Programme Area: Smart Systems and Heat

Project: EnergyPath

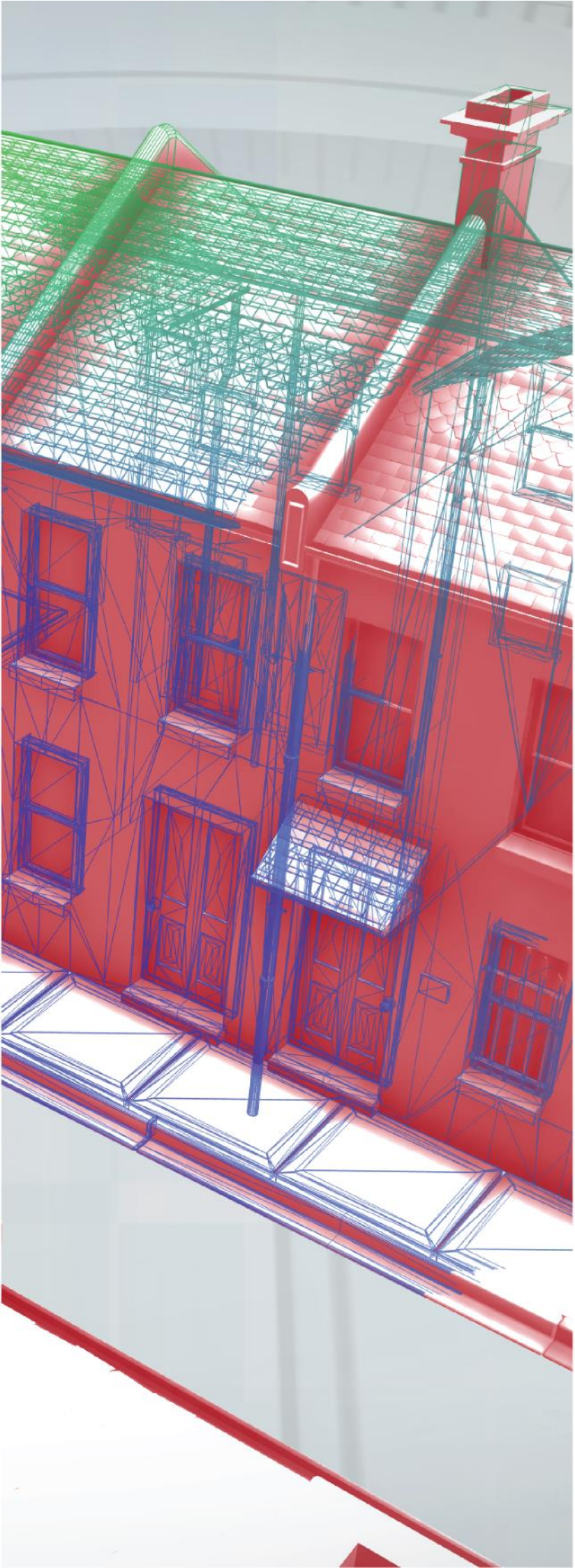
Title: Insight Report 3: Local area energy planning implications for government

Abstract:

This report sets out the potential role of local area energy planning as a valuable activity that can assist with meeting the ambitious decarbonisation and housing energy performance commitments of the Clean Growth Strategy. This work is informed by the pilot studies undertaken using EnergyPath Networks as part of the Smart Systems and Heat Phase 1 Programme.

Context:

Energy consultancy Baringa Partners were appointed to design and develop a software modelling tool to be used in the planning of cost-effective local energy systems. This software is called EnergyPath and will evolve to include a number of additional packages to inform planning, consumer insights and business metrics. Element Energy, Hitachi and University College London have worked with Baringa to develop the software with input from a range of local authorities, Western Power Distribution and Ramboll. EnergyPath will complement ETI's national strategic energy system tool ESME which links heat, power, transport and the infrastructure that connects them. EnergyPath is a registered trade mark of the Energy Technologies Institute LLP.



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Smart Systems and Heat Phase 1

WP2 Bidders Pack

D11 Insight report 3:

Local area energy planning implications for government

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- Our project delivery partners including Baringa LLP, Element Energy, University College London, Newcastle University, Ove Arup and Partners Limited and Jones Lang LaSalle Ltd.

Disclaimer

Executive summary

The decarbonisation of heat is arguably the biggest challenge facing UK energy policy over the next few decades. (Ofgem, 2016) [1]

Short summary

This report argues that local area energy planning is a valuable activity that can assist with meeting the ambitious decarbonisation and housing energy performance commitments of the Clean Growth Strategy. The next phase of decarbonisation will focus heavily on the challenges of heat and the energy performance of buildings, with costs measured in hundreds of billions of pounds by 2050. This will require a whole-system approach to help decide on the best mix of building improvements, low carbon heating technologies, power, gas and heating networks to deliver low carbon and affordable energy. A whole-system approach inevitably demands locally-specific focus as it is concerned with building stock, energy network capacity, spatial features and other locally-specific characteristics. Local area energy planning enables stakeholders, led by local government, to interrogate different energy futures for an area and to develop the most promising, cost effective options for decarbonisation. For network operators, it provides a foundation for justifying and planning network upgrades. Local area energy planning develops a shared vision as a basis for targeting investment, encouraging innovation, securing value for money, gaining public understanding and support. A small, additional investment in planning future local energy systems, using a whole-system approach, can leverage far greater savings in the capital required to improve existing or build new energy infrastructure.

Key findings

- Government has made ambitious, legally binding commitments to contribute to the global effort to tackle climate change through deep decarbonisation of the UK energy system, cutting greenhouse gas emissions by 80% by 2050, compared to 1990. The latest expressions of its plans to achieve this goal while sustaining UK prosperity are the Industrial Strategy[2] and Clean Growth Strategy[3].

- One of the toughest challenges in UK climate and energy policy is to make progress on the decarbonisation of *heat*. This will require a major overhaul of the energy system, extending into homes including the building fabric and domestic heating system. Almost all heating systems in homes will need to be replaced with advanced low-carbon technologies. The gas grid will need to be substantially scaled back or converted to distribute low carbon gases like hydrogen. Choices made for heating technology will affect electricity networks along with the introduction of electric vehicles – these developments demand coherent whole-system energy planning.

[1] Ofgem, Future Insights paper 2: The decarbonisation of heat, 14 November 2016
https://www.ofgem.gov.uk/publications-and-updates/ofgem-s-future-insights-paper-2-decarbonisation-heat
[2] HM Government, Industrial Strategy: building a Britain fit for the future, 27 November 2017.
https://www.gov.uk/government/topical-events/the-uks-industrial-strategy
[3] Department for Business, Energy and Industrial Strategy (BEIS), Clean Growth Strategy, 12 October 2017.
https://www.gov.uk/government/publications/clean-growth-strategy

- Research for the National Infrastructure Commission has estimated costs to 2050 for decarbonisation of heat from £100 billion to £450 billion (discounted present value)[4]. The resources required to decarbonise are thus very substantial. For comparison, the scale of the UK's largest infrastructure project, high speed rail HS2, is £55.7 billion by 2033. Unlike a major rail project, heating technology and housing investment will be diffuse and spread over thousands of small and medium-sized investments. However, the need to secure efficiencies in a large but diffuse programme is no less important than it is for a mega-project like HS2.

- Fuel poverty remains a source of misery, illness and premature death throughout the UK. 2.5 million households are classified as in fuel poverty in England (2015), 649,000 in Scotland (2016) and 291,000 in Wales (2016). Upgrading home energy performance and improving heating is one of the most important and effective responses, but it requires careful targeting and design. For England, there is a statutory commitment to ensure that as many fuel poor homes as is reasonably practicable achieve a minimum energy efficiency rating of Band C, by 2030[5]. The 2017 Conservative Party manifesto[6] pledged "*to improve the energy efficiency of existing homes, especially for the least well off, by committing to upgrading all fuel poor homes to EPC Band C by 2030*". The Clean Growth Strategy expresses this commitment as government policy. The government's advisory committee on fuel poverty estimates that beyond March 2019, £15.4 billion of funding will be required to install the necessary energy efficiency measures in the 2.3 million fuel poor households with energy performance at Band D or worse[7].

- The energy performance of the general UK housing stock is still poor. The government wishes to improve the energy performance of all housing, not just the homes of households in fuel poverty. 16.2 million English homes, 70% of the total, have energy performance at EPC B and D or worse. In the Clean Growth Strategy, the government set out an aspiration to improve all English homes to B and C or better by 2035 where this is cost effective, practical and affordable[8]. This is a potentially vast infrastructure programme involving assessment and possible upgrade of up to one million homes per year to 2035. Local area energy planning could provide the framework for assessments and upgrades where practical, cost-effective and affordable in a whole system context.

- Local area energy planning is a means of exploring a range of different future local energy scenarios to achieve deep decarbonisation. The planning process takes a whole-system view, accounting for building energy performance, heating technologies, electrification of transport, the capacity of and potential for gas, power and heat networks, local spatial constraints and opportunities. It involves area-specific energy system modelling embedded in a process of collaborative dialogue between stakeholders enabled by local government.

