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Opportunities and challenges for rural communities from zero net carbon legislation

June 2021

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Rural England's mission is to build the strength and resilience of rural England by helping to inform and engender better policy making. It does this by encouraging informed debate, providing independent research, supporting information exchange and building a network that draws together all those who seek to improve the social, economic and environmental wellbeing of rural England.

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Foreword

Rural communities make up 17% of England's population and will need to play a full part in decarbonisation if the UK's net zero targets are to be met

It is widely recognised that urgent action at scale is required to address the growing climate emergency and a momentum is building behind the policies and strategies being developed to take the UK towards its statutory target of becoming a net zero country by the year 2050. This includes the Government's recently published 'Ten Point Plan for a Green Industrial Revolution' and its aim to cut CO2 emissions by 68% by 2030 from the 1990 baseline.

Rural communities, who are 17% of England's population, will need to play their full part if those ambitions for 2030 and 2050 are to be met. A crucial question, therefore, is what in practical terms might it mean for our rural households, businesses and communities?

It must not be taken for granted that the policy implications from decarbonisation are the same for urban and rural areas. Indeed, there is good reason to think that in certain respects they will differ. The rural housing stock is relatively older and harder to insulate, many rural communities have no transport alternative to the car, rural people typically travel further to reach jobs and services and many rural homes lie off the mains gas grid. Both rural challenges and opportunities need to be understood.

Given the right policy framework and incentives there will be economic benefits for rural communities, such as employment opportunities making the (existing) housing stock more energy efficient. It is likely some rural communities will organise and seek to benefit from local power generation initiatives.

Looking at existing and likely future green energy technologies it seems evident that there is no silver bullet. Different technologies may be suited to powering differing modes of transport and different technologies may be suited to heating rural homes in differing locations.

Rural thinking needs to become embedded within the growing list of national and local net zero-related strategies which are being developed and implemented. These include the Government's upcoming Heat and Buildings

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Foreword

The report is intended to fill a knowledge gap in the rural decarbonisation of energy, housing and transport

Strategy and the Local Enterprise Partnership energy strategies, to name just two examples.

Rural England asked its associates at Mickledore Consultants – Nigel Wilcock and Tim Rose, to fill a knowledge gap: in particular, to explore the rural dimension to decarbonisation in the energy, housing and transport sectors (since issues concerning rural land use were reasonably well understood already). We hope the result – this report – proves a timely contribution to the net zero agenda. If it stirs rural debate and helps inform the work of those leading on producing policies and strategies then it has achieved its purpose.

Brian Wilson
Chair of Directors, Rural England CIC

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Chapter 1 – Executive Summary

The scale of change required is huge and the UK is behind target. The route to a zero-carbon future is, however, clear and it offers opportunities for new economic development in rural areas

The UK Government has set a target for the country to generate net zero carbon emissions by 2050. This report considers how this is likely to be delivered by rural economies – and the benefits that it could create. The main focus is the consideration of power generation, transport and heating for buildings.

The UK is behind target. In power generation, a generous tariff and permissions for large offshore wind developments has allowed good progress. In areas where incremental investment is required retrofitting equipment and losses would be likely in sunk capital, progress is slow.

Rural areas are not all the same, the route to zero carbon will differ by area. The shift to low carbon is no longer a technological challenge, however, the issue is more generally about setting the correct commercial model. Where this is achieved, rural economies can develop new economic sectors.

Zero carbon heat starts with better insulated buildings - an issue for older rural buildings. A combination of biofuels and electrification of heat is required – with biofuels reducing emissions immediately followed by a potential transition to heat pumps in low density rural areas where it is economic and technically feasible.

Transport follows a similar model – development in edge of village settings, maintaining local services and deployment of excellent broadband all reduces vehicle miles. Use of biofuel can immediately reduce emissions, but with a transition to electric vehicles.

Both heat and transport increase the demand for electricity but in rural areas there is the opportunity for greater local generation. If those savings from local generation can be passed onto the consumer then communities are incentivised to approve more local schemes and create decentralised power grids.

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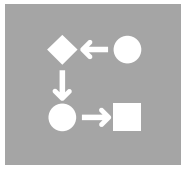
Executive Summary

In order to succeed there is a need for Government leadership, stronger legislation, better information and clarified long term financial structures – in such a framework the solution will be delivered faster and opportunities realised

A mixed technology approach is required for rural homes and business to move to net zero, particularly for hard to treat homes. Biomass can have a role in transition and back-up capacity but if this slows the transition to zero emissions this will be counter productive, and air quality impacts must be considered. Bio-fuels have a role in heating older properties. Hydrogen may become the solution – but delaying deployment of known technologies now will result in goals being missed.

Incremental change is difficult and there is currently a lack of clear political leadership – the central legislation is weak around low carbon requirements for new homes, provision of EV charge points, enablement of local grids and many other relevant areas. This ties the hands of local government to drive change.



Statutory planning legislation changes have created barriers to local power generation whilst downward pressure on feed-in-tariffs have undermined the commercial model for investment. The bolt on incentives from government are piecemeal removing any clear signposting for the preferred technical solutions.

There is an urgency for action and direction would stimulate the rural economy creating an opportunity for business – building improvements, supply chains, installation, repair and maintenance. There is also room for new financial models – commercial service provision (of heat for example) or equipment financing.

This is not ‘plug and play’ but neither is it new to market – and other economies are ahead of the UK. There is therefore a need for training – industry and the consumer – not least because the ideal solutions involve whole systems rather than single steps (eg PV powering a heat pump and the EV for battery storage).

Heat and power are areas where rural areas have many advantages whilst EVs can make significantly greater inroads with a stronger charging network. Despite the issues there is a path to a zero carbon rural economy and there is a clear opportunity for those who secure first mover advantage.

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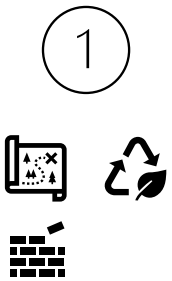
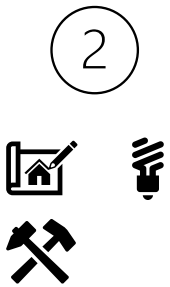
Executive Summary - Imagining a Zero Carbon Village system

Easy wins



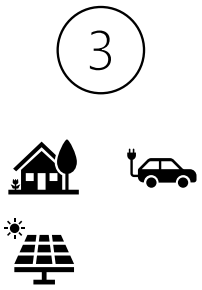
Start with the fundamentals. Planning decisions support more sustainable locations – reducing the need for car use. Fuels switch to bio-fuel equivalents to generate immediate savings.

Building standards



The built stock needs a higher standard of insulation – floors, walls, windows doors roofs. All fittings switch to low energy.

Plug and Play

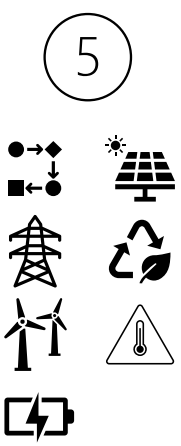


Better understood plug and play technologies can be introduced into all facilities such as the wider scale introduction of solar PV and EVs.

Building systems

Homes & premises adopt a whole system approach including electrification of heating, smart systems, battery storage (incorporating EVs) and user education. Older built stock utilises bio-fuels where electrification is uneconomic or technically infeasible.

Community systems



Communities adopt a whole system approach including local generation and private wire grids encouraging more local power generation backed up with batteries and biofuel generators. Heat shared where densities allow.

Unpredictable future

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Different technologies such as hydrogen may offer alternatives in the future – but they remain distant and cannot yet deliver against the required pace of change. Relatively low energy density of hydrogen may limit its application in off gas grid areas

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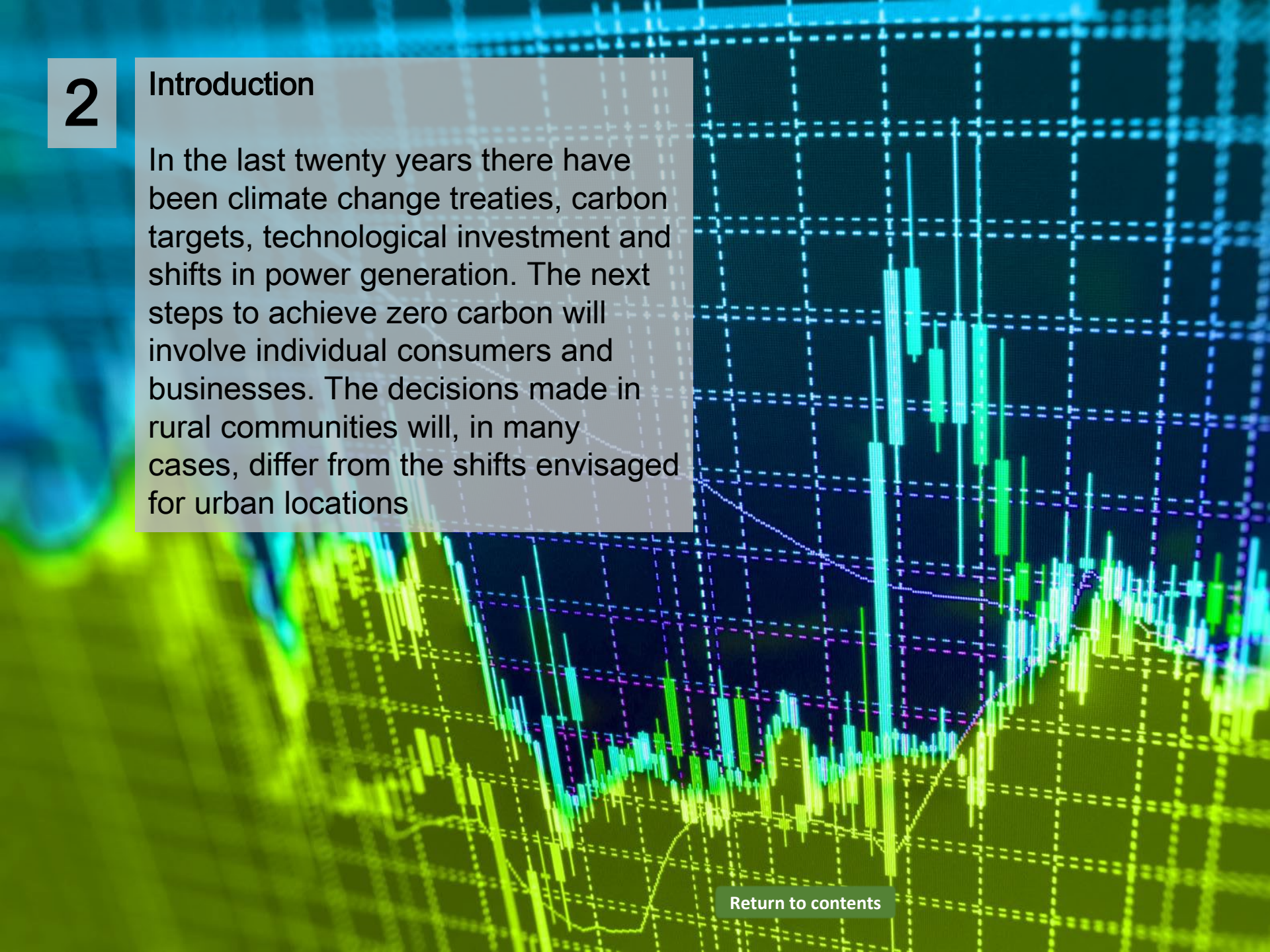

2 Introduction

In the last twenty years there have been climate change treaties, carbon targets, technological investment and shifts in power generation. The next steps to achieve zero carbon will involve individual consumers and businesses. The decisions made in rural communities will, in many cases, differ from the shifts envisaged for urban locations

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Chapter 3 – Introduction

Climate change is an issue impacting on everyone – but the narrative on a move to zero carbon has not identified many of the important differences in the rural context

The Project

The context for this project is that the threat of dangerous climate change and the policy response to address it matter every bit as much to rural communities as they do to urban communities. In many instances it has been rural communities that have been at the sharp end of flood events, storm damage and periods of drought. Furthermore, it stands to reason that rural communities (as 17% of England's population) will need to play their full part in the policy response if the national net zero target is to be achieved.

It also seems clear that most of the renewable energy production or generation will take place in rural areas (as it does at present). Alongside that, there are expected to be many opportunities arising for business growth and new jobs in the green economy. Rural communities will, of course, want to ensure they benefit fully from these.

There are a number of features of rural areas that are likely to be pertinent. They include:

- That while most rural households have access to mains gas, a good half of households in smaller settlements (villages and hamlets) lie off the mains gas grid, so must rely on other heating sources e.g. solid fuel fires, oil, electricity, LPG;
- That one in ten rural households was classified as being 'fuel poor' in 2017. Moreover, fuel poor households in rural areas would need twice as much additional income to escape that classification as fuel poor households in urban areas;
- That many rural households have little or no access to public transport and services can be infrequent, especially away from inter-town routes. One result is that car ownership is high, even among low income rural households;
- That as a result of rural settlement patterns, households living there typically travel longer distances than their urban counterparts in order to reach jobs, education, health facilities, shopping centres and other facilities;
- That more of the housing stock found in rural

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areas is older in age, which makes it less energy efficient and which adds complexity if installing energy efficiency measures;
- That many rural areas face additional development constraints. Some 9% of the land area in England is a National Park, 15% an Area of Outstanding Natural Beauty and 13% is designated as Green Belt. This has implications for developing energy infrastructure.

It is not clear that policy responses, thus far, have been designed in a way which properly recognised such features. For example, some energy efficiency initiatives appear to have - in the absence of any rural target - focussed on easier to reach or cheaper to implement urban properties.

The background to zero carbon

The starting point for the decarbonisation of the UK's energy system was the Stern Review (2006). Nicholas Stern estimated that 2% of GDP should be spent on climate change avoidance measures to avoid a far greater economic loss if global temperatures continued to rise.

Following publication, the UK Climate Change Act was passed in 2008 whereby the UK committed to an 80% reduction in CO2 emissions in the period 2008 – 2050[1]. International commitments for similar measures were enshrined following the Paris Agreement (2016).

The UK's biggest impact on this target to date has been the shift away from fossil fuel power generation, but in order to hit the carbon budgets significant change is required throughout the energy system.

In Autumn 2017 the Department for Business, Energy and Industrial Strategy (BEIS) produced its Clean Growth Strategy (CGS), a document which is monitored on an ongoing basis, with annual published reviews. These set out the next steps involved in the decarbonisation process, the milestones that should be achieved, and progress to date, all alongside seeking continued growth in the economy.

The UK's Clean Growth Strategy sets out an approach to maintain growth whilst decarbonising the economy but does not specifically address the different challenges and opportunities for rural areas

[1] The original legislation set out a position where the UK reduced emissions by 80% by 2050 but the aim was subsequently strengthened to 'net zero' by that date

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Introduction

Aspects such as rural transport systems, fossil fuel heating and ageing building stocks present challenges whilst low population densities limit cost effective solutions

The CGS seeks to establish and embed an approach that will ensure that the UK has a secure supply of affordable energy which allows and enables economic growth, but at the same time achieve the UK's commitments under the Paris agreement to reduce significantly its carbon emissions.

