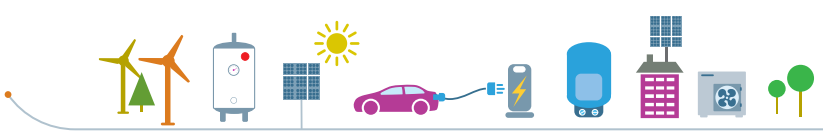
Technology has a fundamental role to play in decarbonising our energy infrastructure. The use of batteries and other technologies to store low carbon electricity from renewable generation at times of high output for use at times of higher demand is changing the way energy is distributed, from a direct and passive approach to an approach where the timing of delivery or use of energy is more actively dictated by when it is needed. Smart tariffs and price signals will influence consumer behaviour and shift demand to times when generation output is high and cost is lower. Electric vehicles can put strain on the network if clustered and multiple vehicles recharge at the same time, but shifting charging to times when renewable generation is abundant, demand lower and energy cheaper will help to manage these new demands.

The networks technology supply chain already offers well advanced technology solutions to enable flexibility services, and have developed efficient low carbon heating, hot water, transport and energy management products. Many of these products are available on the market today and providers are waiting for the emergence of the cost drivers required to create the flexibility services and the associated cost benefits for consumers. It is important to highlight that good initial progress is being made, and that markets and services will continue to evolve to ensure maximum value and benefit can be realised. However, it is critical that these are delivered at scale and accessible to all customers and system users and at all voltage levels. To date network operators are procuring flexibility to defer reinforcement to the order of hundreds of mega watts, and ToU tariffs are being brought to market by some energy suppliers. Ultimately, any delay in delivering the market changes necessary or enabling the proliferation of new services and customer offerings could lead to the loss of market opportunities for the UK electricity system and more specifically for transport, storage, networks, low carbon heat and hot water systems, and much more besides.

A new role for network operators and wider system delivery

The CCC focusses on the need to enable a low carbon electricity system and to strengthen networks, particularly for electric vehicles and heat pumps,[27] as well as highlighting the need to accelerate the take-up of these technologies from 2020. The CCC recommends bringing forward the deadline for the ban on the sale of new petrol and diesel vehicles to 2030. This would leave fewer than ten years in practice to deliver and rollout the changes required. It would also mean that during RIIO2 ED1 (2023 – 2028) significant investment would need to be made available and reinforcement and new solutions rolled out in a systematic way based on customer needs. Electricity networks play a key role in facilitating strong growth in electric vehicles and heat. As such it is crucial that this is effectively coordinated. Regardless of the generation mix, without the means to distribute and transmit low and zero carbon energy we could risk not delivering against these essential ambitions.

As network operators move to new ways of network operation as Distribution System Operators (DSOs), more tools will become available to them to operate the networks more efficiently and effectively. This will give rise to new solutions and new market opportunities for a multitude of industry parties and will help to ensure best use is made



of flexibility, heat and transport electrification, DSR, storage and renewable generation at all network levels. This will help to support decarbonisation ambitions and deliver an efficient, resilient and future proofed energy system.

The DSO and system operator have a key role in enabling open and accessible markets and associated flexibility platforms. However this does not address formation and delivery of the market in its entirety, and other incumbents will also need involvement. Additionally, and critically, oversight, ownership and leadership are required from a responsible authority. This emerging role is essential if markets are to work for customers, market participants, new entrants and the system, and to provide certainty to all parties.

Currently there is clarity on the new energy services that will emerge and the role of technology in enabling them. There is less clarity and more importantly firm agreement on how our system will technically operate and the 'winners and losers' therein. For example, smart charging for EVs is a solution to manage demand on our system, but its technical delivery, communications infrastructure, user experience and technical solution(s) are less clear (although work is underway to better understand this). With scenario planning and the development of firm market requirements, responsibilities and ownership will enable participants to make sense of what the system should look like, its application in driving decarbonisation and what is needed to deliver it.

CASE STUDY 2: FUTURE ENERGY SCENARIOS 2019

National Grid's Future Energy Scenarios (2019) indicate that net-zero is achievable with swift action across technology and policy areas. The scenario highlights indicate that:

- Homes will need to use one third less energy than present day usage
- 37 million tonnes of carbon must be removed by carbon capture and storage
- More than 23 million homes will need to install low carbon heating solutions by 2050[28]
- By 2050 85% of homes will need to be thermally efficient at EPC Class C or higher
- Over 75% of EVs could be using smart charging by 2050
- Over 7 million hybrid heat pumps could be installed by 2050
- Approaches to heat decarbonisation are regional and uncertain, although there is action that can be taken now[29]

National Grid explore net-zero ambitions and examine the key criteria in the 2019 Future Energy Scenarios. The net-zero analysis explores improved energy efficiency, consumer behaviour, new technologies and electrification in more detail. In this analysis electrification is greater than in any of the FES 'core scenarios'. Additionally, improved building thermal efficiency and carbon capture, increased generation capacity at 263 GW and storage feature prominently. From a transport perspective, in the net-zero sensitivity the Government's ambition to ban the sale of conventional vehicles by 2040 is met, and by 2050, there are no conventional or hybrid vehicles on the road at all.[30]

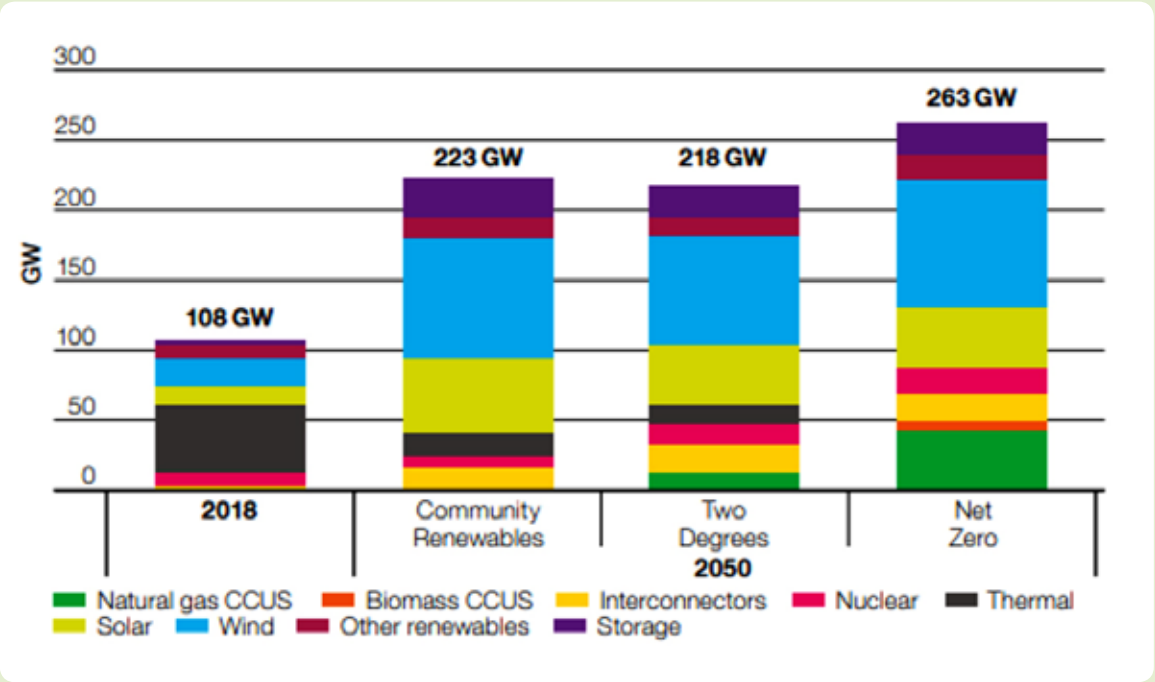


Figure 5: *Installed electricity generation capacity: Community Renewables, Two Degrees and Net Zero in 2050*[31]