- Local area energy planning pilots conducted in Newcastle, Bridgend and Bury have shown that the best options for decarbonising heat in these areas vary significantly to reflect local circumstances, with pronounced differences in the reliance on heating networks and electric heat pumps, for example. The pilots have shown that solutions are highly specific to local conditions and that there is no single solution that could be applied nationwide.

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[4] Element Energy Limited and E4Tech, Cost analysis of future heat infrastructure, Report for the National Infrastructure Commission (UK). 17 May 2018. https://www.nic.org.uk/publications/cost-analysis-of-future-heat-infrastructure/
[5] Fuel Poverty (England) Regulations 2014. SI 2014/3220 https://www.legislation.gov.uk/uksi/2014/3220/contents/made
[6] Conservative Party Manifesto, *Forward, Together: Our Plan for a Stronger Britain and a Prosperous Future* 2017. https://s3-eu-west-1.amazonaws.com/2017-manifestos/Conservative+Manifesto+2017.pdf
[7] Committee on Fuel Poverty, Annual Report 2017, 17 October 2017. https://www.gov.uk/government/publications/committee-on-fuel-poverty-annual-report-october-2017
[8] Department for Business, Energy and Industrial Strategy (BEIS), Clean Growth Strategy, 12 October 2017. https://www.gov.uk/government/publications/clean-growth-strategy

- Local area energy planning could become a key implementation tool for the Clean Growth Strategy by helping to meet the challenge of decarbonising heat. This can set out the options that are possible and cost-effective and where investment is needed. For example, modelling could show that a heat network may offer the best solution in some areas, but such networks are unlikely to emerge through market forces alone. They require a co-ordinated approach to determine the commercial proposition, engage householders, lay new heat networks, replace boilers with heat interface units and so on. Likewise, a major uptake of electric heat pumps could only work if there is sufficient electricity network capacity and this is planned with consideration of other parallel changes such as increasing consumer uptake of electric vehicles.

- The costs involved in delivering energy services are substantial even under business as usual. For the three pilot areas, with total population of 620,000, just less than 1% of the UK population, the forecasted future cost of providing energy services to homes, businesses, public buildings and industry is £24 billion over the period 2015-2050 for 'business as usual'. The increase between business-as-usual and deep decarbonisation, to 95% below 1990 levels, is a further £3.4 billion. This difference reflects the difference in energy system configuration (costs of energy, networks, building energy performance improvements) for decarbonisation, and this delta is the where the processes of local area energy planning seeks to realise efficiencies and optimum solutions.

- Local area energy planning provides many potential benefits:

    - A clear pathway to meeting ambitious national decarbonisation objectives based on locally specific, viable and cost-effective plans.

    - A focus on whole-system and multi-vector planning that should realise system-wide efficiencies and secure value for money, and limit increases in consumer bills.

    - A credible local area energy plan that provides a basis for assessing or contesting energy developments in local spatial planning applications.

    - A framework for targeting investment and funded programmes directed at fuel poverty and improving building energy performance.

    - A means of providing evidence to target investments in network infrastructure upgrades, meeting an efficiency requirement of Ofgem's network price-setting process which provides the capital for network investment.

    - The potential to use local area energy planning as a basis for accountability, governance and performance management.

    - A compelling and locally specific narrative for meaningful engagement with local citizens and businesses in the national effort to decarbonise, adding a democratic element to the significant changes ahead.

    - The aggregation of insights from many local area energy plans and local energy system models developed over the next five years would provide valuable national level insights to inform policy, including on major decisions that need to be taken before 2030 relating to the future of the gas grid.

- This report provides: an overview of local area energy planning (section 1); an account of the main environmental, social and economic drivers underpinning the Clean Growth Strategy (section 2); a summary of the provisions of the Clean Growth Strategy that address heat, energy networks and energy performance of buildings (section 3); ten ways in which local area

energy planning can address the delivery challenges of the Clean Growth Strategy (section 4); observation on the planning policy framework for local area energy planning (section 5); and decisions for government and recommendations (section 6).

Recommendations

The Energy Systems Catapult and Energy Technologies Institute recommend adopting an evolutionary approach to local area energy planning, with the initial emphasis on encouragement, facilitation and support. If the case based on initial experience is compelling, moving to an obligatory approach in the mid-2020s should be considered.

- **Recommendation 1**. Rationalise planning system commitments to addressing climate change mitigation by taking a holistic whole-system approach to local area energy planning as a component of a local areas Local Plan.
- **Recommendation 2**. Establish a suitable function within government to drive, support and co-fund whole-system local area energy planning and consider options for decentralising to regional energy hubs.
- **Recommendation 3.** Energy network companies should actively participate in local area energy planning as part of their obligation to take a whole-system approach under the RIIO-2 framework.
- **Recommendation 4.** Align delivery of Energy Company Obligation and housing retrofit programmes with local area energy planning.
- **Recommendation 5.** Undertake national-level analysis and consolidation of insights from local area energy planning to build up a knowledge base to ensure local action aligns with and informs national energy strategy and policy.
- **Recommendation 6**. Support and publish data gathering standards and requirements to enable wide engagement in the process.

1 Introduction – local area energy planning

This section provides a short introduction to local area energy planning.

1.1 Context

The government has set ambitious goals for decarbonising the UK's energy system and has set out its programme in the Clean Growth Strategy[9]. The Clean Growth Strategy stresses improvement in the energy performance of the housing stock and commits to addressing the problem of fuel poverty through home energy efficiency improvements. The strategy places significant new emphasis on energy consumed as *heat* in homes and buildings – principally for space and water heating.

The Energy Technologies Institute (ETI) and the Energy Systems Catapult (ESC) consider local area energy planning to be necessary for efficient achievement of national objectives for decarbonisation. More effective local area energy planning based on objective, technology-neutral evidence can support transition in a way that enables local communities to realise the benefits and understand the options and costs of decarbonisation. Local areas will require locally-specific technology combinations of retrofit, new low carbon technologies and investment in electricity, low carbon gas and district heating. Network operators would be able to make better investments according to a local area energy plan that incorporates aspects of energy use outside their control, such as building energy performance, electric heat pump deployment or heat network development and expansion. This may in the future include decommissioning of gas networks or strategic gas infrastructure upgrades for the supply of hydrogen, in the context of a future national strategy for hydrogen.

1.2 Local area energy planning - a whole-system methodology

As part of the ETI Smart Systems and Heat (SSH) programme[10], the ESC has developed and tested a new whole-system approach to local area energy planning, and assessed its value in meeting the high-level national objectives of the Clean Growth Strategy – the most recent expression of government strategy for economically efficient UK decarbonisation.

Three pilots, conducted in Newcastle, Bury and Bridgend, have shown local area energy planning can provide evidence, guidance and framework to support the delivery of the Clean Growth Strategy objectives. To be effective the planning process should be centred around a collaborative and open dialogue between local government, network operators and other stakeholders to help plan for the energy networks and changes to homes and buildings needed to deliver a low carbon and clean energy future.

The process should engage the full range of stakeholders in debating and challenging the possible decarbonisation pathways for the local area informed by evidence from energy system modelling. The aim is to explore a range of possible future local energy scenarios and the options and

[9] Department for Business, Energy and Industrial Strategy (BEIS), Clean Growth Strategy, 12 October 2017. https://www.gov.uk/government/publications/clean-growth-strategy

[10] Energy Technologies Institute, Smart Systems and Heat (SSH) programme http://www.eti.co.uk/programmes/smart-systems-heat

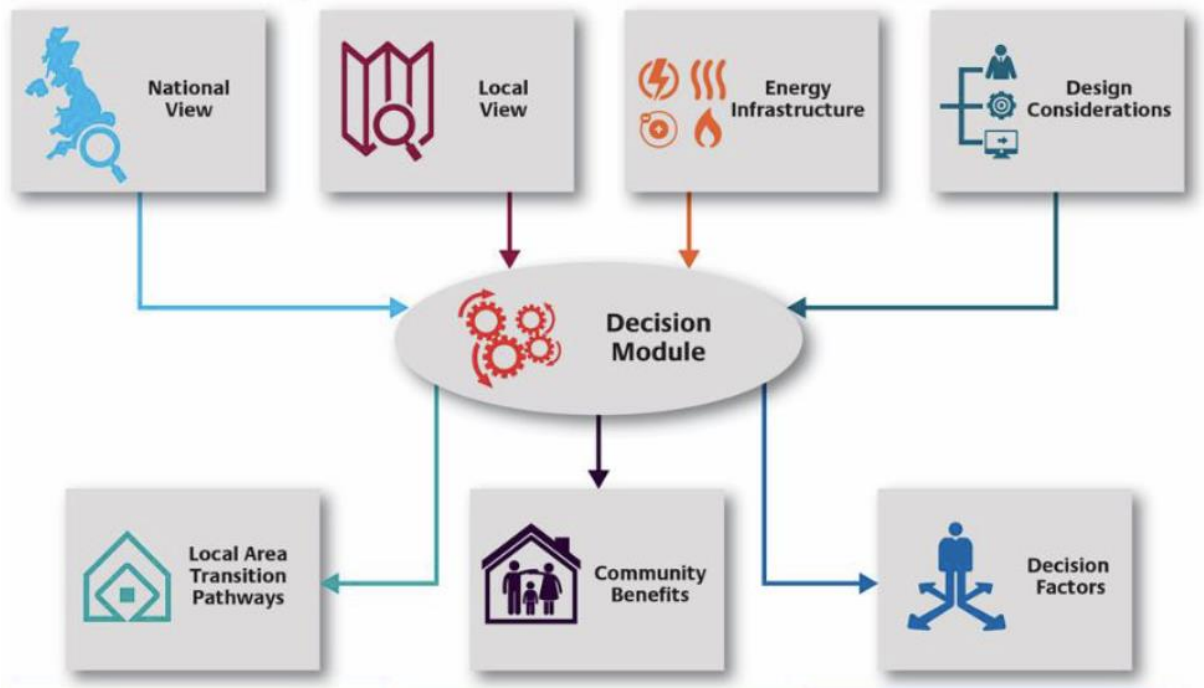
choices for networks and buildings in a local area, based on evidence. The planning process brings together local government, network operators, property owners and tenants, social landlords, businesses, and other energy sector players to forge, to the extent possible, a consensus on the way forward. The figure below provides a schematic overview.