In the same period as the CGS the government also published the Industrial Strategy which highlights decarbonisation of the supply and use of energy across the country as important considerations, cutting across the government's whole approach to economic growth.

As we head towards COP26 in Glasgow in 2021, the Prime Minister has published a 10-Point Plan for a Green Industrial Revolution. Further government policies are being set out in follow up and forthcoming documents such as the Energy White Paper, Future Homes Standard, Heat and Buildings Strategy and Transport Decarbonisation Plan.

The impact on England's rural areas of this road to decarbonisation represents a significant challenge across farming, land management, energy networks & generation, housing & buildings and provision and use of transport. The CGS did not specifically focus on rural areas – but it is clear that there are some unique challenges and opportunities in moving towards 'zero carbon' from a rural perspective. Rural areas in England currently comprise around 17% of the overall population. Each rural area is also unique: they include small town, market towns, villages, hamlets, farms and isolated dwellings. A rural area may also include coastal regions, uplands, or abut large population centres. Livelihoods may be gained from so called traditional rural activities such as farming, but also include heavy engineering, power supply and food production. In the same way that no two rural areas are alike, the challenges and opportunities will also vary.

Carbon Challenges

De-carbonisation in the rural context is a

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Introduction

The report examines the current position, barriers to change and challenges and opportunities for rural areas – both from recent evidence and the experience of consultees across rural England

challenge across a number of areas – notably power generation, industrial and farming processes, heat (domestic and commercial) and transport. It is clear that action across all these areas is essential if the UK is to meet its carbon budget.

Rural areas face these challenges more acutely than much of the UK.

A plethora of support mechanisms and incentives to an extent battle with emerging technologies, scaleability and cost, planning permissions and legislative issues.

In the same vein, the production of energy, its distribution and storage face similar issues around the future of the different technologies, its implementation and the extent to which areas are looking for leadership at a local and national level.

While many areas through the public sector are producing their own local energy plans and pathways to zero carbon, there appears to be a leadership gap in terms of common standards, criteria and aims. Coupled with the market concerns around pre-eminent future technology this represents a real challenge to change.

Commission of the report

This report, commissioned by Rural England, is a result of a comprehensive review of the current situation with regards to three areas:

- Power generation & networks
- Housing & buildings
- Transport

The report follows a consultation exercise with a number of interest groups and sector representation bodies across England including:

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Introduction

The move to zero carbon in rural areas does present some challenges – but there are opportunities as well. This document seeks to inform all those with a role in rural policy making

- Housing associations
- Commercial property developers
- Transport operators and vehicle builders
- Land & estate owners
- Local authorities
- Rural LEPs
- Universities and academics

A full list of consultees is provided in Appendix 1.

The aim of the report is to identify and understand the main challenges and opportunities for rural households, businesses and communities as the country seeks to radically reduce greenhouse gas emissions in order to meet the net zero legislation target and avoid dangerous climate change.

The UK Government has recently strengthened its ambition by introducing legislation that will require the country to reach net zero carbon (i.e. be carbon neutral) by 2050. This will require some very significant changes to the way we all live and work, taking place at a faster pace than the changes made thus far. Inevitably, some of those changes will have distinctive rural aspects to them. Indeed, a cursory look at some of the proposed public policy, technological and societal changes needed, indicates both specific rural challenges and opportunities.

It is important that these are well understood and taken into account by those who make and deliver public policy, as well as by businesses and investors, and the community/voluntary sector.

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3 Current Situation

To understand the challenges that zero carbon presents, it is important to consider what steps have already been taken in moving towards the UK's climate change measures

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Chapter 3 – The Current Situation

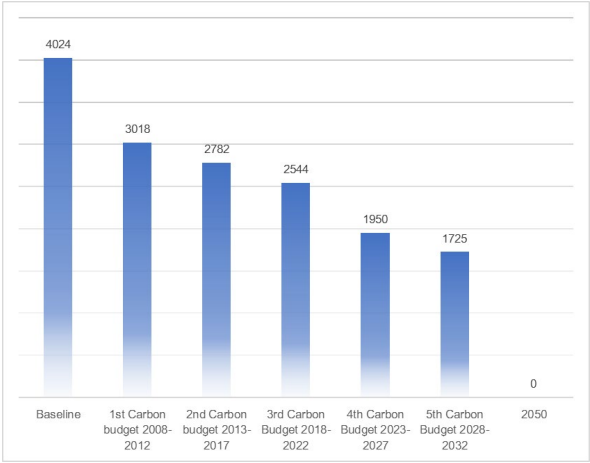
The UK has developed a very clear pathway to a net zero position in carbon emissions and a strategy that demonstrates how economic growth can be maintained whilst a low carbon strategy is pursued

The roadmap for the UK's strategy to decarbonise and maintain economic growth is set out in the Clean Growth Strategy (CGS) and this was published in October 2017; it ties in closely with the Industrial Strategy which was also published in Autumn 2017.

The Clean Growth Strategy sets out proposals for reducing carbon intensity in all sectors of the UK economy through the 2020s. It explains how the whole country can benefit from low carbon opportunities and drive economic growth, while meeting national and international commitments to tackle climate change.

The Clean Growth Strategy also offers the roadmap for how the UK will meet its carbon budgets. The Carbon Budget was established in 2008 and sets out (in five-year blocks) how the UK moves towards a net zero position in carbon outputs by 2050. The targets which were established are set out in the graph below.

UK Carbon Budget (million tonnes of carbon)



The Clean Growth Strategy is set out against the following aspects of energy:

- Business and industry efficiency
- Shift to low carbon transport
- Clean power
- Natural resources
- Domestic
- Public sector

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The Current Situation

The strategy also considers the role of Government in achieving the low carbon goals

The strategy then also sets out:

- How Government can accelerate clean growth
- How the Government can show leadership

A diagram showing these themes, their contribution to carbon emissions and the broad themes of the strategy is set out overleaf combined with comments on the relevance to the rural economy.

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The Current Situation

Business and industry efficiency	Shift to low carbon transport	Clean Power	Natural Resources	Domestic	Public sector
25% of emissions	24% of emissions	21% of emissions	15% of emissions	13% of emissions	2% of emissions
- Energy efficiency in buildings; assistance for large businesses to improve efficiency; specific plans for 7 of the most energy intensive sectors. - Invest R&D in carbon capture and storage. - Phase out fossil fuel heating and recycle heat	- End sale of petrol / diesel and create funds for take-up of low emission vehicles; deploy charging infra-structure; retrofit busses; work with industry on automotive sector deal - Increase use of cycling and walking for shorter journeys; shift freight from road to rail - R&D in autonomous vehicles; batteries and HGV platoons	- Implement the smart systems plan; consumers use power flexibly - Deliver new nuclear - Further stimulate renewable power through CFDs; a sector deal; carbon pricing - R&D in smart systems and storage; nuclear fuel and reactors; renewables including turbine design	- Agricultural support aimed at environmental outcomes; forests; timber in construction; aim for zero avoidable waste; manage emissions from landfill.	Energy efficiency: - ECO funding for claimants; aim for Band C in private rented / fuel poor homes; improve social housing, provide smart meters. Increase energy performance standards for new and existing homes. Low carbon heating: - Roll out heat networks; phase out fossil heating in new / off grid homes; improve boiler standards; reform RHI; innovation funding	- Voluntary target of 30% reduction in carbon - £255m for energy efficiency improvements.
Manufacturing remains important but there are lower levels of carbon intensive industry – but rural issues relate to older buildings, whilst lower densities limit heat solutions.	Possibly the largest challenge for rural areas – low population density is a challenge for infrastructure and longer distances travelled.	With a national grid, little difference between areas. Rural areas have opportunities for generation and local grids.	Aspect of the CGS which specifically dealt with rural issues. There are rural opportunities for energy crops (for bio-fuels), better use of residual waste for bio-fuels and land use methods for carbon sequestration	Rural issues relate to older buildings, whilst lower densities limit heat solutions.	Wider geographic delivery of services results in rural challenges.
Accelerate clean growth:	Establish finance taskforce; develop sustainable finance management standards; clean tech investment fund; green mortgages				
Government leadership	Promotion, inter-ministerial approach and report on emissions intensity				

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The Current Situation

The Clean Growth Strategy sets out areas of significant intervention – and whilst this is all relevant to rural areas, the key differences faced by rural areas are not fully acknowledged

As part of the Strategy a number of initiatives which will provide funding have also been identified and these are as follows. Further details of the funding and schemes involved is at Appendix 2.

1. Accelerating Clean Growth
Providing £20m to provide early stage investment in clean technology.

2. Improving business and industry efficiency
The provision of up to £274m in funding – with the largest portion aimed at process technology. Of this up to £100m will invest in carbon capture.

3. Improving the energy efficiency of our homes
A £8.3bn programme of activities to improve energy efficiency and incentivise a shift to zero carbon heating technologies.

4. Accelerating the shift to low carbon transport
A £1.1bn programme to incentivise the take-up of Ultra Low Emission Vehicles and upgrade the charging infrastructure.

5. Leading in the public sector
A c£2.6bn provision of funds for green taxis, busses, cycling, connected and autonomous vehicles, further transport scheme innovation and battery technologies.

6. Delivering clean, smart, flexible power
A c£2.1bn to support tariffs in offshore wind, smart grid and usage systems, nuclear energy and offshore wind technologies.

7. Enhancing the benefits and value of our natural resources
Provision of c£100m in agri-tech, land use and waste management

Within the 2008 legislation that established the 80% reduction in carbon emissions[1], the Committee on Climate Change was formed. The Committee on Climate Change (the CCC) is an independent, statutory body and its purpose is to advise the UK Government and Devolved Administrations on emissions targets and report to Parliament on progress made in reducing

[1] The original legislation set out a position where the UK reduced emissions by 80% by 2050 but the aim was subsequently strengthened to 'net zero' by that date

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The Current Situation

The UK has enshrined independent scrutiny in its low carbon transition strategy – but the independent panel is generally critical of the progress made

greenhouse gas emissions and preparing for climate change.

In fulfilling its role its focus is to:

- Provide independent advice on setting and meeting carbon budgets and preparing for climate change.
- Monitor progress in reducing emissions and achieving carbon budgets and targets.
- Conduct independent analysis into climate change science, economics and policy.
- Engage with a wide range of organisations and individuals to share evidence and analysis.

Each year the CCC produces a report which sets out progress. The Executive Summary of the 2019 report is interesting context for the challenges that rural areas face – the report noted:

- Overall, actions to date have fallen short of what is needed for the previous targets and well short of those required for the net-zero target.
- Last year, the Committee set out 25 headline policy actions for the year ahead. Twelve months later, only one has been delivered in full. Ten of the required actions have not shown even partial progress.
- The Committee also monitor indicators of underlying progress such as improvements to insulation of buildings and the market share of electric vehicles. Only seven out of 24 of these were on track in 2018. Outside the power and industry sectors, only two indicators were on track. This is a continuation of recent experience - over the course of the second carbon budget (2013-2017), only six of 21 indicators were on track.
- The Government's own projections demonstrate that its policies and plans are insufficient to meet the fourth or fifth carbon budgets (covering 2023-2027 and 2028-2032). This policy gap has widened in the last year as an increase in the projection of future emissions outweighed the impact of new policies. Too often efforts have been isolated to single departments or have progressed too

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The Current Situation

The aspects in which the UK is struggling to make an impact in carbon reduction are those which are most relevant to rural areas – or conversely those aspects in which rural areas can demonstrate some solutions

slowly. The foundations in the Clean Growth Strategy have not been developed into a coordinated approach that will deliver even the existing carbon budgets

- In the 2019 Spring Statement, the Treasury (HMT) announced an end date for gas heating in new homes, but now it must engage more with the delivery challenge for reducing emissions across the economy. The strategic levers at HMT's disposal, including public spending and taxation, will be fundamental in driving the transition to net-zero emissions. The planned review of the distribution of costs for reaching net-zero emissions is an opportunity to ensure that incentives support low-carbon choices and that funding is aligned with the required pace of change.
- Despite good overall progress in the power sector to date, the business department (BEIS) has been too slow in developing plans for carbon capture and storage and has held back deployment of onshore wind that would cut energy bills and emissions. No large-scale trials have yet begun for heat pumps or low-carbon hydrogen. Development of these markets and of a skilled workforce needs to go hand-in-hand but there have been no serious steps towards their development, in buildings, industry or (for hydrogen) transport.
- The departments for transport (DfT) and for housing (MHCLG) are now on the frontline of efforts to meet the net-zero target. They must do more to prioritise emissions reduction, working with BEIS and HMT to drive down emissions in these areas. The 'Road to Zero' ambition for a phase-out of new petrol and diesel cars by 2040 has recently been brought forward to 2030 which will save motorists money, cut air and noise pollution and align to the net-zero challenge.

Conclusion

The current situation provides important context for the entire report. The UK was early to legislate for climate change and has recently created a plan that is intended to encourage economic growth whilst at the same time reduce carbon emissions.

The Current Situation

The Committee for Climate Change echoes the findings of contributors to this report – there is an urgent need for leadership, policy and technology clarity combined with a carrot (incentive) and stick (legislative) approach

The reality, however, is that the Government is missing current targets, is behind implementation projects that will impact on future targets and has only really made significant progress in power generation where there is the ability for Government to directly influence the installation of new green technology and phase out fossil fuels.

In activities where there is a more complex behavioural shift required; where individuals / enterprise will incur greater cost; or where difficult retro-fitting is required, progress has been limited.

Given that rural economies face the greatest challenges in those areas where the UK is making the slowest progress in decarbonising the nature of the challenge is clear – but there remain significant opportunities with clearer leadership, technology deployment, incentives (carrot) and legislation (stick).