Supply chain thinking and network investment

The UK energy system is at a high transition period and there is a need for enhanced supply chain engagement and planning to ensure a buoyant market in the UK and to help channel investment effectively. For some time, manufacturers have witnessed reductions in investment in traditional network products in line with typical asset replacement rates in addition to an absence of new reinforcement which would create additional capacity. This new additional capacity would help to tackle anticipated increased electrical demand from EVs and heat and due to the connection of other low carbon technologies and generation assets. This may be due to network operators seeking to enhance their regulatory returns, shifting spend to the back end of the RIIO period or deferring entirely into RIIO2 and beyond.

The supply chain for transmission and distribution products and services should be recognised as a key stakeholder group and its role in developing, delivering and maintaining key elements of critical national infrastructure recognised. Delivery of Ofgem's RIIO2 outputs will depend on the capability of the supply chain, and their views and needs must be considered. Network companies should be expected to set out their supply chain strategy as part of their business plans. It follows that they would need to include the supply chain in their stakeholder groups.

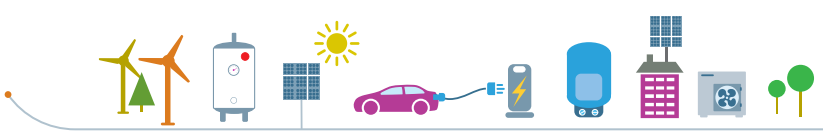
While load-related investment can be subject to uncertainty, network maintenance should be more predictable, and it should be subject to longer term planning, particularly with increasing electrification of transport and, in the longer term, heating, in order to meet legislated carbon reduction targets and net-zero ambitions. It would assist the supply chain if these plans were set out over a longer term. It would also assist if maintenance needs were planned over a longer term so that new approaches had longer investment periods to compete for. When considering innovation manufacturers have real experience of the innovation environment and related developments in the UK market over the past 10+ years.

The demands of the energy transition will require that all stakeholders take a full part in identifying the best way forward and that their views are essential to this process. In the days of RPI-x[32] it was appropriate for the regulated companies to take responsibility for passing on cost pressures to the supply chain. However, for RIIO 2, the knowledge and capability of the supply chain is a vital component and the consultation process should aim to involve product manufacturers and providers of technology and services.

It must be recognised that, in a time of rapid change, especially in demand for connections and power, that there is a real danger that demand for electricity arising from EVs can increase faster than network companies (and their supply chains) can satisfy. It follows that there is risk both in unnecessary investment and delayed investment. Simply waiting for the need for network investment to reveal itself, and then to respond, can be very negative for consumers. Network companies should be expected to state in their business plans how they are dealing with the balance between these risks and be measured against their performance here.

This is essentially a question of who to trust; which parties can be relied upon to make neutral and accurate judgments on the future needs of the networks and consumers. It may be necessary to agree future demand scenarios and allow the networks to invest in meeting these demands with limited penalties for stranded investments. It will be important to establish the roles of the TSO and DSO to ensure a neutral view on what future demand will be and whether there is a credible plan to meet it.

There are competing options for meeting increased demand for power (for instance flexibility and reinforcement) and there is a need to decide early which approaches will be viable and their expected outputs so that network planning can be based on best understanding of available technologies. Based on this approach the networks should be expected to provide strategic plans on how they will meet future demands. The supply chain should also be



consulted on what innovation will offer in terms of avoiding simple reinforcement and how that innovation can be best utilised across the wider GB energy system.

In Imperial College London's report for the Committee on Climate Change 'Analysis of Alternative UK Heat Decarbonisation Pathways' (2018) costs for decarbonising the electricity system are explored. It highlights that up to £2 – 3bn a year of required electricity network upgrades will be required to meet net-zero. This will be mostly at the distribution level in addition to providing costs to reinforce at transmission level of £1.5m – £2m per kilometer and £362k per kilometer at distribution level.[33] Planning for net-zero must be brought into scope of RIIO.

BEAMA Networks – Supply Chain and Innovation Campaign

The UK has ambitious plans to decarbonise the energy system by 2050 with specific focus on transforming our ageing electricity transmission and distribution infrastructure into a smart, low carbon electricity system. These plans will facilitate the delivery of a smart grid, enable the UK to meet carbon targets and allow the decarbonisation of energy, transport (electric vehicles) and, in the longer term, heat.

In order to achieve this, it is vital Government works with industry to deliver a fit for purpose supply chain and that appropriate mechanisms are put in place to ensure this. There is an important enabling role that an improved electricity network can play in facilitating faster decarbonisation, technology adoption and enhanced customer experiences and savings. BEAMA Networks is ready to work with Government to deliver this, we have the solutions and the expertise to ensure the future delivery of green clean electricity.

RIIO2 is expected to increase financial pressures on network operators, regulating them to earn and spend less, whilst the expectation of network transformation and preparedness for low carbon technologies and new energy demand continues to ramp up. **The question is; *does this strike the right balance and enable the appropriate investment signals at such a critical time?*** Utilities are typically assumed to be a low risk investment, but we are now entering a high-risk period and opportunities should be provided for network operators to outperform targets, where they take on board greater risk. Squeezing the network operators will result in a reluctance to invest and in cost pressures being passed on to those less able to bear them.

To enable these plans BEAMA is calling for:

- Government and Ofgem to work with industry to develop clear supply chain strategies and recognise the importance of the UK supply chain.
- Government and Ofgem to provide certainty for investment, industry and supply chain.
- An open call for solutions for the highest priority issues for network development, with a neutral body announcing the winning bids.
- Government and Ofgem to create an environment where successful innovation is promoted, scaled and appropriately rewarded.

Ofgem recently published their position paper on *'Distribution System Operation our approach and regulatory priorities'* which outlines how network operators in the transition to DSO must utilise innovation and create an environment to attract investment whilst keeping costs as low as possible. BEAMA contends that the time for pure economic regulation is over. This approach can work to bring down costs for consumers in the short term, but investing more now could result in lower long-term costs. To deal with network transformation effectively, new ways of working and a responsive and adaptable regulatory regime is required. One example is the financing of offshore wind, which provided high levels of upfront investment spread over increased time horizons, whilst delivering long-term value and exceeding initial expectations. One expert highlighted that "It is vital that the regulatory regime allows DNOs to attract investment to build on their record levels of customer service and reliability and is also joined up with the Government's industrial and clean growth strategies and the achievement of net zero." [34] Catherine Mitchell, University of Exeter.