1.3 Local energy system modelling

Open data, advanced modelling and analytical tools are at the core of a whole-system approach to local area energy planning. The Smart Systems and Heat programme has developed the UK's most advanced local energy system modelling tool – EnergyPath Networks[11].

In the future, we expect a functioning market of many modelling and supportive analytical tools to develop and form part of developing the evidence needed to underpin local area energy planning just as it does in other sectors such as transport and housing.

Figure 1: Local area energy planning: Overview of EnergyPath Networks



Local energy system modelling provides the basis for a robust whole energy system planning process, including:

- Integration and trade-off between gas, heat and power and their associated networks, including demand-side energy efficiency measures.
- Consideration of the energy supply chain including energy production, storage and use with options to build, upgrade or decommission assets including energy networks as well as building fabric and heating systems.
- The ability to understand the spatial relationships between buildings and the networks that serve them so that costs and benefits are correctly represented for the area being analysed.
- Spatial granularity down to building level where data allows.

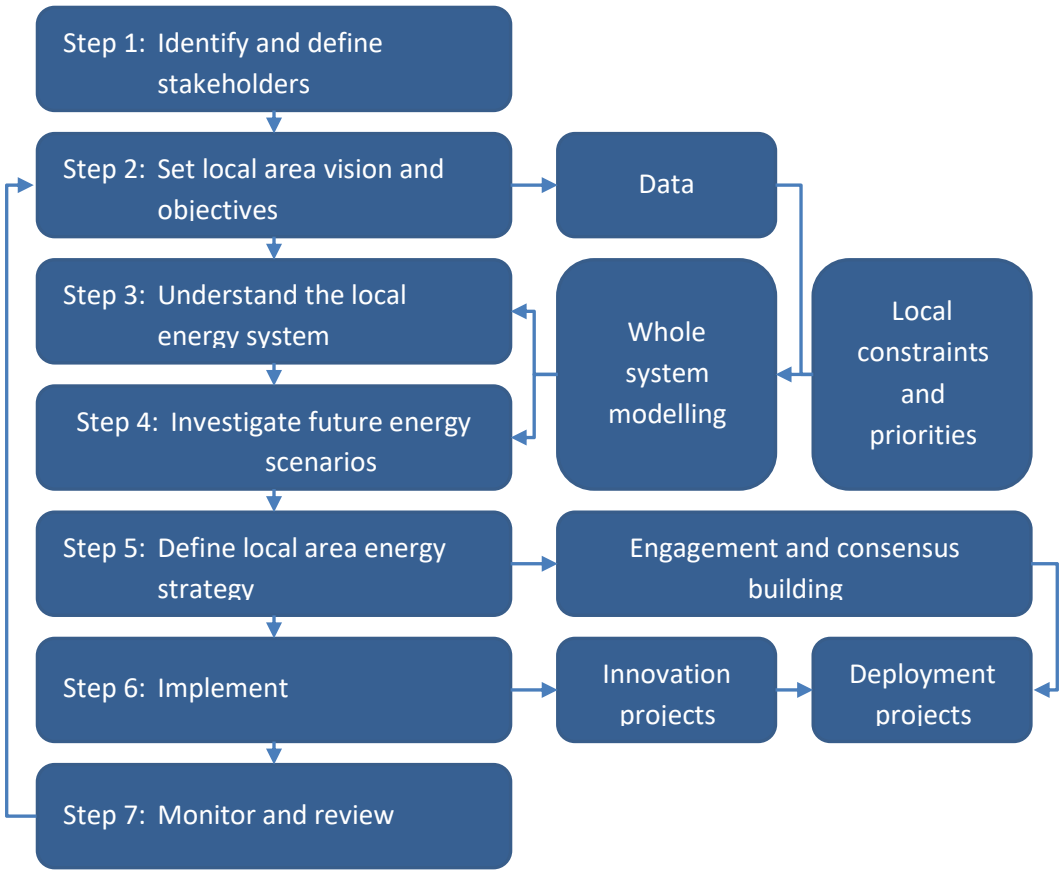
[11] Energy Technologies Institute, EnergyPath Networks. Accessed 19 April 2018. http://www.eti.co.uk/programmes/smart-systems-heat/energypath

- Modelling transition pathways out to 2050.
- Assessing the least-cost, most cost-effective decarbonisation measures needed for deep decarbonisation and so avoiding false economies or poor trade-offs that look attractive in the short term but prove to be expensive diversions or unnecessary in the longer term.
- Identifying where further evidence is required to provide new insights and understand options and choices.

1.4 The importance of the process and stakeholder engagement

The process of local area energy planning not only produces a local area energy plan outlining energy system and network choices for the future, but also a better understanding of the present situation, stakeholder awareness and buy-in, and valuable, locally-relevant information for communications purposes. Energy system modelling is embedded in a broader 7-step collaborative process, as shown below.

Figure 2: local area energy planning: outline process



1.5 The intended impact of local area energy planning

The output of local area energy planning is the creation of a coherent plan to support future local energy system change to meet local decarbonisation goals. By 2030, the country needs to be realising, or at least on track for, wide-scale deployment of low carbon heating[12].

Overall, the purpose of such a plan is threefold:

1. Create a clear direction and pathway for future local energy system design in an area given future decarbonisation ambitions. It allows for linking energy planning to other aspects of local authorities' responsibilities for planning and service provision, with the aim of improving quality of life – adding a democratic dimension to the choices made locally.
2. Inform optimum investment strategy for network operators, commercial third parties, social landlords and large-scale heat producers and potential heat users. It could be employed to inform and justify investment plans through the RIIO-2 process of determining network price controls[13]. This incentive-based price control framework is designed to align the interests of consumers with those of network companies.
3. Enable effort and resources to be deployed where it can have greatest impact and value for money. For example, by targeting the Energy Company Obligation, fuel poverty initiatives or resources for the development and expansion of heat networks and the transition of homes to a range of low carbon heating systems.

The analysis starts by building a detailed account of the current energy system in an area, which is in itself a valuable output of the planning process. The primary output is a range of costed pathways for meeting energy requirements and achieving a desired level of decarbonisation over a chosen time frame. Where consistent trends are identified over multiple scenarios and in sensitivity testing, the process can build confidence in a particular technology or network choices.

The local area energy planning process and its outputs provide benefits to multiple stakeholders:

- Local government can adopt the plan and take on a leadership role as a driver, implementer and communicator.
- Planning authorities have a substantive whole-system evidence-base to inform energy-related spatial planning (e.g. for renewables or heat networks) and area master planning.
- Social landlords have guidance on the most robust direction for energy systems in the stock they own or control.
- Businesses and innovators in the wider energy sector can target incentive schemes, technology initiatives, or innovative energy service offers to areas or housing types. They have a framework through which to market innovative products.
- Energy network operators have a basis for proposing network upgrades that have been subject to a process of examining least-cost alternatives based on all the available information in a local area. This meets a regulatory cost-effectiveness requirement.