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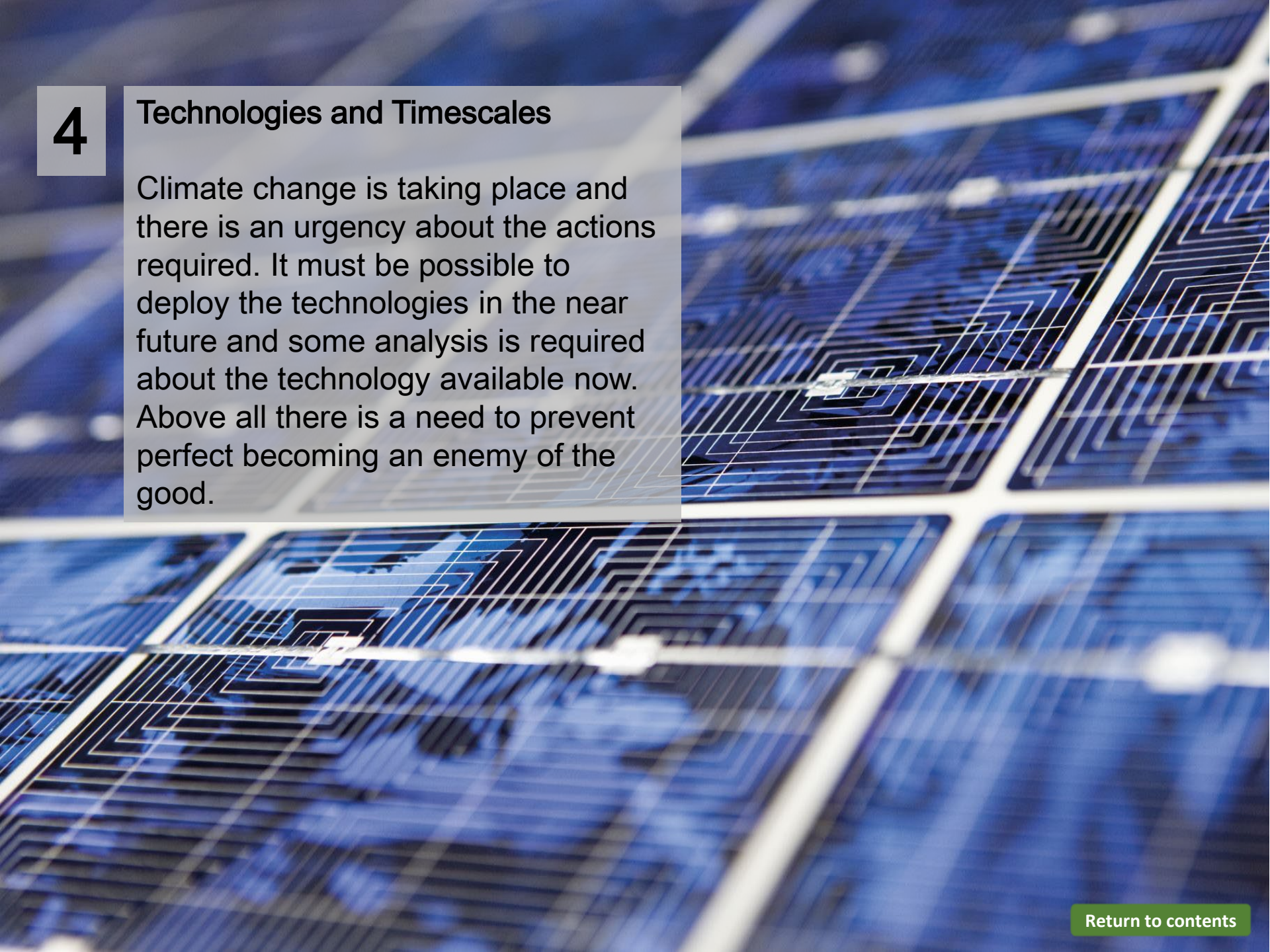

4 Technologies and Timescales

Climate change is taking place and there is an urgency about the actions required. It must be possible to deploy the technologies in the near future and some analysis is required about the technology available now. Above all there is a need to prevent perfect becoming an enemy of the good.

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Chapter 4 – Technologies and Timescales

UK power generation infrastructure is decarbonising rapidly – but continued investment is required. As electricity demand for heat and vehicles increases the UK is losing its nuclear generation capacity

Introduction

Decarbonising the economy has been considered a major technological challenge for many years, but in fact innovation has resulted in many of the key challenges being addressed – the problem is now as much a commercial issue. The new technologies often add cost over existing solutions and therefore create a disincentive to invest.

Before the barriers to uptake are considered it is useful to examine the leading technologies in brief – and in particular their relevance to rural economies.

Electricity – Power generation & Networks

The power industry has decarbonised the most dramatically over the last 10 years but there will be a need for further developments as the UK's ageing nuclear power stations are decommissioned.

Of the eight nuclear power stations currently operating, it is projected that 7 will close during this decade and this will remove almost 7,500MW of generating capacity.

To put this in context, the entire offshore wind generation in the UK at present will need to double in scale to replace that capacity (in 2020 the UK had 8,483MW of offshore wind capacity) to meet current demand. But many of the new low carbon solutions will require clean power and as a result electricity demand is likely to increase.

As a result the revolution in power systems is likely to continue over the next 5 - 20 years and further investment in generation will be made in parallel with smart grid technology.

The Current System

The generation mix is essentially controlled by Government through its pricing regime. Government incentivises different types of power generation through differentials in price dependent on how the electricity was generated. The Government subsidises some types of

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Increased micro generation and storage will be linked to smart grid technology – with demand and supply likely to be controlled by differential pricing

generation by agreeing to pay a price higher than the wholesale price of electricity.

The National Grid provides the high voltage power system for the UK and local distribution is provided by Distribution Network Operators (DNOs).

Price mechanisms which seek to vary electricity usage tend not to be in place (apart from for the very largest consumers). Electricity providers sell power to consumers at a set tariff – and the tariff includes charges to allow the providers to meet their 'renewables obligation' and charges for distributing the power.

Broadly speaking, all UK consumers have access to the same range of electricity tariffs irrespective of where they live – with very small supply charge differences.

The changes expected

There is the potential for significantly greater local renewable power generation. Twenty years ago there were around 90 points of production feeding into the central electricity grid. Today there are over 900,000 – with micro generation from small hydro schemes, small wind farms, and mostly from solar PV.

Localised PV installation has stalled slightly through a reduction in the price paid for the power that consumers exported back to the grid – but with likely increases in domestic power requirements the economics of installation are likely to change.

The low carbon energy generated in the UK is somewhat erratic largely because of the reliance on off-shore wind and the variability in wind speed. One of the solutions to the variability in supply will be battery storage (although this is a technology area where there is a need for further development). Battery storage is being deployed within the grid and in the domestic and commercial environment – and could also be supplemented through the battery storage in electric vehicles.

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Technologies and Timescales

Local resilience and the ability to drive down the costs of power will incentivise a move towards localised power networks – with rural areas having greater means to generate local supply

The transformation, brought about by 'smart grids', will be to link local power generation and storage into a central system. Variability in supply could be managed through the reserves in local storage and usage managed by differential charging dependent on overall grid demand and power generation at that time.

This 'smart grid' technology and home energy management is being deployed using a smart phone driven app and 'Internet of Things' development within the home. It means that the ability to use / export power at different times is a near term technology development.

Rural Perspective and localised networks

To accommodate the electrification of heat and transport, significant and costly upgrades will need to be made to local power grids.

The shift to a national smart energy system will be a phased deployment. Its roll out will be dependent on high quality, modern and reliable digital infrastructure (ideally fibre). From this perspective, its development may continue to be a challenge for rural areas – although the progression does make universal access to digital infrastructure for all a key demand of Government.

From a local / rural perspective there are concerns regarding security of power supply and the overall resilience of a low carbon generating system. It is also clear that the cost of electricity from a supplier, loaded with transmission costs and fees to support renewable activity are probably higher than the cost of establishing small localised power networks.

Localised power networks will become an interesting opportunity for villages and / or commercial developments in the future. Land availability and lower population densities will make decentralised power networks particularly attractive for rural areas.

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The UK's reliance on fossil fuels for commercial and domestic heating creates a very significant residual problem – but there are deliverable solutions

Heating

Heating homes, businesses and industry accounts for nearly half of all energy use in the UK and a third of carbon emissions. Nearly 70% of heat is produced from natural gas. Meeting the target of net zero by 2050 implies decarbonising nearly all heat in buildings and most industrial processes.

The UK's reliance on fossil fuels for heat is a consequence of the UK's self sufficiency in these fuels over decades and this has resulted in a significant residual problem of a need to retrofit almost the entire built stock with a different heating system – in fact homes are continuing to be built with fossil fuel based heating systems with gas boilers not being phased out in new homes until 2025.

The real challenge will be retrofitting the UK's existing housing stock, which is some of the worst in Europe in terms of heat loss and energy efficiency. The UK government has signalled that it will move first with decarbonising off-gas grid heating where a large number of old, hard-to-decarbonise buildings are situated.

Alternatives

A combination of three technology pathways can address the UK's heat challenge:

1. Continuing with domestic / commercial boilers and decarbonising the fuel (using biogas / bioLPG / other biomass or hydrogen).
2. Centralising heat (using a heat network)
3. Electrifying heat – and using energy efficient heat pump technology

Heat pumps may provide opportunities for up to 50% of rural households, however the hard to decarbonise older housing stock with limited opportunity for further insulation will need other options, including switching to bio-fuels such as bioLPG. Heat networks may play a role in rural towns and villages, potentially using biofuels in off gas grid areas, but will be limited for remote rural properties.

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Technologies and Timescales

A combination of heating solutions is needed to achieve Net Zero ambitions in rural areas. For many homes a heat pump would be suitable but they are not a plug and play solution – to work effectively they need a low temperature radiator system, very good insulation and a change in occupier behaviour. For others a decarbonised fuel will be the quickest and most affordable solution

At present there is general UK support for exploring the role hydrogen could play, but large-scale deployment of hydrogen will need significant time, especially since there is limited national and international experience of its use as a heat source. There is also limited application for homes not connected to the gas grid.

Biogas is also an opportunity, particularly for homes that will be hard to decarbonise in terms of fabric improvements. BioLPG (biopropane) is already available and can be used in stand alone LPG boilers or alongside heat pumps in hybrid heat pump applications which could be necessary to manage periods of high heat demand in rural properties.

Heat network systems need significant heat densities to become viable. Potential heat networks are therefore largely found in urban and / or industrial areas, although small networks combining big heat users (larger public, commercial, retail or hospitality uses) may be possible to develop in rural villages. Heat networks also require high connection rates, i.e. large portion of the potential clients have to become customers to create the viability for the infrastructure investment. There is also a challenge in connecting large detached residential houses in low density developments – the system does not typically lend itself to multiple connections and small individual loads.

The third alternative is heat pump technology - mainly air source (ASHP) and ground source heat pumps (GSHP) linked into a wet radiator system, and air-to-air heat pumps (A/AHP) primarily for electric heated premises.

ASHP and GSHP are suited to replacing fossil fuel heating systems in some homes off the gas grid in the UK, and for A/AHP to reduce the electric consumption in those homes currently electrically heated. Deployment of heat pumps or heat networks is not however a straightforward switchover.

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There is the potential for a significant economic dividend for those areas securing first mover advantage in the deployment of new technologies

The central heating systems (water pipes) in existing homes are normally designed and sized for a quick raise in indoor temperature due to the on/off heat profile of fossil fuels. To work effectively, heat pumps should be linked to the systems designed for 'low temperature' heating (not exceeding 55°C) which are left running 24 hours per day. They also require space for a hot water tank to be installed – which is something that has often been removed as it is not required in a combi-boiler system.

There is also a need to ensure that such buildings are adequately insulated. Various different technologies are available, including cavity wall, internal wall, or wrapping the entire building in an insulated material but this can be costly - typically costs increase commensurate with the age of the building to be insulated, as frequently cavity wall is not available and issues arise around planning regulations, listed building status, and practicality.

Finally, there is a significant 'education issue' for users in driving the best performance from the system – specifically around leaving the system to run over long time periods.

Nevertheless, when heat pump installation alone is considered as a replacement technology in wet systems off the gas grid (replacing oil fired systems) the technology is now commercially viable. For some existing homes with suitable levels of fabric energy efficiency, using a combination of Renewable Heat Incentive (RHI) and commercial finance it is possible to fit a new system with no change to annual fuel costs and an eventual saving when repayments have been made on the capital costs of the system – although the calculation is sensitive to the fluctuating price of heating oil.

Heat pump technology also lends itself to a smart 'whole system approach' with larger scale deployment of solar PV, greater emphasis on energy efficient buildings, domestic battery storage, and phasing of electrical usage within the premises.

There is a risk that the shift towards electrical

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The Government is faced with very challenging requirements to introduce zero carbon vehicles and electric vehicles represent the only technology that can provide the switch in the time available

heat reverts back to standard electrical heat systems. Certainly the installation of such a system is significantly less expensive and disruptive than switching to a heat pump system.

The Energy Saving Trust estimates that a typical air source heat pump installation costs around £6000 – £8000. The equivalent for electrical heating is likely to be £1,000 - £2,000. The efficiency (and therefore costs savings) thereafter are likely to be high and estimated at 50% of standard electrical heating.

The cost of installation of a heat pump plus the retrofitting of insulation measures in older properties does however make conversion expensive and arguably uneconomic. A recent analysis by Ecuity Consulting shows that up to 44% of off-gas grid homes in England are hard-to-treat and will require affordable decarbonisation options as they might not be suitable for technologies such as heat pumps. A deep retrofit of all rural, off grid homes to facilitate full electrification would entail high upfront costs and considerable time commitments from consumers, meaning many consumers would be unwilling or unable to commit to such improvements. The report finds that a typical oil heated period-home would cost £31,000 to carry out a deep retrofit for electrification and heat pump installation, with over 15 days for the works to be carried out.

In these circumstances a switch to biofuels provides a genuine alternative – with bioLPG the easiest switch in many circumstances.

Rural perspective

The Government intends to publish a Heat and Buildings Strategy in 2021 and introduce new regulations to regulate off-gas grid homes. With many areas in locations off the gas grid, cost effective heating solutions for homes and commercial premises is a challenge, fuel poverty is high and significant support and incentives are required to switch to a new heating solution. The Government's RHI scheme can continue to make a difference in this area. Its replacement from

Even with the progress made to date, vehicle cost and range combined with charging point availability and charging speed remain a challenge

2022, the Clean Heat Grant, should help support a wider number of technologies, including hybrid heat pumps.

There is also a need for the development of new insulation methods which can be retrofitted to the older building stock of the UK.

The slow take-up of heat pumps in the UK and difficulties in retrofitting more heat efficient building materials also presents an economic opportunity. If the technology can be deployed at scale there will be a need for local manufacture, a supply chain of components / materials and replacement parts, installation and service engineers and training facilities. There is therefore a significant economic dividend for the location that secures first mover advantage.

Finally, where retrofitting of new insulation and heating systems is uneconomic there is scope for the adoption of bioLPG and other biomass technologies, perhaps employing heat as a service financial model.

Transport

New petrol and diesel vehicles in the UK are up to 16% more efficient than they were in 2000 but the improvement has been largely offset by a nine per cent increase in road traffic to 2015. The transport sector now accounts for 24% of the UK's carbon emissions.

Improvements by manufacturers in the fuel efficiency of vehicles have largely been driven by tighter regulation, mainly set at an EU level. The fuel we use in our cars is also lower carbon, with the Renewable Transport Fuel Obligation (RTFO) driving the greater use of biofuels.

Biofuels now account for around 3% of fuel sales, with around half of that derived from waste. Average greenhouse gas savings from biofuels are around 70% compared to petrol and diesel.