The Confederation of British Industry (CBI) has recently insisted that the Regulator's statutory responsibilities must have climate action at it's core or risk undermining the UK's climate targets.[35]

There is a need to provide a level of certainty and an environment that allows product providers to invest in people and places. There is currently concern that industry will not have the skills required at appropriate scale and lack of confidence in investing in skills development with little certainty as a result of current market and DNO investment landscape. This current spending pattern could lead to orders being exported when the technology is needed in the UK. Ofgem is considering steps to regulate and incentivise net-zero ambitions. It is considering having decarbonisation as an output for the DNOs in RIIO-ED2 as well as asking network companies in other sectors (electricity transmission) to provide information in their business plans as to how their investments in RIIO-2 will help to achieve net-zero. This is a positive first step and one which has the potential to have far reaching and positive outcomes for the UK if balance between incentivisation and regulation can be appropriately defined and then implemented.

Role for Independent Distribution Network Operators (IDNOs) and Independent Connection Providers (ICPs)

IDNOs and ICPs build new connections for new properties, in some cases up to 10,000 in one zone. If new properties and new connections could be appropriately designed, incentivised and enabled in tandem with new approaches to energy with low carbon generation, heat, and transport supply then large sections of new demand could be catered for at design stage. As well as enabling and providing flexibility services across the connection boundary to DSOs, this regional approach to network building and energy distribution could ensure fit-for-purpose networks for changing consumer needs and an upgraded energy system. The most cost-effective option for new build dwellings is a more robust network that can cope with the increased loads that electrification will bring. Here system resilience is even more important than system flexibility; smart solutions and technologies for EV load management for example will be better suited to retrospective applications or as an interim solution to defer reinforcement. Whilst this approach alone will not address the energy system's challenge in its entirety, it could address new sections of additional demand in a joined-up way. [36]

There is a need for a strategic focus on key energy systems challenges and to move away from the trial and demonstration environment into a real-world environment, particularly if this drives greater penetration of innovation into network operator businesses. Within the time span of RIIO we need to be able to technically facilitate new applications such as Time of Use Tariffs and peer to peer energy as well as enabling the connection of new transport and heat loads.

Network investment is essential in enabling net-zero and we will increasingly see a shift of heat and transport loads relying on the electricity network. Cost and customer experience are key and customers choosing to decarbonise should not be disproportionately penalised for example, if their single heat pump installation triggers a network upgrade. Appropriate levels of funding should be made available for network operators to react to these low carbon triggers and work to implement solutions or upgrades that facilitate the connection of low carbon technologies, rather than the network being viewed as a barrier. There is a balance in practice to be understood, between the need for anticipatory investment and reactive investment in response to 'triggers' and the distinctions between new build and retrofit applications.

Driving innovation and return on investment during RIIO2 and beyond

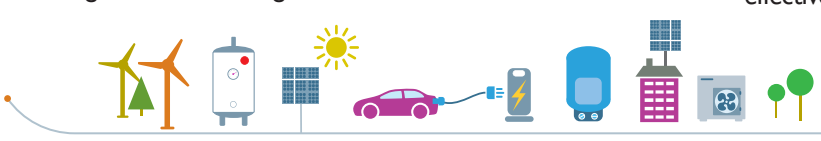
An improved mechanism is required from network operators to provide visibility of innovation trials that have been completed and will actually move to Business as Usual (BaU). This will improve accountability and ensure that there is an appropriate level of emphasis and responsibility on network operators to roll out proven innovation to enhance value and facilitate decarbonisation.

Work is required by Government and the Regulator to further promote the replication (as well as rollout of technology outside of the DNO who initially sponsored it) of successful innovation UK wide, to replicate successful innovation network operators require staff resource and business funding. If a technology or solution is proven and will bring about cost savings, this stated resource, business process and funding 'bottleneck' can often be preventative of delivering increased proven innovative solutions at BaU and the delivery of further customer value.

Increased standardisation and the definition of common terminology for innovative solutions will send a clear signal to the market so that technology providers, manufacturers, and other stakeholders can respond in kind. It is important to note that it can take several years to take solutions through the various Technology Readiness Levels (TRLs) and to deliver a commercialised network ready product. Innovative solutions are not often delivered in short timescales, and need to prioritise the proven solutions and technologies at UK scale to deliver customer value ensures that innovation can continue through the TRLs in parallel. Funding can facilitate this and provide certainty to network operators and partners to allocate or recruit staff, invest the time and bridge the visible gap between proven innovation and business as usual.

There is a need for a strategic focus on key energy systems challenges and to move away from the trial and demonstration environment into a real-world environment, particularly if this drives greater penetration of innovation into network operator businesses. Within the time span of RIIO we need to be able to technically facilitate new applications such as time of use tariffs and peer to peer energy as well as enabling the connection of new transport and heat loads.

Innovation and scale rollout of proven technology is an essential component of a smart system. If the UK is to realise net-zero ambitions, innovation will need to play a fundamental role across the built environment, transport, energy use and heat. UK network operators have received regulated funding for innovation projects since 2004. While traditionally there can be long lead times between research and development, trial and demonstration, to scale deployment, there is a need to act now. The CCC has shown that scale implementation of technology and systems to meet net-zero will have a cost. However, the cost of alternative approaches or the cost of not meeting net-zero will be greater. The UK energy sector must work to deliver an environment where complex systems and technologies are delivered as BaU. Network Operators have a wealth of innovation projects and a wide range of tools to operate their networks differently, more effectively and at lower cost to the consumer.[37]



Increasing interactions and emerging roles

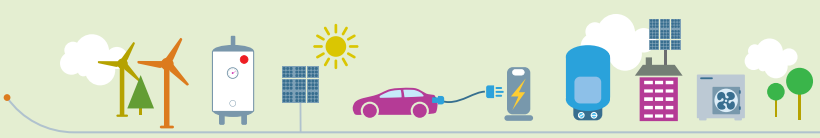
There is a challenge for all parties to develop ways of facilitating simple, flexible and responsive energy use. This will be achieved by developments in IoT and intelligent home and network automation. For example, more visibility of the load and cost of running specific appliances may encourage consumers to schedule their use according to static Time of Use (ToU) tariffs or price signals, but load shifting in response to dynamic ToU tariffs is most likely to be at least partially automated.

CASE STUDY 3

Western Power Distribution (WPD) – Smart Three Phase EV Charging

WPD in collaboration with partners are working on a project to install three phase supplies in all new homes alongside photovoltaics, energy storage, heat pumps, electric vehicle charging and smart white goods. All are connected to a controller which will consider the various inputs such as the demands of the house appliances, needs of the householder and network signals to minimise the electrical cost to the householder.