[12] Royal Academy of Engineering, A critical time for UK energy policy: what must be done now to deliver the UK's future energy system, 23 October 2015
https://www.raeng.org.uk/publications/reports/a-critical-time-for-uk-energy-policy

[13] Ofgem. RIIO (Revenue = Incentives + Innovation + Outputs) is Ofgem's performance-based framework to set network price controls. The second phase, RIIO-2, will apply from March 2021 (transmission and gas distribution) and March 2023 (electricity distribution) and last five years.
https://www.ofgem.gov.uk/network-regulation-riio-model/network-price-controls-2021-riio-2

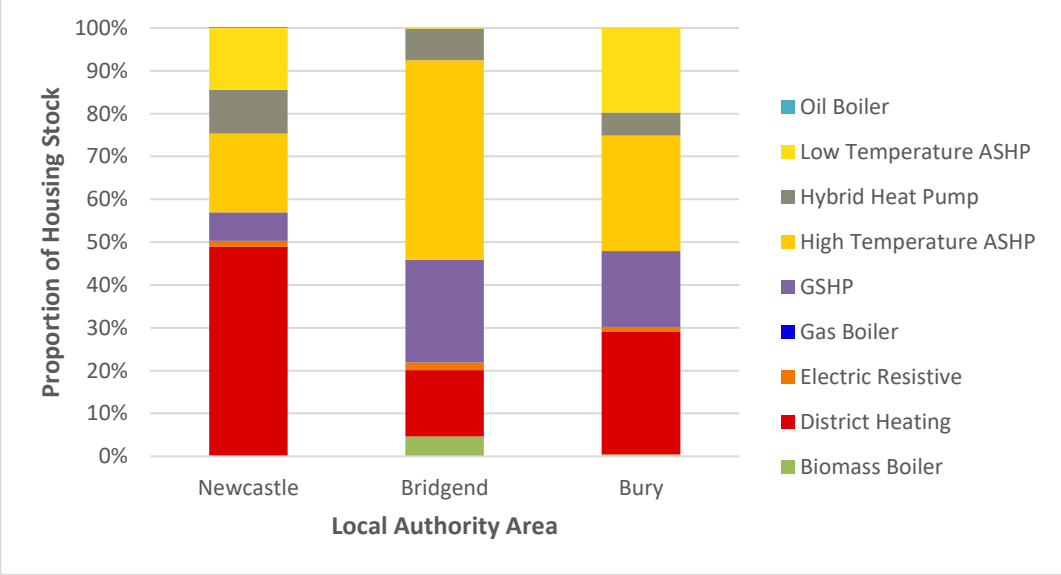
- For regulators, including Ofgem and the Planning Inspectorate, local area energy plans provide a framework and evidence base for assessing, and if necessary contesting, the proposals and decisions of regulated entities. It could also provide the basis for consumer protection and governance of currently unregulated activity, such as heat networks or embedded generation.
- For central government and regulators, local area energy planning provides some assurance that the very large investments needed to enable decarbonisation will be made cost-effectively and will be implementable, and with some accountability. Local area energy planning would provide an integral component to support the implementation and the commitments of the Clean Growth Strategy and Industrial Strategy.

1.6 The experience of three pilots

The development of the local area energy planning concept has been informed by three pilots as part of the Smart Systems and Heat Programme in three local authority areas: Newcastle, Bridgend and Bury in Greater Manchester; representing examples of different but typical urban areas. The work with the three pilot local authorities has found that the cost of decarbonisation is significantly influenced by the local environment, buildings, resources and socio-economic priorities in different areas[14].

Figure 3 is an output from the local area energy planning process employed in the pilot areas and shows very different cost-effective configurations to meet low-carbon heat demand by 2050.

Figure 3: Proportion of different domestic heating solutions installed by 2050



In this example, Newcastle shows significant potential for heat networks, influenced by its housing density and existing heat networks and committed developments, Bridgend a greater reliance on electric heat pumps, and Bury a wider range of heating systems in which no dominant heating technology stands out. The pilot experience suggests a “one-size fits all” approach will not provide the most efficient solution and that local area energy planning provides options tailored to local circumstances and can inform a national level understanding of the implications of an increasingly diverse patchwork of local energy systems emerging over time.

[14] Energy Technologies Institute, Local area energy planning: A National Perspective, May 2018

2 Clean growth policy drivers

This section provides a brief overview of the main environmental, social and economic policy drivers that ultimately underpin the case for local area energy planning, with a focus on domestic heating systems and the energy performance of buildings.

2.1 Environmental drivers

2.1.1 The overall challenge of deep decarbonisation

The UK is committed to substantial reductions in greenhouse gas emissions through local, national, European Union and international treaty commitments. Through the Climate Change Act (2008), the government has committed to reducing UK greenhouse gas emissions by at least 80% by 2050 compared to 1990 levels. To achieve this, the government is legally obliged to set and meet five-year carbon budgets, and to consider independent advice from the Committee on Climate Change, which was established under the 2008 Act[15].

The challenges of such deep and rapid decarbonisation demand significant changes to buildings and energy networks, and this, in turn, requires better planning. The fourth (2023 to 2027) and fifth carbon budgets (2028 to 2032) mark the start of deep decarbonisation. These budgets reduce average annual emissions by 52% and 57% respectively compared to the 1990 baseline and substantially below the current (2016) level of emissions which are 41% below 1990 levels. These are demanding targets and the programme, and each successive budget, will need to reflect the availability of more complex and novel technologies and techniques.

2.1.2 The challenge of heat and energy performance of buildings

The initial policy response to climate change has focussed heavily and successfully on the decarbonisation of electricity supply through fuel switching, renewable power generation and demand reduction. Between 1990 and 2016, overall greenhouse gas emissions fell by 41%. However, energy supply emissions, which fell by 57%, mainly from power generation, contributed disproportionately to the overall reduction. In contrast, residential emissions, mainly from space and water heating, have declined by only 13% and transport emissions fell by just 2% between 1990 and 2016[16]. The next phase of action on climate change inevitably demands a stronger emphasis on energy consumed as heat and for transportation. In turn, this will have significant locally-specific implications for decarbonisation.

By the 2030s, electricity is likely to play a much greater role in decarbonising both transport and residential heating through increasing uptake of electric vehicles and heat pumps respectively. This will create novel demands on local power networks, with greater seasonal and daily variability and more intense peaks. It would be inefficient to meet such demands with a ‘predict-and-provide’ approach, in which infrastructure is built to avoid constraints on expected demand. It will be more efficient to plan and manage network development and technology choices together, taking a

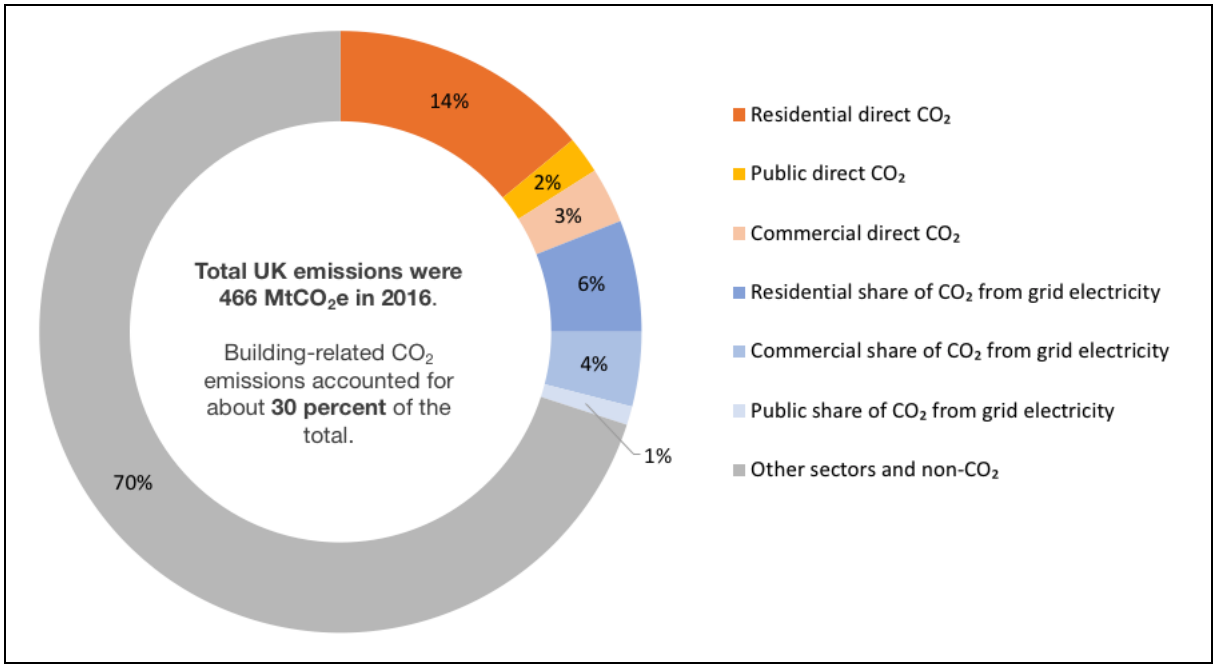
[15] Climate Change Act (2008). Part 1: Carbon budgeting and targets. Part 2: Committee on Climate Change. https://www.legislation.gov.uk/ukpga/2008/27/contents

[16] Department for Business, Energy & Industrial Strategy, Final UK greenhouse gas emissions national statistics: 1990-2016, 28 March 2018. https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-2016

whole-system perspective, and draw on 'smart grid' functionality to balance and optimise the use of demand-side, supply and storage resources[17].

Direct greenhouse gas emissions from buildings, mostly arising from gas consumption to provide space and water heating, accounts for 19% of UK greenhouse gas emissions, with a further 11% of emissions attributable to the consumption of grid electricity in buildings (see Figure 4 below). Heating in residential, commercial and public-sector buildings, combined with heat used in businesses and industry accounts for around one-third of UK total greenhouse gas emissions[18].