Despite these savings however, in order to meet the Government's 2050 target, almost every car and van will need to be zero emission by that

Limiting carbon emissions from transport is not just about the vehicle – it is also about maintaining local services, providing excellent broadband and only allowing residential development in settlements which all limit the necessity to travel in the first place

date. The Government has announced an end to the sale of all new conventional petrol and diesel cars and vans by 2030. Emissions from heavy goods vehicles (HGVs) and busses will also need to reduce significantly to make a meaningful contribution.

Transport Technology

In the short-term electric vehicles offer the best decarbonising transition of the transport sector, but over time hydrogen may offer an alternative solution.

The starting point in the UK has been to focus on the uptake of Ultra Low Emission Vehicles (ULEVs). An ultra-low emission vehicle is a vehicle that produces less than 75g/km of CO_2. Today there are less than 10 car models that are considered Ultra Low Emission Vehicles (ULEVs), all of them being electric or hybrid cars.

There remain a number of stumbling blocks to be overcome – cost, range, charging point access and speed of charging. Government investment is seeking to address these issues through innovation and subsidy.

ULEVs should become progressively more affordable as economies of scale are realised and they could provide savings for consumers compared to equivalent internal combustion engine cars by the mid-2020s or sooner. Their uptake would then start to have a commensurate impact on vehicle emissions. As a result, at least 30% of new car sales are expected to be ULEVs by 2030, and possibly as many as 70%. For new vans, up to 40% of sales could be ULEVs by 2030. The Government are spending £1 billion to drive the uptake of ULEVs.

Nevertheless, this is one area of the decarbonisation challenge where addressing the technical issues in time to meet the deadline set continues to be a race against time.

Hydrogen

Hydrogen and fuel cell (HFC) technologies can also provide solutions in delivering transport

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There is some doubt about the sustainability status of the use of some bio-fuels but they can be considered an immediately available solution where electrification is not viable

services and this is an area in which the UK has developed some competitive strengths.

Companies such as Ceres Power, Intelligent Energy and Rolls-Royce Fuel Cell Systems are designing products which may revolutionise transport and these are being integrated into public transport solutions – both busses and trains.

Nevertheless, these products would be cost prohibitive to be introduced without very significant subsidy and in that sense are really at a pre-market stage. There is no prospect of the take up of these technologies for private vehicles at any point soon and they can therefore be considered to be at least ten years behind EV development if they are ever to achieve commercial viability.

Biofuel

The Government also want to see a near doubling of sustainable bioenergy used in the transport sector. At present the availability of E5 fuel at the pump has had an impact on carbon reduction and the proposed introduction of E10 could lead to a further reduction in UK carbon emissions.

Rural perspective

Decarbonising rural transport systems is probably the most significant challenge in rural economies progressing to a zero-carbon future.

This is not to say that nothing can be done however, take up of ULEVs is increasing, increased biofuel content can reduce emissions and in addition, comprehensive availability of fast and reliable broadband, maintaining the availability of local facilities, services and amenities and ensuring the rural development is limited to the edge of current settlements will all drive carbon reduction.

The closure of a village shop / school / doctor's surgery are all likely to add more carbon miles

European scientists have lobbied the European Commission to remove bio-fuels from the zero carbon calculations.

than an increase in ULEV penetration will save.

ULEVs will need to become the normal means of transport if zero carbon targets are to be achieved. To a large extent, the ability to make this change will depend on the extent to which vehicle cost is reduced, range can be extended and then charging points deployed in low density areas.

ULEV busses will be required to provide rural public transport services – and this is likely to increase the level of public subsidy that will be required to provide these services.

Biofuels

Biofuels extracted from plants, woods, food waste, algae or manure, are already broadly used across both the transport and building sectors. Wood, chip, pellets and bioethanol have for many years been used in off grid rural homes, while bioethanol has long been an additive to diesel fuel for domestic and public transport. There are many perceived advantages to biofuels:

- Cost – current prices are similar to those of diesel although overall costs are lower given cleaner operation and lower maintenance
- Availability – a ready, local source of raw material
- Ongoing security of supply
- Job and economic stimulation – biofuel conversion is frequently a local, relatively labour intensive operation
- Lower emissions than fossil fuels: lower carbon, better air quality
- Renewable source either by growing or continued use of waste
- Proven technology and scaleability – Kristianstad in Sweden operates as a biofuel city

There are, however, also very clear disadvantages to widescale adoption of the technology:

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Technologies and Timescales

The sustainability of feedstocks will be fundamental to the low carbon delivery through biofuels.

- Water usage – the process of growing biofuel crops is water intensive
- Land usage
- Monocrop soil issues – degradation of soil through the constant production of fuel crops
- Whole lifecycle carbon footprint – the additional carbon cost of growing, processing of fuels is significant
- Lower output compared to fossil fuels
- Competition with food crops and associated price volatility

Clearly the most important reason why the biofuel substitute for fossil fuels might be problematic on the road to zero carbon is that it adds to the carbon footprint when it is used. Its use in the transport industry as an additive to existing fuels, and the capability of increasing the ratio, has had a significant impact on emissions. Similarly, biofuel has been used for centuries in rural areas and is seen as a cost effective, local source of fuel. However, with the future technologies around electrification and hydrogen reaching maturity and scaleability, biofuels could be considered to be essentially an intermediate solution, unless the sustainability of feedstocks are improved.

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5 Experience across England

A wide-ranging consultation exercise has been undertaken to fully understand the actual experience of organisations and the issues they faced in selecting and implementing zero carbon projects in everyday settings

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Chapter 5 – Experience across England

The cost of entry for most of the lower carbon technologies is frequently comparatively high with a lower payback than traditional solutions

As part of the project, a broad section of stakeholders were interviewed to obtain as wide a view as possible of the impact, future potential, barriers and opportunities, uptake, pace of change, and the differences of opinion that exist throughout the country.

Stakeholders included:

- Housing associations
- Farmers
- Land owners and agents
- Industry associations across the three sectors
- Universities
- Local authorities
- LEPs
- Interest groups
- Services operators
- Rural businesses

As was to be expected, certain themes emerged from these interviews which are set out below. While opinion was not unanimous, there were certainly some topics which were raised repeatedly, and these are highlighted in the pathway to change section of the report. The following sets out the summarised views of contributors.

Cost

- There is a mix of proven technologies, innovative new technologies, and future potential technologies across each of the areas of power generation, heat and transport. The cost of entry for most of these technologies is frequently comparatively high when compared to existing systems (although in many cases not prohibitively high) and this is creating a disincentive to investment, particularly where there remains debate about the likely future solution.
- At the household level, consumers are caught in the “Betamax / VHS conundrum”, uncertain whether or not to invest and risk high level of investment in fast dated technology.
- The implementation of the whole agenda will be very capital intensive, often with long term payback - the returns offered by some of the technologies is either too low for any sensible

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Gaining momentum for the shift to new products is difficult despite the imperative to get the transition started

payback period, or the investment risk is considered too high given a lack of long term data about the solution / a perception that alternatives are emerging.

- Rural areas are faced with a greater challenge than the country as a whole – a switch to low carbon is perceived as expensive in terms of investment as opposed to urban areas where economies of scale may be achieved – with deployed resources either being better utilised (heat networks or charging points) and demand is lower (greater proportion of modern well insulated buildings or lower distances travelled). For these reasons, the government's intention to decarbonise rural homes first could prove to be perverse given these challenges.
- There is an information disconnect between policy / technology and the consumers, intermediaries, suppliers and investors. In common with the introduction of any new product, gaining momentum is difficult despite the imperative to get the transition started.
- In addition, despite the best intentions, some subsidies, grant regimes, RHI, Feed in Tariffs have led to short term thinking, and in some cases abandoning of proven technology and retrograde environmental reactions eg grant support for gas fired central heating systems
- The cost of retrofitting many rural houses, including relatively modern stock, is typically not economically viable, and despite best endeavours will still not meet the future standards required.
- From a positive perspective the pricepoint of EVs is now at a tipping point for consumers with a quote from one participant that rural householders make up the second largest group of EV purchasers after central London residents; the cost / benefit of installation of heat pumps in domestic housing can offer clear drivers for installation when RHI is used – although the calculation depends on the expected long term price of heating oil.

Clarity

- The market is distorted by the variety of different messages coming from central

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Experience across England

Much of the early adoption of technology has been at community / grass roots level with local evangelists demonstrating the way forward – this has been useful, but such projects don't always make the best case studies for mainstream adoption

government; interest groups; manufacturers; innovators; scientists. There are clear vested interests in maintaining or prolonging the status quo.

- New technology is frequently touted as the "silver bullet" which leads to the VHS / Betamax dilemma
- The decarbonisation agenda means different things to different groups. There is little common agreement or target setting established with a common baseline. The implementation for example of targets by various councils and LEPs is often predicated on different understandings of what the baseline is, what the measurement of carbon usage might be, and the inclusion or exclusion of externalities.
- There is a plethora of information generated at a central government level but this is perceived as being disjointed as it originates from a number of different government departments; uses different baselines and criteria; and is perceived as changing too frequently
- Much of the early adoption of technology has been at community / grass roots level. This may lead to poor quality information dissemination, lessons learned, implementation and promotion of success. There is a need for an understanding of what the agenda means for mainstream communities and businesses – with solid examples of where whole systems deployment has been a success and the lessons learned / pitfalls to be avoided.

Capability

- The decarbonisation process requires a step change in not only attitude and will, but also in the capacity, skills and expertise required to implement that step change. There is a shortage of companies available to manufacture, build, install and then maintain the different technologies that will be required to achieve a zero carbon outcome.
- There is also a risk that the reputation of the installation companies at the early adoption stage have, in many cases, been considered disreputable – for example early providers of

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Experience across England

The supply chain is not in place for large scale adoption – manufacturers, installers and the subsequent maintenance all requires investment and training

PV over-selling the benefits.

- The financial models for investment into the decarbonisation technologies are not yet fully refined for the market. Innovation in for example, long term leasing of heating systems alongside retrofitting of properties; providing heat as a service; biofuel fired systems on lease; community owned and daily rented transport; demand responsive public transport are all ideas that have been touted but little financial modelling has been undertaken and few 'off the shelf' approaches has been made available.
- Suppliers may steer consumers down a particular technology route simply because that supplier does not have the skills available to install, for example, an air source heat pump system – and so the risk is that the consumer selects a less efficient product.
- The supply chain for new technologies is frequently not ready for the scale required. The manufacture of such as air and ground source heat pumps components in the UK is largely in the hands of smaller operators. The predicted shrinking of international supply chains post Covid 19 may well have a significant impact.

Change

- The road to decarbonisation requires a step change in attitude from all governments, at a national, principal local authority and parish council level
- Rural areas are perceived both by outsiders and by themselves as being inherently conservative, suspicious of change, and cautious about adopting new technologies. The facts don't always bear this out, but the perception persists. Indeed community led action is consistently more common in rural compared to urban areas in schemes such as shops, pubs and transport
- The change required to facilitate decarbonisation is perceived as being detrimental to the rural environment – the desire to keep rural areas pristine has been seen to conflict with the implementation of some generating capability (wind farms, solar farms). Planning permission is increasingly

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In making investment decisions there is always the fear that there is a new technology on the horizon – but the technologies exist that can allow 2050 targets to be achieved and 'waiting for hydrogen' is not the answer

difficult to secure for these developments – although communities may recognise some benefits if there was an opportunity for a private grid and lower local costs.

- In the same way that individuals in communities frequently act as the advocates and champions of the decarbonisation agenda, individual opponents of schemes can have disproportionate wrecking power – and the community consultation required for approvals has essentially stopped commercial on-shore wind farm development.
- It was stated repeatedly during consultation that rural areas are undergoing more change than equivalent urban areas as there is a shift towards the new ages of digitalisation; social mobility; changes in transport; working from home; farming and food preferences and choices; shorter supply chains.
- Vacillation exists because of the emerging technologies. However in each of the three areas of power generation, heat and transport suitable solutions exist to hit the 2050 goal and their implementation is proven. It is clear that "Waiting for hydrogen is not the answer" if the required shift is to be made by 2050.

Technologies

- The majority of interviewees did recognise that in each of the three areas of power generation, heat and transport the technology exists to enable a significant impact on the road to zero carbon.
- Consultees recognised that a high percentage of housing and building heat provision in rural areas is likely to be provided by a combination of heat pumps and solar PV. In some isolated areas the approach may also include some biofuels, but frequently these will be part of the transitional solution.
- Retrofitting of houses and buildings is possible in a variety of ways, suitable for many different types of properties, from internal insulation, roofing of various kinds, and building wrapping
- In transport, EVs are widely thought to be the future solution for private transport, for cars, vans, 4WD.
- Hydrogen is already proven for the larger vehicles such as buses where there is limited

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The area of transport is a difficult area to address particular in terms of HGVs, public transport and agricultural machinery

need to create a widespread hydrogen infrastructure – refuelling can take place at the bus depot. The same is not the case for HGVs where the future predominant technology is less clear.

- Similarly, the technology shift for agricultural vehicles is less clear – consultees suggesting that farms may operate smaller electrically powered, semi autonomous drone type models or there could be a shift to larger vehicles that serve as community assets.
- The agricultural machinery shifts will be partly dependent on the economics of agriculture post Brexit with the real prospect of consolidation and a shift to greater farm automation.
- The provision of public transport in rural areas has been addressed with a very specific policy approach, with large numbers of routes requiring significant subsidy in order to be viable but with the provision left to the market (which secures the subsidy) which creates no incentive to change the approach. Private operators on subsidised rural routes are unlikely to invest in expensive and somewhat unproven technologies. Successful trials of EV minibuses as demand responsive transport suggest a possible way forward in this area.
- The technologies for micro grids fed by different types of low carbon power generation are clearly defined but the requirement of the Distribution Network Operators (DNOs) and their requirement to connect all properties in an area makes this a complex area to navigate in terms of permissions and charges, whilst at the same time ensuring that the micro-grid has an alternative supply.
- Intermediate technologies such as E10 fuel can be introduced immediately - but with a clear timetable for phase out as it is clear that this would only represent a small step along the road to zero carbon.

Leadership

- In rural areas the impetus for implementing decarbonisation measures frequently comes from individuals or small groups of committed parties wanting to change their immediate

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Experience across England

At a national level, the perception is largely one of a lack of coherent leadership across two issues: the decarbonisation agenda; and also rural affairs

environment. This is a model which depends on continued commitment, funding (often self-funded), succession planning, and ability to scale up.