The charging of the electric vehicles is then able to follow price signals and charge when demand is low, helping to smooth the local daily electricity demand. This can help WPD manage the electricity network more efficiently and in practice could reduce the need for reinforcement.[38]



Many consumers are likely to respond to the increase in access to near real-time energy consumption data by becoming more engaged with the way they buy and consume energy. However, this renewed interest will not be seen everywhere and may not last long if there are limited consumer-centric offerings. The challenge for Government and industry will be to maximise the public's engagement with their energy and their new options for energy management, control and services. However, this should not be used as an opportunity to increase energy prices but rather to drive decarbonisation and provide a key step in realising our net-zero ambitions.

Customer choice and a level playing field for market participants is key. Innovation and new market entrants should be encouraged and enabled, we should not seek to deliver markets or market frameworks that are overly complex and unwilling or unable to adapt as innovation occurs and new opportunities arise. Affordability is crucial but so is accessibility, convenience and simplicity, be that via the customer themselves, a third party, technology or services packages.

Unlocking flexibility

Flexibility can be delivered in very different ways, based on different market models. For DSR from the residential sector, this is especially true, with the option of remote control of domestic appliances and/or supply capacity, frequency responsive appliances or usage managed by real time pricing. Ensuring that all options have an equal market opportunity will be very difficult. This reinforces the need for detailed and accurate understanding of network costs so that the cost benefit for different implementations of flexibility can be compared on a common basis, ahead of any rollout. Alternately some flexibility offerings may be implemented as an interim solution that can defer reinforcement or more significant investment in flexibility temporarily.

Whole system thinking

Effective whole system coordination will open-up new opportunities for distribution connected flexibility providers to provide services at a local level, either aggregated or provided by a single asset. Providing visibility of network needs at distribution and transmission boundaries and better inform needs here in terms of flexibility requirements, generation visibility and network management and better inform system needs and requirements at those network locations. This should in principle allow network operators to more efficiently manage their networks and underpin the potential for new services and opportunities for market participants.

Network planning and regional approaches

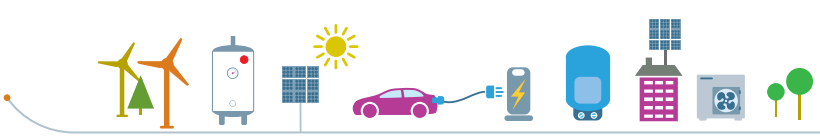
A controlled and sustained switch to electric heating powered by regional or local networks will have the following benefits: decarbonisation of heat, response benefits to upstream actors, improved efficiency, and optimised approaches to heat and transport planning (ensuring that the network is appropriately reinforced). Sensitivity to local conditions will also have the benefit of supporting regional development objectives. These regional principles are explored in detail in the 'Local approaches to infrastructure deployment and finance' section of this report.

Both the Reshaping Regulation[39] and the BEIS Cost of Energy Review[40] point towards a different future for network technology providers as they respond to well-planned and timely specifications of system optimisation and reinforcement solutions. A better coordinated and leadership-driven value chain will utilise macro data analysis and locally-driven energy service provision to invest more appropriately in the resilience, reinforcement and smart control technology required to balance the network and drive down infrastructure development and maintenance costs. This will smooth technology investment cycles and empower the supply chain to manage manufacturing output better and develop more appropriate design and installation skills.

The distinction between upstream and downstream technology is less important than the need to acknowledge that the markets for each are becoming inextricably linked. In a disaggregated and poorly coordinated market we would continue to have an increasing amount of load impacting technology in and around the building but be blind to the requirements to reinforce the network; similarly, we would have the TSOs and DSOs proposing business plans for reinforcement with no real understanding of what is being connected.

Networks and the replacement opportunity

Traditionally network operators have specified products and their networks to behave in a passive way that distributed energy from A to B. As the electricity system, the consumer and market incumbents become more active, there will be a need to implement new network assets that can enable new functionality such as automation, connectivity and communications, sensors and online monitoring to ensure that network operators or third parties know how key assets are behaving and any impact that may have on supply. Future system thinking and vision will serve as a basis to



future proof our energy infrastructure and enable new solutions and technologies to proliferate ahead of need. Network operators and market participants should work to understand what a well evolved electricity system end point up to 2030 and beyond looks like and then develop the critical path required to implement it. This will limit asset stranding and missed opportunities and allow network operators to move away from 'short term' thinking over the course of a price control.

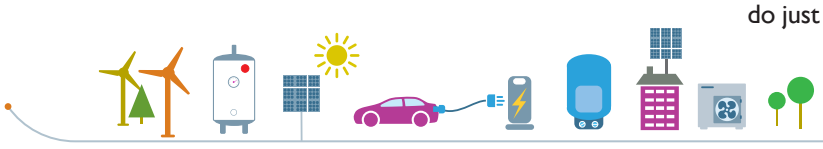
Maximising efficiency and network losses

Where network losses are concerned, the UK must work to align responsibility for those losses with those who are able to actively reduce them. The UK is one of only six countries in Europe that do not include networks losses as a network owner charge. When considering losses the UK total transmission and distribution losses of total injected energy (generation output) equates to just below 8%. In comparison Germany's combined losses are just over 4%. Realising a similar level of losses reduction in the UK would improve network efficiency, resulting in approximately a 4% efficiency gain. In the shift to net-zero, minimising energy waste is a logical first step and will help maximise the low or zero carbon electricity reaching the end consumer.[41] Imperial College highlight that 80% of the technical losses are in the 'last mile', i.e. at the lower distribution voltages where (I2R) becomes more of a factor. With greater activity on the lower distribution voltages from both generation and load, there is a risk of increased technical losses. The UK should aspire to be a world leader in network performance and efficiency as key founding principle of our net-zero ambitions.

- The market needs variable ToU tariffs and a framework for DSR. This needs to happen in tandem with smart appliance regulation. Only when there is a clear market mechanism will smart appliances be economically viable in the UK.
- A clear market framework for flexibility services needs determining as a matter of urgency. Fudging the current regulatory framework is not enough and brings about gaps and uncertainty for the supply chain therefore limiting progress. Radical change is needed[42] (e.g. forward and residual charging and retail market reform).
- The market needs to be open to new energy service business models. Energy as a service presents a viable solution to the Capex issues associated with whole house retrofit and brings added benefits to consumers in terms of cost, comfort and overall experience.
- Target innovation funding at large scale to establish real world testing and trial environments that can better enable commercialisation of new business models. BEAMA will continue to support the work by the Energy Systems Catapult to develop the energy as a service model and 'living lab' opportunities for industry to trial new market propositions.
- Proactive investment in response to 'triggers' or 'just in time' is key for customer experience and in maximising the connections of LCTs.
- While load related investment can be subject to uncertainty, network maintenance should be more predictable, and it should be subject to longer term planning, particularly with increasing electrification of transport and, in the longer term, heating.
- There is a need for a strategic focus on key energy systems challenges and to move away from the trial and demonstration environment into a real-world environment with innovation implemented at scale.
- Network efficiency: the UK must work to align responsibility for network losses with those who are able to actively reduce them.