Figure 4: Buildings CO_2 emissions as share of UK greenhouse gas total (2016) [19]



2.2 Social drivers

2.2.1 Fuel poverty

The government recognises that clean growth also has a strong social dimension, and that poor building energy performance, which wastes energy and money, has a severely detrimental effect on quality of life and can be a cause of premature death. According to the government's advisory committee on fuel poverty[20]

> *Living in cold, damp homes impairs the health and wellbeing of householders and is a contributor towards the 25,000 excess Winter Deaths that occur each year in England. NHS England recognises that these deaths are largely preventable and that measures*

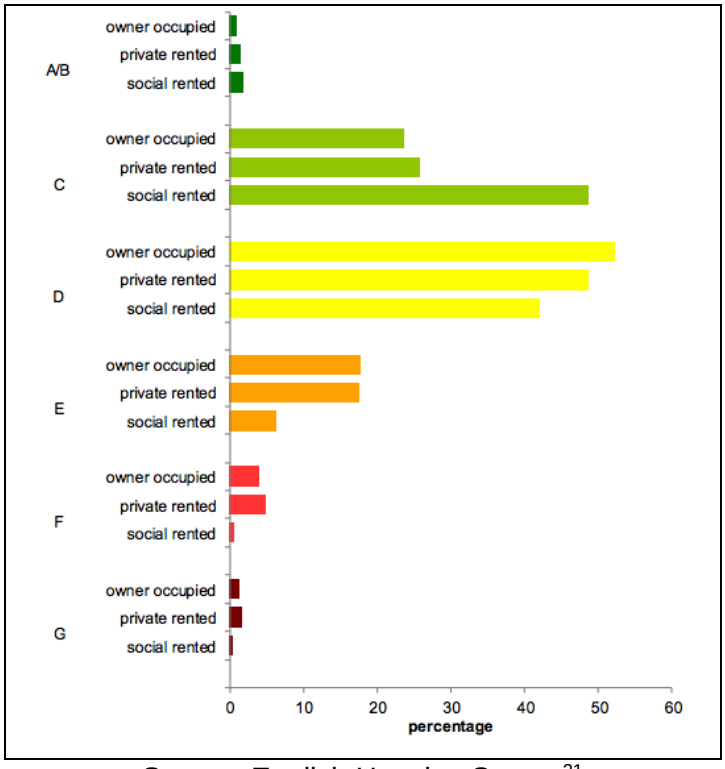
[17] Institution of Engineering and Technology & Energy Systems Catapult, Future Power Systems Architecture Project. https://www.theiet.org/sectors/energy/resources/fpsa/index.cfm
[18] BEIS, Final UK greenhouse gas emissions national statistics: 1990-2016, 6 February 2018. https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-2016
[19] Committee on Climate Change, An independent assessment of the Clean Growth Strategy Technical annex – Buildings. Figure 1. January 2018. Underlying data from: BEIS (2017) Final UK greenhouse gas emissions national statistics 1990-2015; BEIS (2017) Provisional UK greenhouse gas emissions national statistics 2016; BEIS (2017) Energy Trends, March 2017. https://www.theccc.org.uk/wp-content/uploads/2018/01/CCC-An-independent-assessment-of-the-Clean-Growth-Strategy-Technical-Annex-Buildings.pdf
[20] Committee on Fuel Poverty, Annual Report 2017, 17 October 2017. https://www.gov.uk/government/publications/committee-on-fuel-poverty-annual-report-october-2017

such as increasing energy efficiency in the home through installing insulation and efficient heating systems can have health benefits.

2.2.2 The general housing stock

Improving the energy performance of buildings can improve quality of life, reduce energy demand and carbon emissions, and may create savings for householders, providing further welfare gains. BEIS analysis puts the average annual energy bill for a band C home at around £1,000, compared to over £1,500 for a band E home and over £2,000 for a band F home. Households can take the gains of improved energy performance as a combination of cost savings and improved comfort and welfare in having a warmer home.

Figure 5: Energy efficiency rating bands, by tenure. England, 2016



Source: English Housing Survey[21]

In 2016, the average energy efficiency rating (SAP) of English dwellings was 62 points out of a possible 120 (highly efficient), up from 45 points in 1996[22]. This increase was evident in all tenures.

The rate of improvement appears to be slowing and there was no change in the average SAP rating of homes between 2015 and 2016 in any tenure[23]. While the rising average has been a success over the last 20 years, driven for example by the mandatory requirement to fit condensing boilers and programmes to improve insulation, both the current average level and variation in energy performance remain a concern. Any future upgrade of energy performance for many homes will depend on more difficult improvements to building fabric and the complete replacement

[21] Ministry of Housing, Communities & Local Government, English Housing Survey 2016 to 2017 headline report, 18 January 2018. https://www.gov.uk/government/statistics/english-housing-survey-2016-to-2017-headline-report

[22] The Standard Assessment Procedure points score underpins the A-G energy performance certificate system for rating household energy efficiency: Band A (most efficient) SAP = 92–120; Band B = 81–91; Band C = 69–80; Band D = 55–68; Band E = 39–54; Band F = 21–38; Band G (least efficient) = 1–20.

[23] Ministry of Housing, Communities & Local Government, English Housing Survey Headline Report 2016-17. 25 January 2018. https://www.gov.uk/government/statistics/english-housing-survey-2016-to-2017-headline-report

of heating systems, rather than the more straightforward measures that have underpinned progress to date.

2.3 Economic drivers

2.3.1 Industrial strategy

The government has placed high priority on improving economic performance and has established broad policy objectives through the Industrial Strategy published in November 2017[24] The strategy aims to improve the UK's sluggish productivity growth and to focus on four major 'Grand Challenges' facing the UK: artificial intelligence and big data; clean growth; the future of mobility; and meeting the needs of an ageing society.

2.3.2 The challenge of clean growth

'Clean growth' is one of the four Grand Challenges and the Industrial Strategy highlights the potential for resource-efficient technologies and related techniques and expertise as a major industrial opportunity.

> *The move to cleaner economic growth – through low carbon technologies and the efficient use of resources – is one of the greatest industrial opportunities of our time.*

As a way of advancing the clean growth challenge, the Industrial Strategy strongly endorses the idea of taking a whole-systems approach to the decarbonisation of energy:

> *Many of our stakeholders have called on us to take a 'whole systems approach' to the decarbonisation of energy infrastructure systems. We agree with this principle, and will position the UK as a leader in clean and efficient power, transport and heat through an integrated approach to decarbonising these increasingly connected systems.* (page 145)

The government's approach to meeting the clean growth Grand Challenge has been articulated in depth in the Clean Growth Strategy[25]. This provides an ambitious blueprint for Britain's low-carbon future.

2.4 Energy policy drivers

UK energy policy[26] involves meeting environmental, social and economic objectives and resolving trade-offs between them to meet the triple challenges, or 'trilemma', of:

1. Maintaining an appropriately secure and reliable energy system that provides the energy services people need and want: space and water heating and cooling, light, electric current for electronic devices, motive power, industrial process heat etc.
2. Addressing externalities by delivering the policy and legal commitment to deep decarbonisation and air quality improvements.

[24] HM Government, Industrial Strategy: building a Britain fit for the future, 27 November 2017.
https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future
[25] Department for Business, Energy and Industrial Strategy (BEIS), Clean Growth Strategy, 12 October 2017.
https://www.gov.uk/government/publications/clean-growth-strategy
[26] For example, Rt Hon Amber Rudd MP, Secretary of State for Energy and Climate Change (2015-2016), 'A new direction for UK energy policy', 18 November 2015.
https://www.gov.uk/government/speeches/amber-rudds-speech-on-a-new-direction-for-uk-energy-policy

3. Achieving value-for-money and equitable distribution of costs as new technologies and techniques are integrated at scale to ensure the first two challenges are met without excessive burdens on householders and businesses.

In addition, the innovation generated by clear and reliable policy signals about the direction and magnitude of change required in the energy system and its architecture should position the UK as a leader in the technologies and services that underpin modern energy policy. This creates a strong linkage between energy policy and Industrial Strategy.

Energy sector investments require a long-term view – anticipating network requirements years in advance. However, those network investments can constrain or enable the possibilities at the local level – for example, widespread electric vehicle and heat pump uptake may require grid enhancements, but these may be reduced if a district heating network is planned and developed and alternative sources of low carbon heat identified, or the gas grid is repurposed in combination with fabric retrofits and better local thermal storage. Local area energy planning allows the local options and network requirements to be considered together, as a whole system.

3 The Clean Growth Strategy

This section reviews the government's most recent expression of its overarching policy to address the drivers discussed above, The Clean Growth Strategy[27] as it relates to heat and local energy development. The strategy provides direction in four main areas.

1. Improving the energy performance of buildings
2. Rolling out advanced low-carbon heating technologies
3. The development of energy networks
4. Strategic decisions regarding grid infrastructure

These are discussed in the sections that follow.

3.1 Improving the energy performance of buildings

For the domestic sector, the Clean Growth Strategy envisages substantial upgrades of the energy performance of homes in the privately owned, private rented and social housing sectors. The strategy contains broad commitments to raise the energy performance of most homes with a focus on tackling fuel poverty through improvements in energy performance, backed by a utility-based investment scheme, the Energy Company Obligation[28].