- Parish and town councils have been crucial in enabling start up programmes of decarbonisation often by offering local buildings to act as beacon projects for eg retro fitting better insulation and / or adopting solar PV, and often larger towns have led the way on the green agenda eg Frome, Stroud and Totnes.
- At a Local Authority and Local Enterprise Partnership level, leadership across England is seen as varied. Many of these have produced zero carbon plans, instituted climate change emergencies and operate Energy Hubs or Carbon Councils. However, the methodology of these vary enormously with little coherence often between neighbouring areas.
- Even where the Local Authority has adopted low carbon planning, it has tended to be a plan for their organisation rather than for the areas they serve. Policies are then added for the overall area as best as can be implemented – but this is often difficult without stronger national policy.
- At a national level, the perception is largely one of a lack of coherent leadership across two issues: the decarbonisation agenda; and also rural affairs. For both of these wide-ranging topics the representation falls across various different departments, and there is perceived to be nobody taking control or reading across the agendas. In many cases the policies pull against one another or don't have legislative safeguards – for instance there is no central legislative position on low carbon heat for new homes. If Local Authorities try to create their own local rules the position is open to legal challenge. If the legal challenge is successful there is a risk that Local Plans are delayed. If the Local Authority has no Local Plan adopted, it has little power to stop housing development which is then often in unsustainable locations.
- In order to achieve significant change towards

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A common complaint from the consultation was that too frequently, the road to zero carbon seems to be "nobody's job".

the decarbonisation targets it is felt that there need to be common criteria in measuring carbon in regions; planning issues need to be addressed at a national level and then devolved to the local authorities; a decision should be taken about the DNOs and how they will work with smaller and micro grids; public transport in rural areas needs to be addressed and is a national issue. Technological questions have largely been left to the market leading to a degree of paralysis in the decision-making process.

- The two biggest issues which were raised by nearly every consultee were: 100% fibre broadband and full 5G coverage of rural areas will have the greatest impact of all on decarbonising England; many others added that there are many large infrastructure projects that could be abandoned with the funding distributed more widely into a large number of projects supporting the climate change agenda.
- Consultees recognised that companies have a leadership role to play in the agenda although their need to be profitable in limited timescales often leads to low carbon projects being abandoned – and there is also a suspicion of new / small players representing a single technology.
- A common complaint from the consultation was that too frequently, the road to zero carbon seems to be "nobody's job".

Forward thinking

- The market continues to seek new, innovative, and profitable ways to satisfy the future demand for energy and its effective use.
- The university sector is active in not only innovation, but also bringing together different technologies.
- Large manufacturers and producers are looking forward to the future needs of the market. The design for some EVs that will still be on sale in 2050 is already underway and the manufacturers expect to be offering products with an extended range, an ability to charge faster and a working assumption that the product will be available at a lower price point. The clear direction of the automotive

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Experience across England

The tying together of planning legislation and decarbonisation alongside the needs of rural areas will be vital to moving towards zero carbon

industry is in marked contrast to heat suppliers – this is in part due to the power of the large automotive manufacturers or OEMs (Original Equipment Makers) - but also because of clear signals from Government.

- Central government through the Climate Change Committee continues to set the agenda at a national level with annual reports and reviews on progress against targets. The ability to drive home the agenda in terms of local implementation is perceived to be flawed.
- Clarity is needed that not one single technology or programme will solve the decarbonisation issue, but that collaborative technologies and implementation will be required.
- Various tipping points are either imminent or could be given a confident timetable. For example with EVs there is now substantial uptake in rural areas with the price point and range now perceived as acceptable to the market. However, the future of many of the technologies and demands is interconnected and the perception is that this is not being sufficiently mapped at a national level.
- Increased use of EVs will require significant addition to the charging network and will then require a surge in energy provision from the grid which itself will be constrained through the move away from fossil fuel fired power stations.
- The tying together of the land use planning system and decarbonisation alongside the needs of rural areas will be vital to moving towards zero carbon.

In all thinking around the road to zero carbon consultees were keen to impress that there is no single entity captured by the term rural area. Each has its own issues, capabilities, geographical and historical quirks. Any solutions will need to be flexible to respond to these differences and on that basis one size will not fit all.

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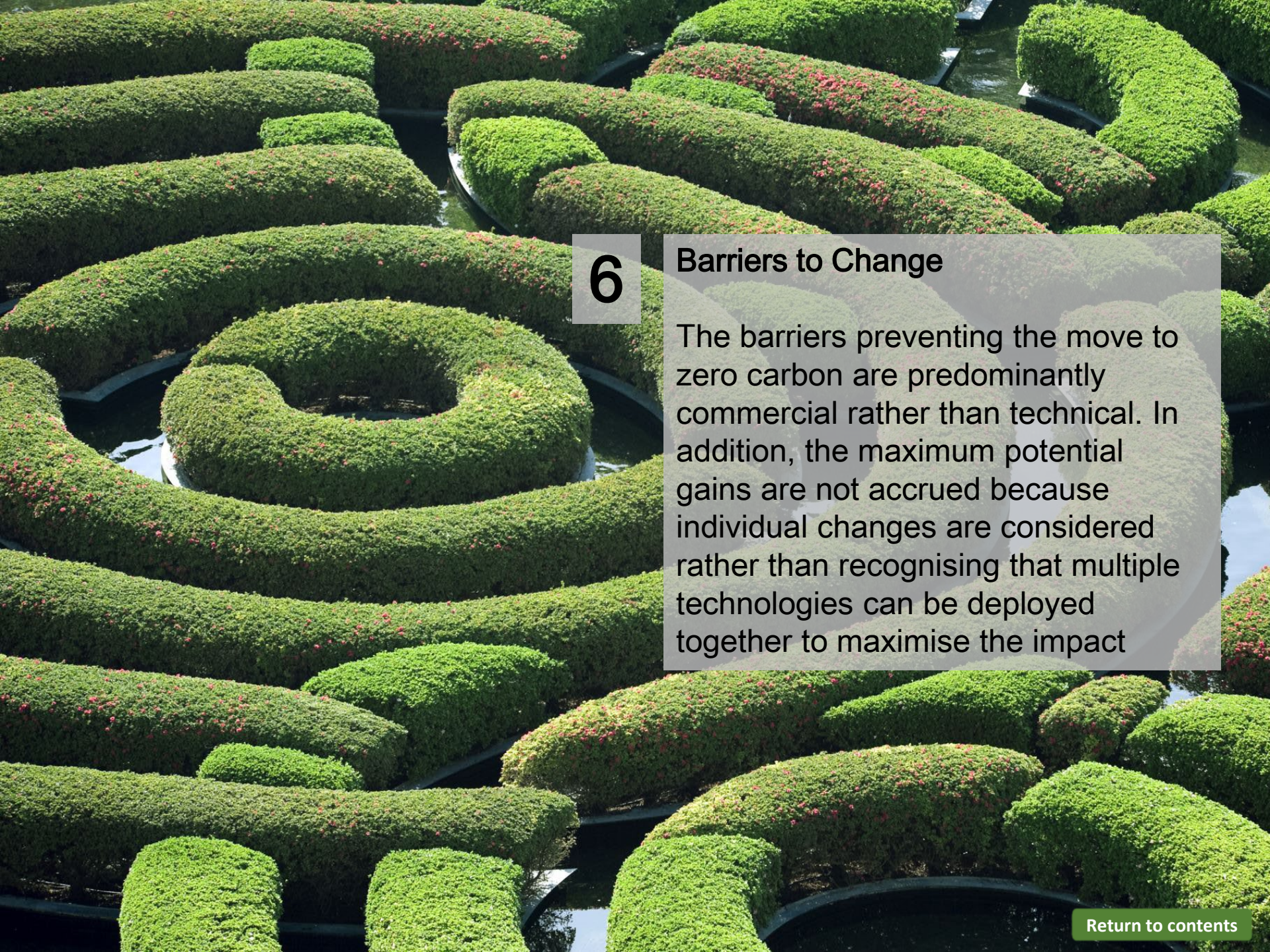

6

Barriers to Change

The barriers preventing the move to zero carbon are predominantly commercial rather than technical. In addition, the maximum potential gains are not accrued because individual changes are considered rather than recognising that multiple technologies can be deployed together to maximise the impact

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Chapter 5 – Current barriers to change

EV take-up will need a significant investment in charging points – and this needs better coordination. If private providers can cherry pick prime locations and secure high levels of profitability with no commitment to provision in areas of lower demand the roll out of EVs nationally will be undermined

There are significant barriers to the change that will be required in each of the three sectors considered – power, heat and transport. In fact one of the key barriers to change is that they are frequently considered as entirely separate items rather than the reality that they are interwoven in their issues and their potential solutions – there is a need for more 'whole system' solutions:

Transport

- The current infrastructure of charging points in rural areas is inadequate for a mass shift in behaviours towards EVs. Hundreds of thousands of charging points need to be installed over the next 20 years to meet projected demand. In some cases a large shift will require greater supply / grid resilience and there is also the need for some locations to make significant electrical alterations – for example where residential dwellings have no garage or driveway.
- The density of demand issue, frequently faced in the provision of a wide range of services is likely to lead to a cherry picking of urban areas by EV charging point installers leading to a lack of provision in rural areas. A situation which could be addressed by providing licences for a provision network (as with other utility or telephony supply).
- This lack of forward thinking in terms of infrastructure suggests that there is no concerted programme from central government, or private sector champion to push the EV or alternative technologies in rural areas other than the general tax / subsidy measures that are intended to nudge market provision. Only Local Authorities / LEPS are managing to deliver wholesale initiatives and inevitably these are focused on local areas.
- The current actual / perceived driving range of current EVs precludes take up in rural areas where distances between destinations / charge points can be beyond their capability.
- Private vehicle usage in rural areas is high compared to urban areas with poor coverage of public transport and few alternatives given the distances involved.
- The limitations in the capability of the current EVs available is compounded by their high

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Current barriers to change

The starting point for any discussion about future heat requirement is insulation standard of the building – the approach needs to move significantly beyond double glazing and loft insulation

purchase price – whether for the individual or fleet transfer.

- It is also clear that the impact on the power grid in rural areas will be significant at a time when the electricity networks will already be under pressure from the shift to electric powered heating solutions. This is an area where it is easy to see the confluence of power, heat and transport. The most effective solutions will consider investment in all three as an integrated approach.
- As with other areas of the shift to net zero, there is a transition technology of hybrids / biofuels. These interim technologies may compete into the medium term with EVs. The true carbonisation level of different technologies remains a subject of serious debate with EV batteries in particular a cause for concern.
- There remains the potential of a longer-term hydrogen / biogas solution but at present this gas technology is considered too distant to provide any prospect of it making a significant contribution to emissions from private cars by 2050.
- The barriers to any potential ultra long-term aim of hydrogen powered transport must first address challenges in terms of zero carbon hydrogen production at scale, vehicle technology and hydrogen handling and refuelling.

Housing and Buildings

- The overriding issue about housing and buildings in rural areas is the state of the existing stock. Many buildings in rural areas date back over 100 years and do not lend themselves to retro fitting of insulation to meet modern targets of EPC C. The cost of retro fitting such insulation is expensive and currently considered uneconomic using any standard payback calculation.
- In addition, modern homes are still being built where retro fitting will not be possible except at significant, often uneconomic cost and yet it remains possible (at some additional cost) to build a passive house.
- Most future heat solutions are generally considered hand-in-hand with high levels of

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Current barriers to change

The equipment, suppliers, maintenance engineers and support network is currently insufficient in England to enable a shift in heat provision – even if there were the sustained demand for a specific technology

building efficiency and this is not currently the case for large numbers of rural businesses and dwellings

- From a heat perspective, the market continues to look for an emerging technology that will become the future standard. No one solution is being championed by the new build sector; by the retro fit sector; or by the government – although in the case of heat this is partly because different solutions better fit different settings.
- The housing and building sector's guidelines around decarbonisation are predominated by criteria rather than strict regulation or technology guidance. This has led to new build housing that is not "future proofed" and in some cases where the standard gas boiler would otherwise have been fitted, developers are returning to traditional electric heating rather than investing in other low carbon technologies.
- Different incentives for changing heating systems; changing Feed In Tariffs; diverse planning regulations in different areas; have all led to a confused picture of which technology to choose.
- RHI and a concern over its future availability is often a hindrance to effective investment in new heat systems with developers and individuals following the subsidies rather than consideration of the best complete system solution.
- This has had a follow-on impact with the infrastructure in terms of supply chain, from equipment suppliers to installation and maintenance, combined with the associated required investment in skills and capability not being stimulated and therefore an inability across England, particularly in rural areas, to create the capacity required to achieve the step change required to meet current government targets.
- Planning rules and regulations in different areas allow developers and individuals to focus on the easiest options rather than taking the necessary longer-term decisions.
- The pathways to the change required in rural areas, in particular, are perceived as capital intensive and as a result the investment in new zero carbon solutions is falling behind that in urban areas which offer economies of

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Current barriers to change

Long term universal access to a single electricity grid has supressed any type of debate in the UK about the role that local generation and decentralised grids could play in a future mix of power supply

scale when it comes to innovative projects and funding (and where the solution may also be heat networks because densities of development make this the most effective solution).

- As with the transport system, more could be done in off gas grid areas to support the transition technology of bio-gas as a lower carbon alternative to standard LPG or even oil.
- In addition, despite the legislation to prevent the installation of gas boilers in new build properties, the market has not yet moved away from gas grid connections where available, with some rural housing associations still receiving subsidies for installing mains gas powered heating systems.
- In gas grid areas, hydrogen supplied through the existing gas pipeline network is held up as a beacon to what the future solution might be, but as with the transport sector there are issues to address at each stage of the supply chain (production and distribution in particular). This means that the chances of hydrogen making a significant contribution to zero carbon by 2050 is unknown but the debate has the impact of creating delay and indecision in the adoption of other technologies more widely.

Power generation and distribution

- The centralised energy generation and distribution network combined with the utility supply sector split with major players competing with each other; minor players in the market; and new entrants wanting to break in through eg micro grids has created a confusing picture – and one in which there is very little awareness or debate about anything outwith the 'national grid'.
- There is also a lack of clarity over the future usage requirement of electricity – it is widely acknowledged that it will increase significantly (largely due to the increase in EVs and moves away from gas heating), but any "gap" is seldom quantified and there is no clear discussion about whether there will be a role / need for decentralised networks. once the move is made away from conventional power generation models.

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Current barriers to change

Smart metering got off to a false start in the UK (with dumb systems). In the future they will be used within a demand management system linked to variable tariffs – but their effective use will require fast broadband access for all

- The centralised system to date has enabled a tariff structure that has allowed investment to be made in new and non-fossil power generation (albeit at a cost to consumers) but the creating of multiple feed-in points hasn't kept up with the potential supply – the growth in decentralised micro generation has somewhat slowed.
- From a rural context, there is the opportunity to generate significantly more local power but any future land based rural power generation will continue to face issues around planning consent – with community planning consultation needing a high approval threshold.
- The different, and changing nature of government subsidies to the power generation industry, through Feed in Tariffs (FITs) dependent on scale and technology and which shift over time has led to a nervousness around planning longer term investment by smaller companies, or with resources and direction of the industry hopping from one grant regime to another rather than developing genuine national specialisms.
- There has been a reluctance at the consumer level to buy into the roll out of Smart metering (partly because the initial generation of meters were not particularly 'smart') and if this cannot be addressed there will be a limit to the demand knowledge captured by suppliers and the extent to which variable tariffs can incentivise different usage profiles of consumer consumption.
- In rural areas the potential for Smart metering in driving different behaviours will completely fail unless all households have good and reliable broadband access.
- The shift to a new system will also result in cost being incurred – without shifts being nudged with legislation and incentives the capital investment required to effect change (often replacing something that is perceived to work effectively anyway) will seldom pass a return on investment threshold, better returns will be available in the short / medium term, and as a result investment is stalled.