1. **Create a proportion for the consumer – net-zero must be customer led**
2. **Incentivise a labour force.**

Policy development to meet net-zero will have to include a combination of creating customer demand and choice editing (removing high carbon options from the market, facilitating market take-up of smart appliances and low carbon heating and hot water). Enabling new market services will help to ensure the customer proposition can be embedded. We have to think radically to overcome upfront costs consumers would otherwise face in the take-up of new low carbon heating and hot water, and energy as a service models will do just that.



Energy Data

Data is key to the transition to net-zero. Here we refer to two strands to this – **consumer access to data and third party and Local Authority access to aggregated energy data** – and the policy and regulatory levers to help enable data access for the net-zero transition.

Technologies in both cases are increasingly enhancing our ability to understand energy use and energy management across the UK energy system, e.g. smart metering, low voltage monitoring on the electricity networks. But there is a long way to go before we have enough data to build a full picture of UK energy demand and supply.

Arguably, past policy and regulation have been set without adequate access to data and therefore incentives and policy have been designed without an adequate understanding of how customers may actually use energy and how the system is equipped to manage energy. This may be the reason for previous policy failures. Policy makers need data to transition to net-zero.

1. Customer access to data

The smart meter rollout will provide customers with the data they need to understand their energy use in the home. A key part of the smart meter rollout, in many respects unique to Great Britain, is the provision of an In-Home Display and the ability to connect a Consumer Access Device.

BEAMA, with our members, has conducted much research to understand the value of the provision of real time data and how it can enable consumers to save energy. The Consumer Access Device[43] goes one step further, really setting Great Britain apart and putting us on a sure footing to provide a gateway for data into the home and enable demand side services.[44]

Significant Government policies such as mass adoption of EVs, 24-hour switching, half-hourly settlement, adoption of demand side response and flexibility, peer to peer trading and net-zero carbon emissions are all dependent on the successful rollout of smart meters across Great Britain. This will ensure consumers and their approved third parties have access to real time energy data to help them make informed decisions about their energy use. Access to real time energy data is an emerging opportunity, and the vast majority of the potential uses are still to be realized.

To maximise the potential of real time energy data, consumers and industry need forward looking, progressive policies that facilitate access to data in the public interest but maintain consumers' privacy and data security.

✓ Third party and Local Authority access to aggregated energy data

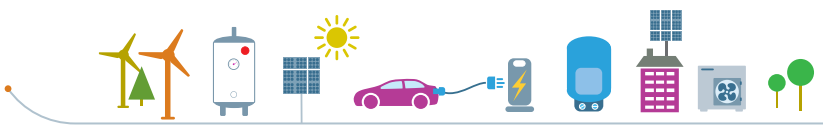
One core theme of this report is the need for long term planning and a strategy for infrastructure rollout, both in the home and across the electricity and gas networks. Without data none of this will be possible.

The smart meter rollout doesn't entirely ensure key third parties (e.g. Network operators or Local Authorities) responsible for enabling and delivering the net-zero transition have access to aggregated data at scale[45]. The rules governing permitted access to aggregated smart meter data needs to be amended, and this requires regulatory change.

Without access to this data, industry and Government will not be able to understand the full extent and complexities of gas and electricity use. This understanding is vital for regional energy planning, especially for referring our existing housing stock to use low carbon electric heating and hot water technologies.

As we move to low carbon heating and hot water technologies, many more options will be available for different housing types, dependent also on the local network conditions. As highlighted in this report, it is right that customers are offered solutions better tailored to their energy use patterns, building type and network position. Providers wishing to offer these complex services and the institutions that govern and regulate them will all reply on access to aggregated data.

For these reasons, the timely rollout of smart metering to every home and small business in Great Britain, the effective management of near real time energy data, and the engagement of consumers with their energy use are all essential to the Government's net-zero targets.



CONCLUSIONS AND RECOMMENDATIONS

Setting the net-zero target in legislation alone is not enough to drive the unprecedented levels of investment needed to ensure we can deliver net-zero by 2050. For BEAMA members to deliver on their commitment to the net-zero target further action is needed now to provide market certainty.

The uncertainty that exists in the market today following recent political change and Brexit should not delay action by Government in ensuring net-zero can be delivered. This is a co-ordination challenge at unprecedented scale, it is a cross-Government, cross-industry, global challenge and one that requires collaboration. Changes to regulation and policy will have knock on effects that need to be understood if we are to ensure the fair and equitable distribution of risk, cost and finance.

Action must be taken now to de-risk investment in the UK energy sector to ensure our transition to net-zero remains commercially viable for business and consumers. The current market is struggling to gain the levels of private investment needed to scale up UK market development of some key technologies (e.g. storage, heat pumps and hot water storage) and action is needed now to make sure we make the most of this opportunity in terms of UK growth and manufacturing, and retain business in the UK.

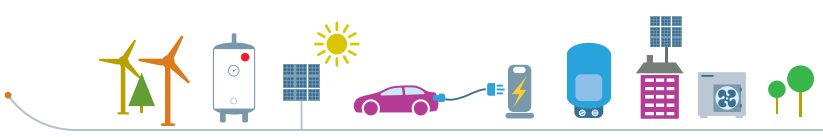
There are immediate actions that can be taken in the next two years to reform policy and regulation which will help our members make clear investment decisions. It is our firm belief that if we pass these without sufficient ambition the net-zero target may not be met, and the UK supply chain will struggle to deliver the UK requirements for this. Fundamentally what is needed is clear long-term market signals set out in UK law that will provide the confidence to manufacturers that the UK WILL deliver on the net-zero target. Infrastructure planning is necessary to ensure a supply chain can gear up for the unprecedented levels of change implied by the target and trajectory to 2050.

We believe there are strong actions that can be taken by Government now to set this trajectory, allowing time to then build a more detailed roadmap in terms of technology development and more local infrastructure planning. These are actions that prevail in the research, and from our discussions with companies, that would set a clear signal to investors and industry of the Government's intentions.

Recommendations

Buildings:

- Complete smart meter rollout, ensuring all UK customers are offered a smart meter.
- Set ambition high within this round of the Part L review[46] – setting clear signals for the new build market (phase out high carbon technologies and enable storage capacity), as well as setting higher standards for existing homes in the UK, enabling the uptake of low carbon heating and hot water through SAP. Using the Building Regulations to set out a robust trajectory for energy efficiency improvements in the UK alongside low carbon technology deployment will produce economies of scale for technologies like heat pumps and drive prices down for consumers.
- Set a carbon price for heat and hot water and a long-term trajectory for fuel subsidies.
- Replace RHI with a Capex based incentive for low carbon heating AND hot water products.
- Maintain and enhance financial incentives through reduced VAT rates for key low carbon technologies.
- Increase enforcement to prevent non-compliance to the Building Regulations.
- Open data to enable local level energy planning,[47] policy design and compliance and enforcement.
- Amend the Energy Company Obligation to stop the removal of water cylinders, and where suitable replace with new efficient low carbon water heating technologies.