Figure 6: Clean Growth Strategy commitments: Improving the energy efficiency of our homes

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
- We want all fuel poor homes to be upgraded to Energy Performance Certificate (EPC) Band C by 2030 and our aspiration is for as many homes as possible to be EPC Band C by 2035 where practical, cost-effective and affordable
- Develop a long-term trajectory to improve the energy performance standards of privately rented homes, with the aim of upgrading as many as possible to EPC Band C by 2030 where practical, cost-effective and affordable
- Consult on how social housing can meet similar standards over this period
- Following the outcome of the independent review of building regulations and fire safety, and subject to its conclusions, we intend to consult on strengthening energy performance standards for new and existing homes under building regulations, including future-proofing new homes for low carbon heating systems
- Offer all households the opportunity to have a smart meter to help them save energy by the end of 2020

3.1.1 Addressing fuel poverty

In England, there is a statutory commitment to ensure that as many fuel poor homes as is reasonably practicable achieve a minimum energy efficiency rating of B and C, by 2030[29]. Under

[27] Department for Business, Energy and Industrial Strategy (BEIS), Clean Growth Strategy, 12 October 2017. https://www.gov.uk/government/publications/clean-growth-strategy
[28] Ofgem. Energy Company Obligation. https://www.ofgem.gov.uk/environmental-programmes/eco/about-eco-scheme
[29] Fuel Poverty (England) Regulations 2014. SI 2014/3220 https://www.legislation.gov.uk/uksi/2014/3220/contents/made

the Clean Growth Strategy, it is government policy to ensure the homes of all fuel poor households fuel poor homes to be upgraded to Energy Performance Certificate (EPC) Band C by 2030.

There were 2.5 million fuel-poor households in England in 2015, 11% of the total. Of these households, only 7.8% were occupying homes rated EPC Band C or better in 2015, so the number of homes in scope for the commitment to improve energy performance is 2.3 million[30].

Estimating the scale of the task is complicated because the number of households in fuel poverty varies with energy prices and incomes, as well as energy efficiency. The number of households in fuel poverty has been increasing – from 2.38 million in 2014 to 2.50 million in 2015. Over the same period, the number of fuel-poor household in homes at Band C or better increased from 6.8% to 7.8%. The *net* effect of these changes between 2014 and 2015 was to *increase* the number of fuel poor households living in homes below Band C by 100,000, from 2.2 million to 2.3 million. Meeting the fuel poverty commitment will be likely to require a programme that, on average, improves up to 200,000 homes to Band C per year until 2030.

In Scotland, 649,000 households are classified as in fuel poverty, 26.5% of the total, a substantially higher proportion than in England, though with some differences in the definitions used[31]. The Scottish Government is developing a new policy and legislative framework for addressing fuel poverty. It has proposed to remove poor home energy efficiency as a driver for fuel poverty by ensuring all homes reach a minimum energy performance rating by 2030[32].

In Wales, 291,000 households are classified in fuel poverty, 23% of the total. The Welsh Government has a number of innovative schemes focussed on fuel poverty, including the area-based Arbed programme, which funds the installation of energy efficiency measures delivered in deprived communities across Wales by local authorities[33].

3.1.2 Improving the general housing stock

The Clean Growth Strategy also sets the aspiration to have "as many homes as possible to be EPC B and C or better by 2035 where this is practical, cost-effective and affordable". Figure 7 below provides an indication of the scale of this ambition[34].

Figure 7: Potential number of homes to be upgraded to EPC level C or better (England)

Tenure	Number of homes (thousand)	Proportion with EPC rating D-G	Number with EPC rating D-G (thousand)
Owner occupied	14,444	75.2%	10,865
Private rented	4,692	72.8%	3,415
Social housing	3,947	49.4%	1,949
Total	**23,083**	**70.3%**	**16,229**

[30] Department for Business, Energy & Industrial Strategy, Fuel Poverty Statistics Report 2017 (2015 data), 29 June 2017
https://www.gov.uk/government/statistics/annual-fuel-poverty-statistics-report-2017
[31] Scottish Government, High quality, sustainable homes. Accessed 27 May 2018
http://www.gov.scot/About/Performance/scotPerforms/partnerstories/HARO/Indicators/High-quality-sustainable#A1
[32] Scottish Government, Home Energy and Fuel Poverty, Accessed 27 May 2018
https://beta.gov.scot/policies/home-energy-and-fuel-poverty/fuel-poverty/
[33] Government of Wales, Fuel Poverty. Accessed 27 May 2018
https://gov.wales/topics/environmentcountryside/energy/efficiency/arbed/?lang=en
[34] Ministry of Housing, Communities & Local Government, English Housing Survey 2016 to 2017 headline report, 18 January 2018.
https://www.gov.uk/government/statistics/english-housing-survey-2016-to-2017-headline-report

This aspiration represents a major upgrade of the housing stock, with 70% of all housing in England in scope. For England, this aspiration means assessing upgrade options for 16.2 million homes in EPC range D-G and applying criteria for practicality, cost-effectiveness and affordability. That would mean assessing approximately one million homes annually and determining the appropriate upgrade options, if any, that are consistent with criteria for practicality, cost-effectiveness and affordability.

This means a total effort of assessing and possibly upgrading an average of up to one million homes per year of which 200,000 are fuel-poor households. The Clean Growth Strategy commitments and aspirations represent a major infrastructure challenge.

3.1.3 The costs of housing retrofits

The Energy Technologies Institute[35] research into the costs and benefits of retrofitting housing and improving energy performance as part of the Smart Systems and Heat Programme highlighted the very large investments required:

> *Although very deep housing retrofits are technically feasible, their cost could potentially be similar to the greater than two trillion-pound cost of rebuilding the entire UK housing stock, so a more targeted approach is needed. There are significant opportunities to improve the performance of a traditional business-as-usual approach to housing retrofits. A coherent long-term strategy that recognises the underlying economics will enable more entrepreneurial businesses to invest in the changes required to deliver more cost-effective, high performing retrofits more aligned to the needs and drivers of home-owners*.

This highlights the need for a coherent long-term strategy to deliver this vast investment, which will comprise of millions of small-scale investments.

- For the 2.3 million households in fuel poverty in homes with energy performance of B and D or worse, the government's Advisory Committee on Fuel Poverty estimates that beyond March 2019, £15.4 billion of funding will be required to install the necessary energy efficiency measures to raise energy performance to B and C or better by 2030[36].
- The Clean Growth Strategy did not present an estimate of the costs of meeting the aspiration of upgrading the full 16.2 million homes that are currently Band D or worse to Band C or better by 2035. But if the average unit cost was the same as estimated by the Advisory Committee on Fuel poverty the cost would be £108 billion. This would be an upper bound and reduced by applying criteria for practicality, cost-effectiveness and affordability.

National averages conceal significant local variations, and these substantially change the appropriate response in a given local area. The housing stock in the three pilots found significant differences in baseline characteristics. In general, the housing stock in Bridgend is younger and larger than that in either Bury or Newcastle. Newcastle has a much higher proportion of small flats than Bridgend and Bury. In all the pilots some fabric retrofit was found to be cost-effective, even under business as usual in a whole system context, and that this could be effectively aligned with areas with the highest levels of fuel poverty. These differences affect the appropriate response in each area.

[35] Energy Technologies Institute, Housing Retrofits – A new start. 15 November 2016. http://www.eti.co.uk/insights/housing-retrofits-a-new-start

[36] Committee on Fuel Poverty, Annual Report 2017, 17 October 2017. https://www.gov.uk/government/publications/committee-on-fuel-poverty-annual-report-october-2017

3.1.4 Commercial buildings

The government has also stressed the importance of energy efficiency and decarbonisation of heat in the commercial and industrial sectors, and highlighted the role of low carbon heat and the importance of recycling waste heat from industrial processes; this aims to create efficient and synergistic linkages between industrial and community energy use.

Figure 8: Clean Growth Strategy commitments: Improving business and industry efficiency

Improving business and industry efficiency

- Develop a package of measures to support businesses to improve their energy productivity, by at least 20% by 2030, including by:
  - following the outcome of the independent review of building regulations and fire safety, and subject to its conclusions, we intend to consult on improving the energy efficiency of new and existing commercial buildings
  - consulting on raising minimum standards of energy efficiency for rented commercial buildings
  - exploring how voluntary building standards can support improvements in the energy efficiency performance of business buildings, and how we can improve the provision of information and advice on energy efficiency to SMEs
- Phase out the installation of high carbon forms of fossil fuel heating in new and existing businesses off the gas grid during the 2020s, starting with new build
- Support the recycling of heat produced in industrial processes, to reduce business energy bills and benefit local communities

3.2 Rolling out advanced low-carbon heating technologies

As well as a focus on the efficient use of energy in buildings the Clean Growth Strategy also has ambitions for substantial development of low-carbon heating, including through heat networks, new boiler technology and electric heat pumps. It proposes to continue with a reform of an important funding mechanism, the Renewable Heat Incentive[37].