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Current barriers to change

It is acknowledged that part of the issue in full implementation of zero carbon is that the technology, whilst in existence, is not 'plug-and-play' and there is limited knowledge of the most compatible solutions in a full system approach

Full Systems Solutions

- In general there has been a failure in awareness raising to demonstrate that to be most effective solutions should reach across different parts of the agenda eg heat pumps driven by local power generation, energy storage via EV batteries, and the potential of offshore wind farms to generate significant clean hydrogen. There is even incomplete knowledge about the availability of products such as bio-gas as an alternative to a fossil fuel approach.
- At present the compatibility of multiple parts in the system are unclear and complex. This is not a plug-and-play activity even for energy specialists – often because the companies and trades involved have only focused on one sector of the wider solution – heating engineers are generally procured from different organisations to electricians.
- At all levels there is also a reluctance to 'write off' investment in previous equipment which still has a useful working life – this is true from the household to entire national networks.
- As with all the other sectors there is an element of waiting for the "silver bullet" solution to emerge – or regarding low carbon as something that can be left to the early adopters to get right before the solution is suitable at a mass scale.

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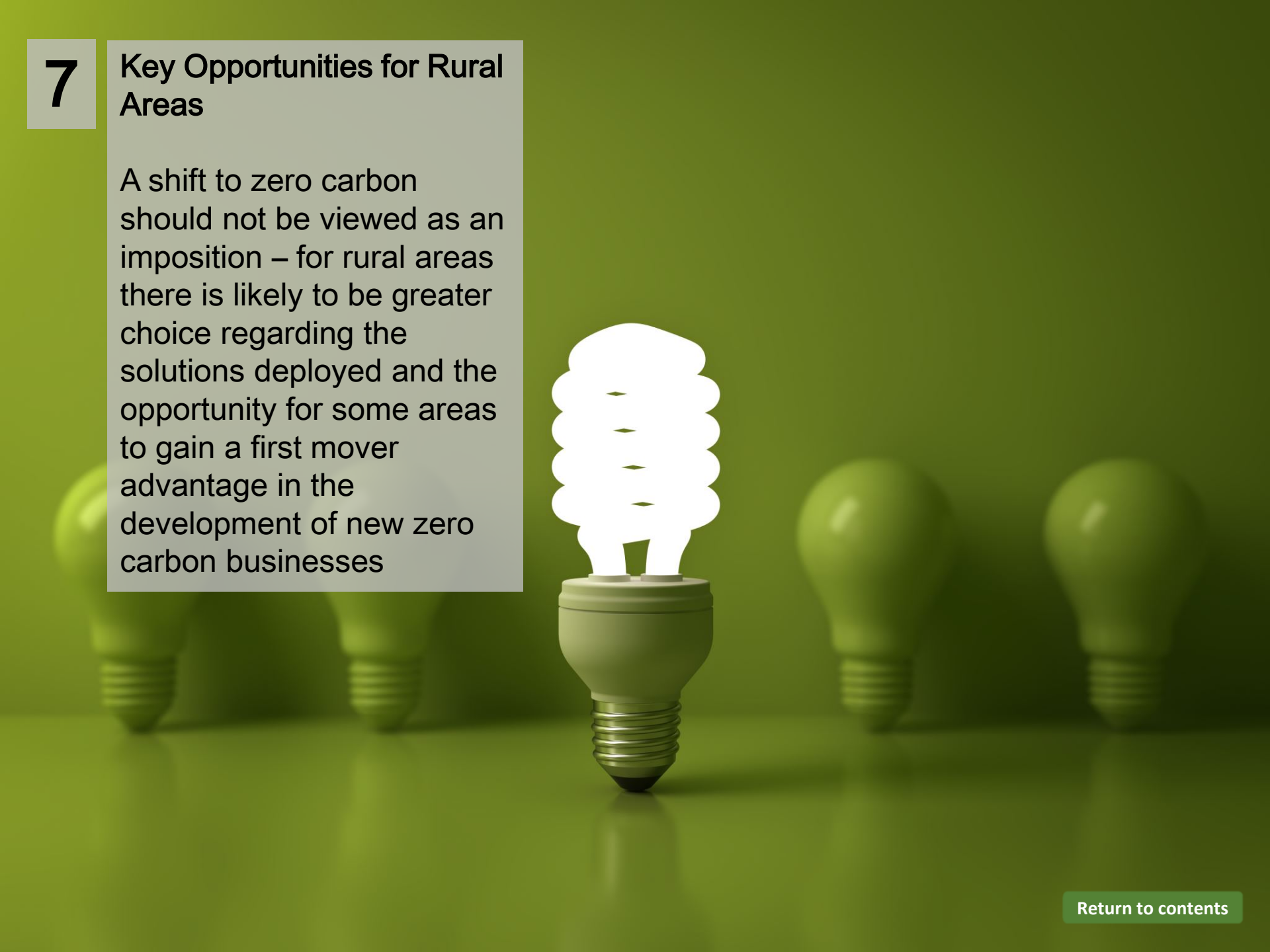
7 Key Opportunities for Rural Areas

A shift to zero carbon should not be viewed as an imposition – for rural areas there is likely to be greater choice regarding the solutions deployed and the opportunity for some areas to gain a first mover advantage in the development of new zero carbon businesses



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Chapter 7 – The key opportunities for rural communities

Even before transport is considered as a single issue, there is an opportunity to build on existing sustainable villages, increase the vitality of villages to retain local services and improve broadband to enable different ways of accessing work and services

The consultation demonstrated many of the barriers to the successful implementation of the decarbonisation agenda for rural England. However, there are also a number of opportunities which became apparent through discussion with the interviewees, some of which are already underway.

Transport

- Even before the transport solution is considered, there is an opportunity to make planning decisions regarding commercial and residential developments within or as extensions to existing settlements that already provide existing services and are connectable by public transport – this is broadly in place already but can be better incentivised / enthusiastically encouraged.
- In addition to planning policy, the road to zero carbon offers an opportunity to better tackle the whole issue of public transport and the use of private motor vehicles for commuting. The development of eg: community asset schemes such as car sharing; sequencing of shift patterns to public transport; demand responsive electric mini-buses and enforcement measures around vehicle sharing all have a role to play.
- In addition, the response to Covid-19 has demonstrated that high quality broadband can reduce vehicle miles not only through greater use of working from home and carrying out meetings remotely but also in accessing services such as routine medical appointments.
- The maintenance of local services also reduces carbon miles – the retention of village shops / post offices and the like probably does more to reduce carbon miles than any single EV initiative in a local area.
- More specifically, in terms of private car use, the EV charging network can be encouraged in rural areas; council owned parking and large private parking can be equipped with charging points; many rural areas because of the lower density of housing have the opportunity for charging points to be installed at home.
- EV batteries can be used innovatively with

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The retrofitting of building materials with high insulation qualities can create an increase in local employment an construction skills

housing and buildings to provide excess energy storage.

- A national approach to EV charging infrastructure permissions can also ensure that heavily used urban charging points provide some subsidy / result in a requirement to contribute to the rural network. This national perspective will be the only way that large scale EV take-up will take place – almost everyone will need to use a more rural charging point at some time in the life of the vehicle.
- In concert with the anticipated future demands on the electricity grid, smarter use of local generation of electricity (such as PV, wind power backed up with batteries and bio-fuel generators) can provide supply into those charging points where the central grid would otherwise require greater resilience.
- Eventually, existing infrastructure across rural areas can be converted to new fuels such as hydrogen and biofuels should the market continue along those paths but this is a longer term scenario with many uncertainties remaining at present.

Clean hydrogen could be economically produced via land-based wind farms to fuel the HGV and farm fleets

Houses and Buildings

- The programme to retrofit existing housing stock provides a significant employment opportunity and for growth in the supply chain in rural areas.
- Housing retrofitting is likely to require new higher quality door and window installation but also innovative materials and building methods to improve the insulation of buildings with solid walls and floors with no prior insulation qualities. Low temperature heating systems / radiators are also likely to be required on a retrofit basis.
- New skills and business capability for transfer from traditional fuel fired heating systems to heat pumps will be needed imminently – and ideally training to ensure that these heating engineers have experience of inter-operability of (for example) PV, batteries and heat pumps and the compatibility issues between different

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Rural England has a significant contribution to play in strengthening low carbon power generation – an area where more investment is likely to be needed soon

supplier specifications.

- New build housing will need to ramp up to cope with increased demand arising from smaller households, greater life expectancy continuing to slow the recycling of old stock and demand from new to market residents. New stock may also be needed to replace housing which will not comply with future standards.
- Existing homes with existing gas systems can switch to bioLPG where housing retrofit is uneconomic ensuring that lower emissions are generated even without housing improvements being made.
- Rural areas can act as beacon projects for scaleability of innovative building and heating projects such as Passivhaus with the associated benefits in the supply chain and employment – off gas grid rural areas already have the greatest incentive to move towards this type of approach.

Power generation and distribution

- It is generally acknowledged that future demand for electricity will increase with the switch in transport to EV and with heating gradually shifting away from gas. This, coupled with the phasing out of fossil fuel power generation offers a real opportunity to rural areas to provide some of the solution for the future.
- The ability to provide some of the solution is partly because of land availability (although local planning issues will remain) and partly because of access to some of the natural resources required for some energy types.
- The contribution will clearly vary by location but could be drawn from a wide range of solutions such as:
  - PV farms, and feed back capability
  - Energy crops
  - Bio-gas generation from agricultural and food processing waste
  - Energy storage
  - Wind farms both on and off shore
  - Tidal generation
  - Modular nuclear power plants
  - Geothermal
- Smart management of the grid with imaginative local solutions and micro grids

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The key opportunities for rural communities

There would be an incentive for local areas to back plans for local energy generation if this resulted in lower local energy charges – or if the contribution was paid back through improved infrastructure in other areas

presents a great opportunity for rural areas to operate independently in some areas and feed-into the grid in others. This will require work with the DNOs on future mapping of demand and supply with more flexibility than any urban area where both demand and any available sites for a different approach are tight.

- The opportunity will be greatest where there is a clearer incentive to contribute locally – many rural areas already generate significant quantities of clean power but this contribution is:
    a. Not counted in the net carbon position of an area because the power is supplied into the central grid
    b. Despite generating the power, the local area is still required to pay the (almost) standard grid distribution charges and the levy placed on all users to contribute to future low carbon projects
- Community planning objections to some on-shore wind farms and some larger scale solar PV farms might be reduced where the local community saw an immediate payback through cheaper power through a local grid infrastructure.
- The wider indirect benefit could then be a wider reskilling and upskilling of the local workforce; innovating products and processes; pivoting existing supply chains; and providing leadership in the agenda.

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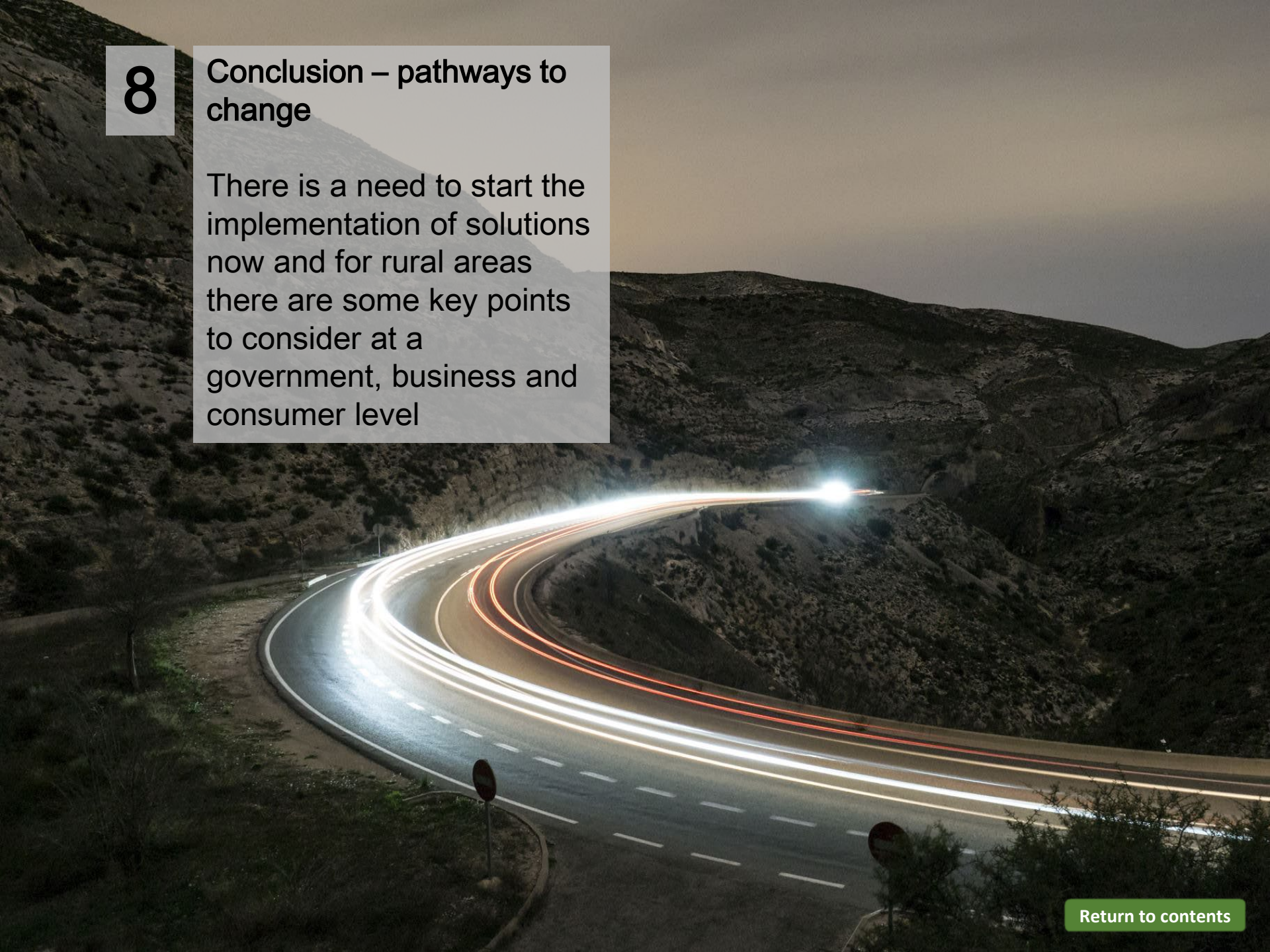

8 Conclusion – pathways to change

There is a need to start the implementation of solutions now and for rural areas there are some key points to consider at a government, business and consumer level

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Chapter 8 – Conclusion – The Pathway to Change

The achievement of zero carbon targets is likely to be more dependent on strong leadership and direction rather than a requirement for unrealistic subsidy

The consultation process , while not always achieving a consensus, did however produce a number of themes that participants considered important on the road to achieving change.