- Enable green financing options including mortgages and energy as a service models enabling whole house retrofit.
- Engage the installer community in locally driven energy and heat planning – to drive retrofit and further economies of scale in the supply chain.

Market design and services:

- Introduce variable Time of Use Tariffs and a market framework for Demand Side Response. This needs to happen in tandem with smart appliance regulation. Only when there is a clear market mechanism will smart appliances be economically viable in the UK.
- Determine a clear market framework for flexibility services as a matter of urgency. Fudging the current regulatory framework is not enough and brings about gaps and uncertainty for the supply chain therefore limiting progress. Radical change is needed[48] (e.g. forward and residual charging, retail market reform).
- Open the market to new energy service business models. Energy as a Service we believe presents a viable solution to the Capex issues associated with whole house retrofit and brings added benefits to consumers in terms of cost, comfort and overall experience.
- Target innovation funding at large scale projects to establish real world testing/ trial environments that can better enable commercialisation of new business models. BEAMA will continue to support the work by the Energy Systems Catapult to develop the energy as a service model and living lab opportunities for industry to trial new market propositions.

Network infrastructure and investment:

- Enable consistent spend and investment strategies so that the supply chain can be ready to tackle the asset replacement needs in the UK.
- Consider current pressures on spend by network operators and the impact this may have on our ability to deliver net-zero.
- Invest in networks to enable net-zero. We will increasingly see a shift of heat and transport loads relying on the electricity network.
- Invest proactively in response to 'triggers' or 'just in time' to improve the customer experience and maximise LCT connections.
- Be realistic on reinforcement. Whilst flexibility and capacity releasing technologies and solutions have a key role to play, the fundamental shift in the way we fuel our transport and heat our homes and hot water will need well considered interventions and network upgrades.
- Make network maintenance more predictable, and subject to longer term planning, particularly with increasing electrification of transport and in the longer-term heating
- An improved mechanism is required from network operators to provide visibility of innovation trials that have been completed and will actually move to Business as Usual (BaU).
- Adopt a strategic focus on key energy systems challenges and move away from the trial and demonstration environment into a real-world environment with innovation implemented at scale.
- Improve network efficiency by aligning responsibility for network losses with those who are able to actively reduce them.

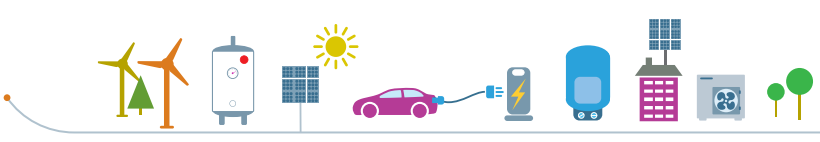
To get to net-zero by 2050 the following principles must be met:

1. **Create a proportion for the consumer – net-zero must be customer led**
2. **Guarantee a rate of return – setting a long-term trajectory for subsidies and pricing in the market**
3. **Incentivise a labour force.**

Policy development to meet net-zero will have to include a combination of creating customer demand and choice editing (removing high carbon options from the market, facilitating market take-up of smart appliances and low carbon heating and hot water). Enabling new market services will help to ensure the customer proposition can be embedded, we have to think radically to overcome upfront costs consumers would otherwise face in the take-up of new low carbon heating and hot water and Energy as a Service models will do just that.

Brexit does pose a risk to industry in the UK, and already we have felt the impact this is having on our sector. However, if we ensure alignment with product regulations and certification procedures in the EU we can ensure manufacturers are not unnecessarily burdened with additional costs to sell products into the UK market and trade in the EU.

Net-zero is a huge opportunity for the UK, for the wellbeing of consumers, and for UK manufacturing. This commitment from BEAMA industries and the report outlines our willingness to work with Government and elevate ambition to meet the target for the benefit of UK plc.



Building type:
Community Pavilion

Requirement:
Heating and hot water for pavilion and changing facilities

Technology used:
2 x 15kW aroTHERM air source heat pumps in cascade ☑

1 x Heat exchanger module ☑

1 x 200 litre buffer tank for heating ☑

2 x 500 litre hot water cylinders ☑

VRC 700 system control ☑

Installer: R&I Cruden Ltd.

Client: Lovat Shinty Club

Founded in 1888, the Lovat Shinty were in need of low-cost heating and hot water demand for their new community pavilion and changing facilities. The community project was almost fully funded by charities and European funding groups including Sports Scotland, Leader, Highland Council, Robertson Group along with many private funders.

As a not-for-profit organisation, being able to fulfil the high demand of hot water for the showers at a low running cost for the club, was a crucial part of the specification. Renewable heating installers, R&I Cruden worked closely with Vaillant to design the heating system to select Vaillant's aroTHERM heat pumps as the most energy efficient and cost effective solution.

Air-to-water heat pumps are a highly energy efficient solution as they safeguard against fluctuations in oil and LPG prices that can leave owners vulnerable to the ever-rising energy bills. Available in four models from 5 - 15kW, aroTHERM is a compact unit which can be easily sited and offers quiet operation with sound power as low as 58dB(A).

After this upgrade, the Lovat Shinty Club now benefits from a highly efficient but low cost heating and hot water solution provided by two aroTHERM air source heat pumps in cascade with a 200 litre buffer tank for heating.

The use of the Vaillant heat exchanger module also contributed to cost savings in the form of saving on glycol required for the heating system. The system is complemented by the Vaillant VRC 700 weather compensating system control which intelligently communicates with all Vaillant appliances.

Building type:
Nine properties on a residential estate development

Technology used:
9 x flexoTHERM 8kW

9 x VRC 700 ☑

Installer: ☑
Be Green Systems

System specification

Heating installer, Be Green Systems, has worked in tandem with developer, Housestyle Countrywide, to develop an estate of nine exclusive three, four and five bedroom properties in the Warwickshire countryside.
Oberry Fields is designed to be a prime example of how new residential properties can achieve outstanding levels of energy efficiency and support a more sustainable future. The homes have been specified with an array of renewable technologies to ensure heating, hot water and air conditioning requirements are delivered as economically and as environmentally friendly as possible.

Each property features a Vaillant flexoTHERM 8kW ground source heat pump, which generates heating and hot water and is designed to reduce running costs and environmental impact.

Installing a flexoTHERM heat pump offers a flexible option for developers and installers as it can be connected to three different sources - ground, water or air. Connected to a ground loop, it provides the highest energy efficiency label and heating performance in its class, whilst also boasting a 'Quiet Mark', issued by the Noise Abatement Society.

The integration of a ground source heat pump system is straight forward when a property's ground works are underway. System optimisation, courtesy of Vaillant's VRC 700 weather compensation controls, ensures that the heat pump will always perform at maximum efficiency to minimise energy consumption under the direct control of the homeowner.