Figure 9: Clean Growth Strategy commitments: rolling out low carbon heating

Rolling out low carbon heating

- Build and extend heat networks across the country, underpinned with public funding (allocated in the Spending Review 2015) out to 2021
- Phase out the installation of high carbon fossil fuel heating in new and existing homes currently off the gas grid during the 2020s, starting with new homes
- Improve standards on the 1.2 million new boilers installed every year in England and require installations of control devices to help people save energy
- 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

[37] Department for Business, Energy and Industrial Strategy (BEIS), The Renewable Heat Incentive: A reformed and refocused scheme, December 2016.
https://www.gov.uk/government/consultations/the-renewable-heat-incentive-a-reformed-and-refocused-scheme

Again, very substantial investments are envisaged to meet the commitments made in the strategy, though these will take the form of hundreds of smaller local projects. Again, the challenge is to make these investments cost-effectively, taking account of all the alternatives options at the local level.

3.3 The development of energy networks

The Clean Growth Strategy refers to a number of network-related commitments:

Figure 10: Clean Growth Strategy: Energy networks

- Develop one of the best electric vehicle charging networks in the world
- Invest […] in smart systems to reduce the cost of electricity storage, advance innovative demand response technologies and develop new ways of balancing the grid
- Ofgem is making up to £720 million of regulated expenditure available to gas and electricity network companies in Great Britain, to support smarter, more flexible, efficient, and resilient networks
- Ofgem's price control regime will enable up to £26 billion of investment in upgrading and operating our electricity distribution networks from 2015-23262 and we will work closely with industry to capitalise on the opportunities for smart integration of electric vehicles into the electricity system.

The whole-system view of energy is strongly shaped by, and constrained by, energy networks that span across multiple local areas. The expected evolution of the current local energy system should inform what network infrastructure is required. Should networks be a constraint on EV and low carbon heating out, or should networks be designed to meet whatever demand is expected? There is a circularity problem with deciding which should determine the other. That can be resolved by taking a whole-system view and looking at the energy system as a whole.

Ofgem has stressed the emerging and positive role of locally based energy developments[38]

> *Local energy, and the overlapping concept of community energy, are growing features of the GB energy system. Local energy projects have a range of characteristics and often cut across traditional sector boundaries such as generation, supply and consumption. These schemes stem from the desire to involve local communities in delivering energy outcomes and, in many cases, contribute to broader local social, economic and environmental objectives. […] We conclude that the emergence of local energy is a welcome development and one that is likely to increase consumer engagement and choice.*

In these statements, Ofgem is drawing attention to both significant uncertainties in the direction of infrastructure development, but also to how decisions made at community and householder level will influence the optimum approach. Ofgem also raises concerns about governance and consumer protection, which are discussed in section 4.8.

3.4 Strategic decisions regarding grid infrastructure

While it is possible to decarbonise electricity networks through renewables, nuclear, fuel switching and carbon capture and storage, the decarbonisation of the gas grid presents a formidable challenge because its purpose is to carry a fossil fuel. Electricity could replace gas at the point of final consumption and the gas grid could be decommissioned or rolled back to supply power generation or heat networks. Alternatively, the gas distributed through the gas network could be

[38] Ofgem, Future Insights paper 3: Local energy in a transforming energy system, 30 January 2017 https://www.ofgem.gov.uk/publications-and-updates/ofgem-future-insights-series-local-energy-transforming-energy-system

decarbonised by mixing or replacing methane with hydrogen produced from low carbon electricity or with carbon capture and storage.

The Clean Growth Strategy highlights major technology choices that need to be made by 2025:

> *We will therefore need to lay the groundwork this Parliament so we are ready to make decisions in the first half of the next decade about the long-term future of how we heat our homes, including the future of the gas grid*

To illuminate the challenge, the Clean Growth Strategy considers three pathways to meet the 2050 goals, a focus on electricity, hydrogen and biomass-based carbon capture and storage.

Figure 11: Clean Growth Strategy: Pathways to 2050

• **Electricity pathway:** Under this pathway, electricity is the main source of energy in 2050. There are many more electric vehicles (EVs), we replace our gas boilers with electric heating and industry moves to cleaner fuels. Altogether this means we use around 80 per cent more electricity than today, and virtually all of it comes from clean sources (renewables and nuclear). In this pathway, carbon capture use and storage (CCUS) is not used in the UK by 2050.
• **Hydrogen pathway:** Under this pathway, we use hydrogen to heat our homes and buildings, as well as to fuel many of the vehicles we drive in 2050 and power the UK's industry. We adapt existing gas infrastructure to deliver hydrogen for heating and a national network of hydrogen fuelling stations supports the use of hydrogen vehicles. A large new industry supports hydrogen production using natural gas and capturing the emissions with CCUS.
• **Emissions removal pathway:** Under this pathway, sustainable biomass power stations are used in tandem with CCUS technology. Carbon is removed from the atmosphere by plants (biomass) as they grow and, when the biomass is used to generate electricity, emissions are captured and stored instead of returning to the atmosphere. There is still a significant clean transition in other sectors but successful innovation in emissions removal allows more time for some of these changes.

These pathways are not mutually exclusive, but they illustrate the range of possible futures and some significant strategic decisions ahead. The ETI has previously considered two broad and viable scenarios ('Clockwork' and 'Patchwork') for meeting the 2050 targets[39]. In meeting the challenge of decarbonising heat, the two scenarios differ as follows:

Figure 12: Two scenarios to meet 2050 objectives: assumptions about heating

Clockwork scenario	Patchwork scenario
• A national framework for large-scale district heating is introduced, enabled in part by waste heat from thermal power plants • A phased shutdown of the local gas distribution network from the 2040s encourages the uptake of district heating schemes • Subsidies are provided for heat pumps and efficiency improvements to speed up rural and suburban decarbonisation	• There is "grassroots" support for small and medium scale district heating projects, coupled with private sector and local authority investment • A mixture of changing attitudes and high energy costs cause the growth in average indoor temperature to level off from 2030 • There is improved efficiency of housing stock through selective the retrofit of existing homes, and with apartments increasingly dominating the market for new builds

[39] Energy Technologies Institute, Options Choices Actions - UK scenarios for a low carbon energy system. http://www.eti.co.uk/insights/options-choices-actions-uk-scenarios-for-a-low-carbon-energy-system

Sir Mark Walport, in his previous role as the government's Chief Scientific Adviser, describes the challenge in the foreword to the report:

> *The scenarios demonstrate the crucial importance of the near-term measures designed to help us achieve our carbon budgets. At the same time, they highlight the scale of the challenge ahead and the action which is required now to prepare for the next stages of our journey towards a secure, affordable low carbon energy system for the UK.*

There are major uncertainties ahead in the development of the British energy system. In its introduction to the next round of network price controls ('RIIO-2'), Ofgem highlighted the uncertainties about the future direction of the networks[40].

> *…there is a wide range of plausible future scenarios for how the networks may be used to transport gas and electricity. For instance, the demand for gas might continue to fall with greater decarbonisation of energy generation; even more so if there is a high degree of electrification of heat. However, the gas network may continue to play a significant role either through technological changes (e.g. if gas continues to be used in hybrid heat pumps) or through unanticipated changes in how the network is utilised (e.g. to transport hydrogen rather than natural gas if that becomes the fuel of choice for heating).*

The need to finance network infrastructure development through periodic price control reviews brings the decisions about infrastructure development forward into the more immediate future.

3.5 A whole-system, multi-vector approach

The preceding sections show that it will not be possible to consider different aspects of the energy system or different energy vectors in isolation. Electricity will be increasingly used for heat (heat pumps) and transport (electric vehicles), with a network increasingly used to support embedded generation. Gas use will be offset by improvements in building energy performance improvements and the use of local heat networks using low carbon fuels and waste industrial heat. Managing peaks of demand for both power and heat will require smart systems to balance supply, demand and storage resources. Addressing the challenges of decarbonisation requires a whole-system approach. But the whole-system approach should be locally specific and built around the specific circumstances and opportunities of an area.

[40] Ofgem, Open letter on the RIIO-2 Framework, 12 July 2017.
https://www.ofgem.gov.uk/publications-and-updates/open-letter-riio-2-framework

4 Clean Growth Strategy: the case for local area energy planning

This section reviews ten Clean Growth Strategy delivery challenges and suggests how local area energy planning can contribute to the response to each. The overall case rests on the locally specific nature of whole-system local area energy planning, and therefore a need to develop specific, cost-effective solutions to meet local needs that reflect local circumstances.

4.1 Nationally significant but locally specific implementation

4.1.1 The challenge

The commitments and aspirations to upgrade the energy performance of buildings and to decarbonise heat set out in the Clean Growth Strategy represent very large investments, with significant impacts on national energy use, the economy and public well-being. Though stated as national objectives, as a delivery challenge they are highly localised and situation-specific.