Leadership

The concept of leadership throughout the zero carbon agenda is perceived as being muddled. Leadership is demonstrated at various tiers - international, governmental, industry or even local level. The broad, and in some instances specific targets are in place via the Paris agreement and subsequent UK legislation but the granular detail of how to achieve those targets has been frequently left to the market to decide.

There appears to be a disconnect within central government between different government departments in ensuring that zero carbon is embedded in the devising and implementation of all policy.

Similarly the representation and embedding of the impact of policy on rural areas does not appear to be central to departmental thinking. Rural proofing does not work across governmental decision and policy making and there is the general issue regarding no specific rural policy on anything other than for agriculture (e.g. ELMs and the 25 Year Environment Plan). This contrasts with the next tier of the public sector. At local authority level, where in some parts of England, detailed cross cutting action plans are in place, rooting zero carbon at the heart of LA or LEPs activities.

At local level, leadership in the form of advocates, community groups and parish / town councils are often at the heart of change. Their work is important in the demonstration and advocacy role that it can provide to others in addition to the positive, incremental changes that have been achieved. However, this leadership perceives itself as disconnected from the heart of decision making, funding, and scaleability. In many cases the drive that these local groups have demonstrated has been portrayed as over-zealous rather than leading required change.

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Conclusion – The Pathway to Change

The target of net zero carbon by 2050 is absolute but even as new technology is deployed, biofuels can mitigate the immediate impacts of the behaviour of today

Intermediate solutions

In the search for the "silver bullet" technology other solutions which may assist in reducing carbon emissions are rejected as lacking "absolute purity" where in the medium term their adoption may contribute significantly to a reduction in emissions. In the short term biomass fuels including BioLPG and others offer significant cuts in the emissions rate of today, while still contributing to those emissions. These technologies can be part of the solution given that in some cases building retrofit including insulation is uneconomic. However, adoption of these intermediate solutions while striving to achieve scaleability in production and price of the longer term answers is a useful approach – accepting that in some cases the bio-fuel approach may be the answer.

Finance – new funding models

Innovative funding solutions will be required in order for industry, housing providers and individuals to make the significant step change required in order to meet emission targets. There are many different models which could provide solutions – for examples products taking the form of:

- Extended mortgages / equity release
- Leasing / rental of new heating systems
- Heat as a service product
- Rent / utility bill balance for the rented sector
- Community assets

There is an opportunity to engage with traditional and novel funders on developing innovative solutions to bridging the funding gap.

Non homogenous

The variety of English rural areas lends itself to a broad suite of solutions. Coastal regions may seek to exploit further offshore wind generation with locally sourced supply chain servicing; tidal generation is becoming scaleable and requires investment in skills and suppliers; in upland areas the development of onshore wind farms, solar / PV farms; peri urban areas could

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There is a need for knowledge sharing – incremental technologies are understood but their inter-operability and the appropriateness of deployment in different settings is less well developed

look to embrace the supply chains of struggling traditional industries looking to pivot into new, future technologies.

The solutions are varied although in general those that can make a significant contribution to zero carbon by 2050 are becoming clear. Efficiencies and improvements will continue but there is a risk that in the medium term perfect becomes an enemy of the good.

Retrofit and future readiness

In the housing sphere it is vital that existing housing stock is made fit for future purpose through effective insulation by whatever means is appropriate and has adequate ventilation and other infrastructure to enable the adoption of new generation zero carbon heat systems. This offers a huge opportunity for a supplier base of businesses throughout the country, and is an issue that is increasing in urgency.

Even where retrofitting insulation is not possible to a standard that allows electrification of heat, better quality buildings will reduce consumption of the alternative bio-fuel source.

Alongside this, there is a need to develop a nationwide programme of installing EV charging points, using innovative funding methods, perhaps on a “as a service” basis or by requiring those companies gaining permissions to develop high demand sites to install additional points in additional locations. A UK network of EV batteries would be a huge asset enabling local or grid storage.

Knowledge base

A great deal of data, experience and information is in circulation about:

- Technologies
- Legislation and its impact
- Implementation
- Success and disappointment
- Metrics and common methodologies

Conclusion – The Pathway to Change

Off-shore wind development has demonstrated that planning policy linked to supportive tariff structures can deliver change – this approach can be better used more widely

- Funding streams

A common, shared repository for such information, developed out to understand 'whole systems' integration and inter-operability would provide an important resource. Such an approach could provide a detailed, updated, granular evidence base for decision making and planning. Expanding the programme to monitor policy development with a forum for ideas exchange would further support rural communities.

The carrot and the stick

The route to zero carbon, the development and adoption of new technologies, and the speed of change has to date been largely dictated by:

- Broad based targets in line with the Paris agreement and subsequent legislation
- Government intervention in large scale power generation using market interventions
- A variety of different, time restricted financial incentives
- Recommendations and criteria as opposed to legislation and enforcement
- The vagaries of the market

It will be important that a framework for the enforcement of implementation of zero carbon actions is introduced, alongside a mapped and verified suite of interventions to encourage behaviour change.

Coherence

The ability for principal local authorities, town and parish councils to enforce actions and behaviours which would contribute positively to the agenda is vague and frequently runs contrary to other agendas / requirements.

Statutory planning in particular remains a barrier to change with Local Authorities unable on many occasions to promote zero carbon investments because of planning legislation. Local advocates and groups frequently encounter unsurmountable issues caused by a small number of opponents to community schemes. Planning issues are

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Conclusion – The Pathway to Change

The economic impact of Covid 19 does create an urgency around economic rebuilding at the very point when impetus in the low carbon agenda is required

perceived to be a major issue for implementation, and a top down enforcement framework and locally delivered approach could be beneficial – as well as ensuring that local decisions in favour of decarbonisation provide local community benefit.

Post Covid 19

The stark reality of the 20% fall in the UK economy in the month of April 2020 is leading to a rethinking of how investment and government spending might assist in recovery. This is an opportunity for the zero carbon agenda and the role of rural communities to be at the forefront of that thinking.

The solutions that are emerging from government are around:

- Skills and the workforce
- Re-employment opportunities
- Pulling forward investment in infrastructure projects
- Pivoting of industry capability

There is an opportunity for rural areas to approach government requesting support for future low carbon projects and these might include:

- Model zero carbon communities at a community, village and small town, or even at a local authority level
- Specific training and upskilling programmes for installation of new equipment, building improvements and retrofitting
- Investment support for supply chain industries including repurposing of existing companies

The projects would forge a strong link between two urgent agendas and seize the opportunity for rebuilding better.

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Appendix 1 – Case Studies

	First Bus – Rural Bus Services	
	Westlakes – Local Grid	
	Britain's Energy Coast Business Cluster – the economic dividend	
	Harbury Energy - community transport and energy generation	
	Borderlands Growth Deal – Low Carbon regional planning	
	English Rural Housing Association - Retrofit affordable rural housing	

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Case Study – Rural Bus Services

Case Study: Rural Bus Services – the Low Carbon Challenge
John Birtwistle
Head of Policy – UK Bus
FirstGroup plc

First operates over 5000 buses and coaches across the British Isles and has what is believed to be the largest electric bus fleet in the UK outside London. Over thirty of these vehicles are providing Park & Ride services in York and some of the oldest are now over 5 years old. First has also operated three generations of hydrogen fuel cell zero emissions buses in London and Aberdeen. This brief paper sets out some of the challenges of decarbonisation of rural bus operations.

There is much media coverage of "dirty diesels" – and most bus services are provided using diesel vehicles. What is often misunderstood is that different emissions standards apply to light duty vehicles (cars and vans) and heavy-duty vehicles (buses and trucks). The latest light vehicles have to meet the Euro 6 standard which can be passed under laboratory conditions. But heavy vehicles have to pass a more stringent Euro VI standard – and pass it on the road, in everyday use. This Euro VI standard represents a reduction in airborne emissions of up to 99% compared with its Euro V predecessor, so the latest diesel buses and coaches are very clean indeed.

In that context, the decarbonization agenda is focusing largely on major urban areas at present and we must ensure that appropriate rural-proofing takes place if the same objective is placed on rural areas. There are practical issues to consider. An electric bus typically costs up to twice as much as its latest clean diesel (Euro VI) equivalent. But whilst there are limited numbers of the latter on the second-hand market, for operators unable to sustain new purchase costs, there are no second-hand electric buses yet available. Charging stations are a cost that needs to be added to the cost of going electric and under the current electricity supply regime, the costs of connecting your depot to the grid, including any necessary additional substation infrastructure to accommodate increased load on the system, is borne by the customer requiring the supply – in this case the bus operator.

Case Study – Rural Bus Services

But, most importantly, the operating range of electric buses is still considerably lower than that of diesel – typically up to 150 miles per day, with diesel vehicles capable of twice that. By their nature, rural bus services generally incur greater daily mileage than urban routes and by no means all are suitable for electrification with current technology. In some cases a second fleet would be required to take over whilst the main fleet received a mid-day charge.

Outside London, where the increased costs of purchase and operation are picked up by Transport for London in contract prices submitted by operators, new purchase of hybrid diesel electric vehicles is now uncommon. They attract a significant price premium over diesel but offer relatively few advantages, the reduced fuel consumption typically being offset by increased maintenance and the need to replace components mid-life. They are gradually increasing their capability of zero emissions operation but at considerably increased cost. Poor reliability and component failure have led to many first generation hybrid buses being rebuilt to use the latest Euro VI diesel engines, abandoning the electric hybrid component altogether.

Technology moves rapidly in this field and we can expect to see cheaper, more durable and longer range electric buses in the next few years. But today, rural electric operation is not viable when so many rural routes are already struggling to survive.

Alternative fuels are also available, and if sufficient supply of biomethane can be secured, this can provide a very clean and environmentally sustainable source of powering buses, with relatively small cost premia compared with diesel. Hydrogen fuel cell vehicles are even cleaner – provided the hydrogen is obtained through the use of sustainable energy – but the cost of the vehicles and infrastructure is largely prohibitive even for urban operations, except through heavily subsidized purchasing competitions.

Case Study – Rural Bus Services

The case for zero emissions bus operation in rural areas is a difficult one to make but if we are to achieve zero carbon for the UK, is one we will be forced into. The difficulty of making a business case for investment is far harder that for an urban environment – not only due to the simple cost differentials, but also practical issues such as vehicle range militate against investment as two vehicles may be required to do the work of one diesel – one having to return to base for a mid- duty recharge. The recent "Electric Town" challenge bidding round announced by DfT in early 2020 requires that all buses in the defined area are zero emissions, meaning that services worked in from rural areas need to be either electric, or equally expensive and technologically less robust extended range hybrid vehicles. A more pragmatic approach to maintaining service whilst meeting the environmental challenges of rural areas needs to be developed, phased to keep pace with technological advancement.

As referred to earlier, every bus, however powered, can operate more efficiently and in a more environmentally friendly manner when it is freed from congestion. This enables schedules to be tightened to provide quicker and more consistent running times which make the service more attractive to the passenger, as well as allowing for more intensive use of expensive assets. All serve to make the case for investment in the latest and greenest technology more achievable.

We have called upon the Government to ensure that the decarbonisation agenda and air quality management take account of both the economics and the practical constraints of rural bus operation, and that their particular requirements are accommodated in a timescale which allows for technological advancements to make zero emissions operation an affordable and sustainable goal for such operation. Buses in rural areas should be provided with an environment in which they can operate efficiently and provide rapid journey times achieved consistently in order to attract new users. An environment where new technologies can be tested and evaluated will be required if the potential benefits from these are to be realised for future rural services.

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Case Study – Westlakes Science Park

Case Study: Pathways to Net Zero project
Westlakes Science Park
Energy Coast West Cumbria
Cumbria

Established in 1980, with almost 30,000 sqm of premium office accommodation, teaching accommodation and laboratories, Westlakes Science Park offers premium business premises of all sizes in a country park setting in West Cumbria. It is already home to more than 2,000 professionals, in a high-tech cluster.

With the UK commitment to net zero Energy Coast West Cumbria (BEC) are keen to develop Westlakes as a demonstrator project achieving a net zero campus well ahead of the UK target date.

But what does “net zero” mean in the context of a science park? BEC has adopted a concept called “Net Zero 3”. This refers to developing pathways to deep decarbonisation in the power, heat and transport associated with their buildings. The strategy for Westlakes adopts the Net Zero 3 concept as it is recognised that the interconnections between heat, power and transport will become increasingly important as they seek to achieve a “net zero” campus. The carbon intensity of the UK power grid has fallen significantly in recent years and is projected to fall further up to 2035. This will reduce the site carbon footprint. However new build facilities and decarbonisation of both heat and transport will place additional burdens on total power demand of the campus. It is however anticipated that new build and retrofit upgrade of existing building will provide multiple opportunities for on-site generation and adoption of decentralised energy systems.

The vision for Westlakes is to create an energy system combining “smart” microgrid, with on-site renewable energy generation and storage, improved energy efficiency, linked to low carbon transport services.

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Case Study – Westlakes Science Park

Net Zero 3 - Power

a) Building Energy Efficiency and Control Systems

Generally, the building energy systems are dated and do not consist of high efficiency equipment or any intelligent control. There is an upgrade programme already in place and the ambition is for progressive replacement phased to match the roll-out of a smart micro-grid.

b) Decentralised Energy Opportunities

There is land available both within the existing campus and around the periphery of the site for solar farm feeding private wire to the campus. There is also potential for limited wind, also for feeding private wire to the site.

In addition, there is considerable potential for solar PV canopies across the existing carparking areas.

c) Demand Side response & Storage

A key element of the strategy is to maximise the use of decentralised energy assets with smart control systems at the building level allowing dynamic supply / demand matching.

Net Zero 3 - Heat

The site is comparatively low density and it is unlikely that a district heating scheme would prove viable. The strategy is therefore to upgrade buildings when the existing heating system comes to the end of its life with various forms of electricity-based heating. These will generally be major upgrades to the building fabric and building systems to reduce demand at source and allow the utilisation of efficient heat pump systems.

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Case Study – Westlakes Science Park

Net Zero3 - Transport

This is a challenge for deep decarbonisation. However, Westlakes offers many opportunities for a viable pathway to “net-zero” in transport. In the first instance the site provides walking and cycling opportunities to reduce commuting demand at source. There is also a car share scheme and access to public transport by bus.

In addition, the smart microgrid concept offers the opportunities for innovation in low carbon transport and implementation of demonstrator projects, including automated vehicles, shared ownership and using IT smart data systems to manage the provision of integrated transport services across the Park.

In the near and medium terms, it is anticipated that there will be an increased penetration of BEV’s into the UK car and light vehicle fleet. This in turn, will drive demand for more local workplace charging points. These will be integrated into the micro-grid, providing complementary loads, opportunities around V2G and additional investment opportunities for the infrastructure operator.