Outcome

All properties at the new development have seen the successful installation of the flexoTHERM ground source heat pump solution. A geothermal ground collector has been installed under a nearby road consisting of seven, 120 metre deep sealed pipes in boreholes to extract the thermal energy stored in the ground and provide all the energy requirements for all nine properties.

In addition, a number of other energy-saving and sustainable technologies have also been installed to complement the ground source heat pump solution. These include mechanical ventilation and heat recovery, wardrobe ventilation, background comfort cooling, air conditioning, solar PV panels, and solar batteries.

According to estimates from installers Be Green Systems, the technologies in place mean residents can look forward to annual energy bills of approximately £350 to £400 - a significant reduction compared to average residential UK energy bills.

In addition, property owners have the satisfaction that their complete heating, cooling and energy solution is being provided in a sustainable way, with a low carbon footprint and minimal impact on the environment.

Developing flexibility as the new cornerstone of the UK grid

Multiple forces are driving the transition to a low-carbon energy future across Europe. These include political, consumer and economic pressures to reduce air pollution in cities, address climate change and above all exponential reductions in the cost of renewable energy and battery storage.

According to Bloomberg New Energy Finance (BNEF)'s respected 'New Energy Outlook' modelling, more than half the total electrical energy supplied to grids in large European economies will come from variable renewables by 2030. On the demand side, an equally seismic change is coming with the mass adoption of electric vehicles (EVs) and electrification of heat.

The main challenges of the energy transition:

- **Energy mix and grid flexibility requirements:** Planning must start now for how to manage seasonal gaps with economic, low carbon solutions when there is not enough wind and solar power to meet peak demand. This change in how we generate the bulk of electricity from fossil fuel to renewable sources will create significant economic, technological and policy challenges for the energy industry and governments.

- **EV charging infrastructure:** As EV concentration increases, charging infrastructure deployment runs into existing grid limitations in the shape of sub-stations, transformers and cables sizing, as it has been doing in Norway in recent years. Being able to time EV charging according to the energy system requirements will significantly lower the system costs by avoiding grid upgrades and providing flexibility to absorb variable renewables cost-effectively.

- **The need for longer-term backup capacity:** A large increase of demand-response, storage and smart charging of EVs can substantially mitigate intermittency issues in a high renewables energy system. However, it cannot completely address it – there will still be weeks and months of low variable renewables (solar and wind) production that require long-term backup capacity. A zero-carbon scenario would require lower carbon substitutes for fossil fuels given doubts about the cost and viability of nuclear power and the need to retain dispatchable on-demand power sources for long periods as well as light-weight, dense energy sources for specific use cases.

Learn more here: www.eaton.com/energytransition

Outdated grid regulation slowing the UK's energy transition

Policies that provide regulatory certainty are urgently needed to spur private investment in the flexibility technologies required to ease the transition to a high-renewable energy future.

The following are the most important deficiencies where regulatory action could make the biggest immediate positive impact. Many of the related recommendations are based on the experience of the Nordic markets, which are the most advanced in Europe in terms of regulation and government policy that encourages private investment in smart, flexible energy systems.

- **Weak or non-existent flexibility markets:** Deep and liquid flexibility markets are an essential prerequisite to provide investors certainty on long-term cash flows. Where they exist today in Europe, they often provide only short-term visibility on possible cash-flows for flexibility assets. Reform is needed to provide predictable, long-term cash flows, for example via a combination of multi-annual contracts and annual auctions guaranteed to run for several years.

- **Unequal access to ancillary services and capacity markets:** Increasingly, electricity will be provided and managed by a range of technologies, including decentralised wind and solar power, batteries and smart EV chargers, working alongside centralised power plants. All these resources should compete on a level playing field, including in balancing markets. Current grid regulation in the UK favours centralised generation assets, through connection, testing and metering provisions, availability requirements, capacity payment haircuts for storage assets and other administrative costs and minimum size thresholds. These hurdles penalise aggregators of small, distributed assets and make it difficult for all flexibility technologies to compete evenly.

- **Need for smart and bi-directional EV chargers:** Smart EV chargers will be essential to integrate variable renewables by shifting peak demand to times of peak supply. Smart charging would also lower the system cost of adding EVs, for example by avoiding the need for local grid upgrades, and new-build generation capacity to meet higher EV-related electricity demand. The latest EU charging rules focus on the numbers of chargers, rather than their flexibility - there is no requirement to make EV charging "smart", or to install V2G. As a result, in the UK, only a handful of either smart or V2G chargers exists. In the case of V2G chargers, there is also limited EV compatibility today.

- **Need for smart meters and dynamic consumer pricing:** Dynamic tariffs offer financial incentives for consumers to change behaviour, for example to shift to off-peak demand periods in response to market price signals. In Nordic countries, there is already near-universal, national rollout of digital meters. In Britain, dynamic pricing is now becoming available due to the target for universal roll-out by 2020. For example, Octopus Energy has introduced an "agile tariff" which tracks wholesale power prices and advises customers 24 hours in advance of low-cost periods.

CP electronics
ENERGY CONTROLS

Energy Controls

Case Study: Volfas Engelman, Russia

The Brief: The Volfas Engelman brewery is steeped in history and its roots date back to the mid-19th century. Situated in Kaunas, the second-largest city in Lithuania, Volfas Engelman is the second-largest brewery in Lithuania and manufactures, among other things, varieties of beers, ciders, energy drinks and alcoholic cocktails.

To help with the refurbishment of its premises including the factory, packaging area and general warehouse, the brewery approached ECOLIGHT, a Lithuanian lighting company and OEM partner of CP Electronics.

ECOLIGHT chose to use CP Electronics' products after successful partnerships on other projects. Martin Allcock of CP Electronics explains: "We've worked with ECOLIGHT since 2015 when they began to regularly sell our detectors. Many of their customers have praised the technical quality of the products."

The project ran from mid-2017 and completed in April 2018.

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Our Insight: "We needed to provide a solution that would cope with the varying levels of height within in the buildings and that would allow for complete lighting control in all areas, even when they are not in use.

"ECOLIGHT were replacing over 360 old 2 x 58W fluorescent luminaires with their 65W LED luminaires so we had to consider the most effective way to provide lighting coverage."

Our Solution: "Rather than fitting one PIR per luminaire, we recommended using one PIR per group of 3-4 luminaires. This would mean that the installation could be done more quickly and more cost effectively while providing excellent lighting coverage.

"We used sensors from the EBDHS-MB range which are ideal for high-bay, high-level lighting control in warehouses and factories and can easily be retrofitted to luminaires.

"To accommodate the varying installation heights, we recommended EBMPIR-MB-DD sensors for the low-level areas up to 7 metres and EBDHS-MB-DD sensors for heights of up to 20 metres. These side-mounting PIR presence detectors are specifically designed for mounting onto batten or box style industrial luminaires via the 20mm knock-out and are rated at IP65."

The Result: Tomas Pukas, Managing Director of ECOLIGHT, explains how successful the project was: "After our installation, Volfas reported a significant light level improvement in all premises, while power consumption had decreased by approximately 50%.