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Case Study – Britain's Energy Coast Business Cluster

Case Study: Seizing the economic dividend
John Grainger, Executive Director
Britain's Energy Coast Business Cluster

Combining the need to achieve the Net Zero position whilst maintaining our regional identity are twin goals that we take very seriously. These have been brought into stark relief during the Covid crisis. We will be so dependant on the youth of today to drive the challenge to meet the net zero targets, and it is important that in the intervening time we protect their employment prospects, and ensure that the training and skills opportunities that are out there remain relevant and pertinent to the point of assuming new priorities for all employers and providers.

Looking at opportunities in Cumbria from Carlisle to the Furness peninsular then we must together make a strong case in this brave new world. Here we represent a position that brings a solution for national Government to get behind and really start to get us back on track, reversing all of the recessionary pressures that will confront us for the best part of this decade, and at the same time realising the value systems that everyone has been appraising and setting new bench marks for, during this period of enforced reflection.

BEC Business Cluster is determined not to leave anybody behind in this scenario. The French company EDF has remained very active over the past couple of months driven to some extent by their need to submit a planning application, as timetabled to develop the next two large scale nuclear powered reactors at Sizewell C. This is a long term investment proposition that needs to follow an agreed and predictive timescale agreed with the planning inspectorate.

Cumbria's globally renowned reputation as a centre of nuclear excellence and therefore a contributor to the net zero target reminds us of the Moorside site in Copeland that remains in the National Policy Statement as one of eight sites designated as being suitable for new large scale nuclear power stations. Since the demise of the Nugen project the focus has shifted somewhat towards advanced modular reactors and small modular reactors (AMR and SMR) as a contributor at fleet scale to more than just a localised economy.

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Case Study – Britain's Energy Coast Business Cluster

The UK SMR Consortium fronted by Rolls Royce has been pre-eminent in presenting a British option and solution for these technologies, and is being encouraged by Government to produce viable and technically able solutions. The consortium has plans to commission SMR's by the end of the decade. BEC Business Cluster along with its partners is determined to put a strong case to ensure that the area remains uppermost in people's, and importantly investors' thoughts as a genuine competitive inward investment location for energy projects. So during this somewhat sterile period, we have been engaging with large and small scale developers on opportunities that would potentially bring "green collar" jobs to our area and reinforce and reinvigorate the supply chain opportunities, already so well established throughout the rest of the fuel cycle. These are potentially exciting times ahead as we talk to EDF and their partners about how as a region we can deliver the concept for a nuclear powered clean energy cluster, including the potential siting of small modular reactors, indigenous fuel production and co-generation with renewable energy sources. For us in Cumbria, at least as and when we can achieve this, then nobody will be left behind, and we will definitely be back on the right track.

Case Study – Harbury Energy

Case Study: Implementation of community transport and energy generation
Bob Sherman
Harbury Energy

The story of HEI begins in 2010. By then nationally and globally we had had a couple of decades of fine words, speculation, good ideas, campaigning demands and political rhetoric. There was, however, little sign of political action or commitment across the globe and not much local concern expressed. HEI formed with a commitment to act positively rather than talk any more. We wanted to do things. We connected straightaway to our Parish Council, which has always supported us and has already given written support to our latest ambitious project.

Working out what we wanted to do wasn't difficult; achieving it was another matter. I might have written here in terms of tentative first steps but nothing we did was tentative. We launched into projects with headlong enthusiasm. It has seemed in retrospect that a positive approach has been somehow unstoppable. Grants applications were successful; failures rarer than we should have expected. The most important grant that we were awarded in my opinion was the government LEAF grant to promote the Green Deal. This got us started with some concrete positive measures and raised our profile locally. It allowed us to install internal wall insulation in our community library, fit an energy generation monitor at the village hall, to show visibly that the solar panels were generating lots of energy and cutting carbon, and many other tangible actions. Managing this grant successfully made future smaller grant applications much more likely to succeed as we now had a track record. The secret to success, if there is one, is to spot opportunities and take them quickly with every intention of succeeding. All our projects have arisen this way. The sequence is: spot an opportunity, form a rapid relationship with the potential beneficiary (school, scout hut, village hall, Rugby Club), apply for a grant, deliver. It can be exhilarating, although not without frustrations.

Case Study – Harbury Energy

Gauging the public mood and level of support for low carbon and environmental measures is much more difficult than action. People don't readily tell you what they think. The village setting helps in that we know many of the people here and meet them in the street. HEI is known and accepted. It is tempting to believe that there is fairly widespread apathy and lack of interest in climate issues but wrong to assume it.

There are many reasons why people would not express a view publicly. It was a great endorsement when 70 people attended the launch of the car club in 2015. Many became members over the next 12 months - but very few actually drove the cars! So here is an example of action not following intention, a common behaviour that, in my opinion, shows awareness and concern without following it through. It has been even more confidence boosting to receive so much support for Harbury e-Wheels. Over 30% of our income comes from personal donations. In this instance the fact that we use EVs is acknowledged but secondary to the attraction of the fact that we serve those in the community that most need us. What is evident from a recent as yet unpublished survey is that over 50% of the respondents felt that they had a good understanding of electric vehicles. This must have come about because we put EVs into the village many years ago.

Perhaps the hardest challenges but also excitement can come from working with external bodies. It was a major step for us to work with E-Car Club, a start-up business when we started the club here. We were delivered a cold dose of reality when they were bought up by Europcar a few years later and we were deemed an unwarranted burden on profits. Our school solar project required the approval of the County Council. This was not readily forthcoming mainly, we suspect, because the official did not like the scheme. It required determination and persistence to deliver along with the support of a commercial company Ineco, which we did just in time to gain a small benefit from the fading FiT. Local authority policies have now changed radically, reflected in declarations of climate emergency. We have had good support since that difficult negotiation from Councils at all three tier levels. Our plans for a Low Carbon Warwickshire Network and for an EV charge point project in Harbury have both been welcomed. We can be part of their delivery plan.

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Case Study – Harbury Energy

For me personally it has been uplifting and life enhancing to be able to deliver successful climate action projects for the last 10 years with some wonderful people. Being part of the solution, however small, is gratifying and so much better than all the talk.

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Case Study – Borderlands Growth Deal

Borderlands Growth Deal – Low Carbon

The Borderlands Partnership brings together the five cross-border local authorities of Carlisle City Council, Cumbria County Council, Dumfries and Galloway Council, Northumberland County Council and Scottish Borders Council to promote the economic growth of the area that straddles the Scotland-England border. Much of the area is rural in nature and this presents opportunities and challenges.

Ministers of the UK and Scottish Governments and the Leaders of the five councils of the Borderlands Partnership have signed off the 'Heads of Terms' for the total £394.5million Borderlands Inclusive Growth Deal. This deal encompasses:

- Place
- Infrastructure
- Innovation and Skills
- Green Growth

The long-term benefits of the Deal is intended to reach all parts of the Borderlands area, driving inclusive growth and delivering significant and lasting benefits for individuals, businesses and communities.

Green Growth

The Borderlands Growth Deal specifically targets rural zero carbon as a large-scale stimulus opportunity for new infrastructure, new industry and new opportunities for installation and maintenance.

At present the organisation is commissioning a data collection and modelling exercise of current and future energy statuses including demand side, supply side and infrastructure. This will lead to the production of individual Local Area Energy Plans.

A prioritisation exercise will then lead to a strategic financial investment report that will drive change and deliver the overall vision of low cost, low carbon localised energy and transport to support both the UK and Scottish Government's

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Case Study – Borderlands Growth Deal

ambitions for inward investment, economic clean growth and decarbonisation. This prioritisation exercise will support and facilitate the individual Local Area Energy Plans.

The Local Area Energy Plans will define and provide a methodology to measure the potential social, economic impacts from the investment choices.

In this way, the overall approach will embed economic development strategy within the zero carbon energy approach at a local level – allowing numerous different energy systems, relevant to local areas, to be developed and to stimulate the economy.

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Case Study – Retrofit affordable rural housing

English Rural Housing Association

Research has shown that low-income rural households are more likely to experience fuel poverty. Working with our own residents, this is something that English Rural sees first-hand. The problem being more acute in older homes remote from mains gas, where traditional electrical heating and hot water solutions have been relied upon.

Separately to the affordability challenges, the repairs team at English Rural noticed that older homes reliant on electrical storage heating were more likely to experience problems arising from condensation. The root cause of which was often the inability of the householder to run heating throughout the whole house.

Back in 2013, English Rural embarked on finding a solution to this problem as part of its long-term approach to investing in homes. This work building on the programme of upgrading insulation levels and installing energy efficient windows and doors. At this time, around one-third of the affordable rented homes English Rural made available, relied on traditional electric heating and hot water solutions.

After considering options available, an air-source heat pump solution emerged as the frontrunner and the decision was reached to initiate a programme of retrofitting. The system chosen was an air to water system.

Using air-source heat pumps solved several problems at once. The new systems provided an efficient heating and hot water solution that could heat the whole house, running costs were reduced alleviating fuel poverty, and as a renewable technology environmental gains were secured. The estimates are that each household will save between £800-£990 annually, whilst reducing related CO2 emissions around 70%.

The same air source heat pump technology was also introduced into new build development activity. This supporting a consistent use of one technology and supplier; improving scale and cost effectiveness.

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Case Study – Retrofit affordable rural housing

Learning from experiences, the repairs team worked in partnership with the supplier to engage with residents. This engagement managed expectations and improved the understanding of the retrofit experience and how the new systems would work.

Since 2013, two retrofitting programmes have been completed by English Rural. Both have been made financially viable through external grant support from the Warm Homes Fund and Renewable Heat Incentive. The level of rented homes with traditional electrical and hot water solutions has fallen to around 15% of our housing stock. The agreed ambition is to reduce this to less than 10% through a third programme of installs by 2024. The feasibility of which is currently being explored.

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Appendix 2 – Consultees

Name	Organisation	Title
Alan Clifton-Holt	AA Clifton Ltd (Farm & Land owners)	Director
John Hildreth	Advance Northumberland	Senior business growth & investment officer
Joe Martin	BEC	Head of Energy & Funding
John Grainger	Britain's Energy Coast Business Cluster	Executive Director
Gail Teasdale	Broadacres HA	CEO
Tig Armstrong	Broadland District & S Norfolk Council	Assistant Director
Andy Parker	Calor	Head of Strategy & Corporate Affairs
Peter Birch	Canals & Rivers Trust	Policy Advisor
Keith Budden	CENEX	Head of Business Development
Susan Twining	Countryside Land Business Association	Chief Land Use Policy Advisor

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Consultees

Name	Organisation	Title
Jo Lappin	Cumbria LEP	CEO
Mary Robinson	Cumbria LEP	Head of Rural
Ken McKewan	Cumbria LEP / Sellafield Ltd	Head of sectors
Prof Will Swann	Energy House Laboratories	Director
Martin Collett	English Rural Housing	CEO
John Birtwistle	First Bus	Head of Policy
Bob Sherman	Harbury Energy	Founder
John Stott	Heart of England Energy	Director

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Consultees

Name	Organisation	Title
Ben Heywood	High Peak and Staffordshire Moorlands Councils	Head of Planning
Mark James	High Peak and Staffordshire Moorlands Councils	Head of Planning Policy
John Turner	Lonsdale Estates	Resident Agent
Paul Jones	Northern Automotive Alliance	CEO
Tim Miller-Fay	Northumberland County Council	Energy policy officer
Gavin Fletcher	Nottingham City Council	Projects manager
Adrian Cooper	Shropshire Council	CC Task force leader
Jan Thornton	Yorkshire Food, Farming & Rural Network	Committee member

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Appendix 3 – Current funding schemes

Government funding schemes are subject to policy change, but at the time of writing this report the following were identified:

Accelerating Clean Growth

- Providing up to £20 million to support a new clean technology early stage investment fund

Improving business and industry efficiency

- Demonstrate international leadership in carbon capture usage and storage (CCUS), by collaborating with global partners and investing up to £100 million in leading edge CCUS and industrial innovation to drive down costs.
- Invest around £162 million of public funds in research and innovation in Energy, Resource and Process efficiency, including up to £20 million to encourage switching to lower carbon fuels.
- Support innovative energy technologies and processes with £14 million of further investment through the Energy Entrepreneurs Fund.

Improving the energy efficiency of our homes

- Support around £3.6 billion of investment to upgrade around a million homes through the Energy Company Obligation (ECO), and extend support for home energy efficiency improvements until 2028 at the current level of ECO funding.
- Invest in low carbon heating by reforming the Renewable Heat Incentive, spending £4.5 billion to support innovative low carbon heat technologies in homes and businesses between 2016 and 2021.
- Innovation: Invest around £184 million of public funds, including two new £10 million innovation programmes to develop new energy efficiency and heating technologies to enable lower cost low carbon homes

Accelerating the shift to low carbon transport

- Spend £1 billion supporting the take-up of ultra low emission vehicles (ULEV), including

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helping consumers to overcome the upfront cost of an electric car
- Develop one of the best electric vehicle charging networks in the world by investing an additional £80 million, alongside £15 million from Highways England, to support charging infrastructure deployment along trunk roads.

Leading in the Public Sector

- Accelerate the uptake of low emission taxis and buses by providing £50 million for the Plug-in Taxi programme, which gives taxi drivers up to £7,500 off the purchase price of a new ULEV taxi, alongside £14 million to support 10 local areas to deliver dedicated charge points for taxis. ▪ providing £100 million for a national programme of support for retrofitting and new low emission buses in England and Wales.
- Invest £1.2 billion to make cycling and walking the natural choice for shorter journeys.
- Position the UK at the forefront of research, development and demonstration of Connected and Autonomous Vehicle technologies, including through the establishment of the Centre for Connected and Autonomous Vehicles and investment of over £250 million, matched by industry.
- Innovation: Invest around £841 million of public funds in innovation in low carbon transport technology and fuels including ensuring the UK builds on its strengths and leads the world in the design, development and manufacture of electric batteries through investment of up to £246 million in the Faraday Challenge

Delivering Clean, Smart, Flexible Power

- Improve the route to market for renewable technologies such as offshore wind through up to £557 million for further Pot 2 Contract for Difference auctions, with the latest one planned for spring 2019.
- Innovation: Invest around £900 million of public funds, including around £265 million in smart systems to reduce the cost of electricity storage, advance innovative demand

response technologies and develop new ways of balancing the grid.

- £460 million in nuclear to support work in areas including future nuclear fuels, new nuclear manufacturing techniques, recycling and reprocessing, and advanced reactor design.
- £177 million to further reduce the cost of renewables, including innovation in offshore wind turbine blade technology and foundations.

Enhancing the benefits and value of our natural resources

- Support peatland through a £10 million capital grant scheme for peat restoration.
- Innovation: Invest £99 million in innovative technology and research for agri-tech, land use, greenhouse gas removal technologies, waste and resource efficiency.

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Our Supporters

We are totally dependent on private sector supporters to fund our operation and we are extremely grateful to:

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