"Using CP's detectors gave another 20-30% energy saving on top of this 50%, depending on the activities taking place at the time. This resulted in a huge cost saving for the business and they were very impressed with the work that was done."

Martin Allcock added. "The main products they have been using of ours are the EBMPIR-MB and EBDHS-MB detectors as these are flexible and easily retrofitted. We're overjoyed to hear that Volfas are happy with the end result, particularly the cost saving element."

About Us

CP Electronics, a brand of Legrand, is a leading designer and manufacturer of cutting-edge presence detectors and sophisticated lighting control systems for a wide range of applications. From passive infrared (PIR) and microwave detectors to fully addressable and networkable control systems, our variety of UK-designed control solutions can reduce energy waste and operating costs as well as enhance a building's performance.

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ENDNOTES

1 HM Government, July 2019, Green Finance Strategy

2 Imperial College London, 2018, analysis of alternative UK heat decarbonisation pathways for the Committee on Climate Change, https://www.theccc.org.uk/publication/analysis-of-alternative-uk-heat-decarbonisation-pathways/

3 Imperial College London, 2018, analysis of alternative UK heat decarbonisation pathways for the Committee on Climate Change, https://www.theccc.org.uk/publication/analysis-of-alternative-uk-heat-decarbonisation-pathways/

4 The hybrid pathway is based on the combination of the use of gas and electric heating systems i.e. hybrid heat pumps. The gas heating system in the hybrid system uses carbon-neutral gas.

5 Imperial College London, 2018, analysis of alternative UK heat decarbonisation pathways for the Committee on Climate Change, https://www.theccc.org.uk/publication/analysis-of-alternative-uk-heat-decarbonisation-pathways/

6 Imperial College London, 2018, analysis of alternative UK heat decarbonisation pathways for the Committee on Climate Change, https://www.theccc.org.uk/publication/analysis-of-alternative-uk-heat-decarbonisation-pathways/

7 Compiled by BEAMA, data source - Government Housing surveys carried out individually for England Wales, Scotland and Northern Ireland between 2016 and 2018. Heat pump numbers based on industry data.

8 The Committee on Climate Change, 2019, Net Zero The UK's contribution to stopping global warming, https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

9 https://www.theccc.org.uk/publication/net-zero-technical-report/

10 The Committee on Climate Change, 2019, Net Zero - Technical report https://www.gov.uk/government/publications/green-finance-strategy

11 BEAMA has reported this evidence to the BEIS Select Committee in March 2019

12 HM Government, July 2019, Green Finance Strategy

13 The Committee on Climate Change, May 2019, Net Zero, the UK's contribution to stopping global warming. The Committee on Climate Change, 2019, Net Zero The UK's contribution to stopping global warming https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

14 BEAMA does not consider in scope of this report the likely role hydrogen or 'green' gas may have to play in the longer-term mix of technologies suitable to decarbonise the UK housing stock. We assume on the transition to net-zero there are at least two generations of heating and hot water systems to consider in any planning. Due to the infancy of the hydrogen market in these terms we assume this will be factored into any post-2035 planning if considered a viable option. In this report BEAMA's focus is on the technologies within our scope as a trade association and therefore will not refer to hydrogen and 'green' gas but acknowledge this is part of the longer-term mix of technology solutions to be considered.

15 8 interviewed. Many members are multinationals and therefore produce products for the EU market, but the questions asked focused on UK R&D investment and market characteristics.

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19 United Kingdom housing energy fact file: 2013, https://www.gov.uk/government/statistics/united-kingdom-housing-energy-fact-file-2013

20 Source HWA statistics

21 Total storage capacity is 110 GWh.

22 https://www.theccc.org.uk/wp-content/uploads/2018/06/Imperial-College-2018-Analysis-of-Alternative-UK-Heat-Decarbonisation-Pathways.pdf

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28 National Grid Future Energy Scenarios (2019) - Community Renewables and Two Degrees
29 National Grid – Future Energy Scenarios (2019) - Future Energy Scenarios in five minutes
30 National Grid – Future Energy Scenarios (2019) p. 150, http://fes.nationalgrid.com/media/1409/fes-2019.pdf
31 National Grid – Future Energy Scenarios (2019) p. 155, http://fes.nationalgrid.com/media/1409/fes-2019.pdf
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34 Utility Week - Ofgem proposals for DNOs 'not sufficient' for net-zero goal (2019) - https://utilityweek.co.uk/ofgem-proposals-electricity-distribution-not-sufficient-reach-net-zero/
35 The Guardian (2019) - Energy regulator is out of touch over climate crisis, say businesses https://www.theguardian.com/business/2019/jul/22/energy-regulator-is-out-of-touch-over-climate-crisis-say-businesses-ofgem
36 BEAMA (2018) – Electrification by Design – Our Electric Future, http://www.beama.org.uk/resource-library/electrification-by-design-series.html
37 UKERC - Accelerating innovation towards net zero emissions (2019)
38 Western Power Distribution Electric Vehicle Strategy (2019)
39 Redesigning regulation - Powering from the future, 2018 – Laura Sandys, Dr Jeff Hardy, Dr Rhodes, Professor Richard Green (supported by BEAMA)
40 BEIS – Cost of Energy Review (2017) - Dieter Helm
41 CEER – Report on Power Losses (2017) p. 17
42 Redesigning regulation - Powering from the future, 2018 – Laura Sandys, Dr Jeff Hardy, Dr Rhodes, Professor Richard Green (supported by BEAMA)
43 For more information on Consumer Access Devices see BEAMA CAD Guide, 2015, http://www.beama.org.uk/resourceLibrary/consumer-access-devices-a-beama-guide.html
44 For more information on the role Consumer Access Devices play in enabling Demand Side Services see BEAMA 2015 Beyond Smart Metering http://www.beama.org.uk/resourceLibrary/the-beama-connected-homes-demonstration---beyond-smart-metering.html
45 Sustainability First, Centre for Sustainable Energy, July 2019, Smart meter Energy Data: Public Interest Advisory group – A policy dialogue and work program – Final Report https://www.sustainabilityfirst.org.uk/public-interest-advisory-group
46 BEAMA will be publishing our full proposals on all relevant parts of the Building Regulations later this autumn
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48 Redesigning regulation - Powering from the future, 2018 – Laura Sandys, Dr Jeff Hardy, Dr Rhodes, Professor Richard Green (supported by BEAMA)

Report Sponsors

Supporting organisations



This work has been lead by the BEAMA Senior Sector Council, a strategy committee within BEAMA providing a steer on our policy work and key industry agendas including net-zero, Brexit, compliance and the overall industrial strategy. The Council members are senior officials from our member companies and key organisations we work with across the industry.

The non-manufacturing companies who are members of the BEAMA Senior Sector Council have also shown their commitment to the net-zero target and have worked closely with BEAMA in the formation of this report. As part of this commitment BEAMA will continue to work closely with these supporting organisations to ensure the requirements for net-zero can be met for our industry.

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