4.1.2 The role of local area energy planning

Options for transition and transformation are constrained and informed by inherently localised characteristics that can be captured through the process of local area energy planning. These characteristics include:

- *Building fabric and heating system*. Is it solid wall construction? Double glazed? Does it have a modern combination boiler? Is there central heating? Has solar thermal been installed?
- *Tenure*. Are the landlord's incentives aligned with the tenant's? Can social housing landlords act in the interests of all tenants? Can individual owner-occupiers reach collective decisions?
- *Householder*. Is the household fuel poor? Can they afford to make and benefit from efficiency investments using their own resources?
- *Household and community preferences*. In achieving the goals, there may be many options and trade-offs, and different attitudes to energy technologies. How can these be considered and reconciled?
- *Location*. How dense is the housing? Are there protected areas such as SSSIs? Is the home located in a conservation area? Is it close to an industrial facility with waste heat recycling potential? Is there space for a communal heating plant? Are there biofuel or other resources available locally?
- *Existing power and gas networks*. Is it necessary and cost effective to upgrade the electricity network to support electric heat pump deployment? Is the house connected to the gas grid, or using fuel oil or electricity for heating?
- *Data quality and availability.* What is the quality and availability of local data? What data handling capacity does local government have? How will data and digital technology

emerge, and how quickly, within the traditional 'analogue' energy infrastructure to form a new layer on which to deliver innovative technologies and services?

- *Planning*. How should planning energy infrastructure interact with the broader spatial planning responsibilities of local government?
- *Innovation*. Can variations in local area energy planning and practice become a driver of innovation with emergent best-practice continuously adopted and improved upon?
- *Growth potential*. Can local energy developments become a source of jobs and enterprise in construction, building services, energy projects and emerging smart grid and heat technologies?
- *Leadership, motivation, trust and agency*. Is there a body able to motivate and encourage householders to make or embrace changes and to act in the best interest of a community as a whole? Is there a community 'counterparty' to engage with network providers? Are businesses linked through Local Enterprise Partnerships?

4.2 Risks in meeting carbon budgets

4.2.1 The challenge

The Committee on Climate Change in its review of the Clean Growth Strategy[41] raises concerns that the medium-term policies are not in place to deliver the key environmental objectives, notably the fifth carbon budget (2028-2032).

- *There are only 10 years until the start of the fifth carbon budget. Lead-times, particularly for UK supply chains, mean that clarity is required soon in order to drive the necessary investments. It is urgent that the Government sets out how the Strategy's ambitions and intentions will be delivered in full, and develops new policies to close the remaining gap.*

The Committee emphasises the importance of taking a consistent long-term approach to infrastructure upgrade. What will be needed to meet the needs of 2030 will not be available at that point unless the pathway towards it has been adopted and followed in advance.

4.2.2 Role of local area energy planning

The Committee's assessment of the Clean Growth Strategy makes the following recommendations:

- ***Buildings energy efficiency.*** *The overarching trajectory set out for improving the efficiency of the existing building stock is promising. Details need to be set out on how this will be delivered, particularly for 'able-to-pay' homeowners for whom there are still no firm policies to drive the necessary actions.*
- ***Low-carbon heat in homes, businesses and industry****. The commitment to phase out the installation of high carbon fossil fuel heating in buildings off the gas grid is welcome. This should include heat pump deployment, which, together with installation in new-build properties, would develop heat pump markets and supply chains in order to prepare, if necessary, for potential widespread deployment in buildings connected to the gas grid from the 2030s. However, the Strategy provides little commitment to a low-carbon supply mix in heat networks and no commitment to biomethane post-2021, both of which the Committee*

[41] Committee on Climate Change, An independent assessment of the UK's Clean Growth Strategy, 17 January 2018 https://www.theccc.org.uk/publication/independent-assessment-uks-clean-growth-strategy-ambition-action/

has identified as 'low-regrets' options at this stage. There is also little commitment to support an increase in the use of bioenergy for industrial process heat.

Local area energy planning could play a significant role in addressing these recommendations by providing a basis for targeted measures to reach 'able to pay' households high-carbon heating and a framework for encouraging householder action. It would not in itself provide the necessary policy framework (obligations, incentives, information etc) but would provide a basis on which such measures could be built.

National level policy would be informed by bottom-up optimisations and national policy and incentives shaped to encourage what works locally. Importantly, the process of local area energy planning can provide the experience of achieving (or failing to achieve) buy-in and the trade-offs required to win public and business support.

4.3 Deep decarbonisation will involve more difficult measures

4.3.1 The challenge

According to the Committee on Climate Change, most boilers have now been replaced with efficient condensing models (around 70% in 2016) and rates of installing improved insulation have been very low since 2012. Uptake of heat pumps and district heating remain minimal and new buildings with high-carbon heating systems are still being built[42]. The Committee recommends a clear strategy for heat and energy performance of buildings:

A clear, combined strategy for energy efficiency and low-carbon heat is needed. It must significantly increase the delivery of energy efficiency measures, heat networks and heat pumps in cost-effective locations for both households and businesses. It should also test the possibility for low-carbon hydrogen to meet heat demand.

4.3.2 Role of local area energy planning

Almost all buildings will need to switch from using the heating systems that are typically installed (e.g. condensing boilers and central heating), to adopt radically different technologies[43] such as heat pumps, district heating or hydrogen fuelled boilers. The technology mix is expected to be very different from the dominance of gas boilers today and will differ markedly between areas. Local area energy planning could be used as a basis to encourage householders or businesses to take up incentive schemes such as the Renewable Heat Incentive[44], Feed-in Tariffs[45] or the Green Deal[46].

The more complex system-level options for local areas (heat networks etc.) must be considered alongside household level changes (e.g. if using a low temperature heat pump) in the whole-system analysis undertaken in local area energy planning. The consequential impacts on gas and electricity networks need to be considered to provide an overall system optimum. The more

[42] Committee on Climate Change, 2017 Report to Parliament – Meeting Carbon Budgets: Closing the policy gap, 29 June 2017. https://www.theccc.org.uk/publication/2017-report-to-parliament-meeting-carbon-budgets-closing-the-policy-gap/
[43] See Figure 3 for the experience from the pilots in Newcastle, Bridgend and Bury.
[44] Ofgem, About the Domestic Renewable Heat Incentive. https://www.ofgem.gov.uk/environmental-programmes/domestic-rhi/about-domestic-rhi
[45] HM Government, Feed-in Tariffs: get money generating your own electricity. https://www.gov.uk/feed-in-tariffs
[46] HM Government, Green Deal: energy saving for your home. https://www.gov.uk/green-deal-energy-saving-measures

complex options require collective action and longer-term commitment than direct to consumer schemes.

4.4 Addressing fuel poverty – targeting the programme

4.4.1 The challenge

To address fuel poverty in England, the Clean Growth Strategy commits to upgrade 2.3m homes by 2030 to EPC Band C or better – see section 3.1.1 above. The government's advisory Committee on Fuel Poverty estimates this will cost in excess of £15 billion[47]:

> *Based on the 2017 BEIS Fuel Poverty Statistics, we estimate that beyond March 2019, £15.4 billion of funding will be required to install the necessary energy efficiency measures in fuel poor households*

There are ways of making these investments with greater efficiency. The Committee on Fuel Poverty has three main areas of focus for success in the national effort to tackle fuel poverty.

1. *Having funding in place to upgrade the energy efficiency of fuel poor homes*
2. *Identifying the most efficient and effective way of delivering assistance to the households in fuel poverty*
3. *Being able to efficiently and effectively identify the address, property type and energy efficiency rating of each household in fuel poverty*

4.4.2 Role of local area energy planning

Local area energy planning assists with the second and third of the recommendations above. Engagement of local government can assist with identifying households in fuel poverty and can help to target measures, such as the Energy Company Obligation, to provide greater social return for the available resources. Local authorities may have multiple contacts with hard to reach fuel-poor households and can pull together data sources and then embed energy performance upgrades into a broader approach to the welfare of disadvantaged families. Any approach to fuel poverty will need to be based on an energy services philosophy, recognise real consumer needs and aspirations and develop an understanding of both the opportunities and risks to poor householders arising from decarbonisation[48].

A comprehensive response to fuel poverty will require consumer insights and innovation. The Energy Systems Catapult is developing a programme – Fair Futures[49] – to better understand the issues faced by vulnerable energy consumer groups and to identify the areas where commercial, governmental, community and householder needs and motivations could be aligned to provide more effective innovative policies, products and services. Local area energy planning would allow the benefits of consumer insights to be captured and create a framework for implementing and testing innovations.

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[47] Committee on Fuel Poverty, Annual Report 2017, 17 October 2017. https://www.gov.uk/government/publications/committee-on-fuel-poverty-annual-report-october-2017

[48] Energy Technologies Institute & Energy Systems Catapult, How Can People Get The Heat They Want At Home, Without The Carbon? 12 February 2018. http://www.eti.co.uk/insights/how-can-people-get-the-heat-they-want-without-the-carbon

[49] Energy Systems Catapult, Fair Futures, accessed 14 May 2018 https://es.catapult.org.uk/projects/fair-futures/

Local area energy planning can also flag decarbonisation 'policy risks' to fuel-poor households. Decarbonisation will often, though not always, involve supplying more expensive low-carbon energy, but with the prerequisite that it must also be used more efficiently to protect the householder from excessive bill increases. Fuel poor households are often those with homes that have the worst energy performance and are, therefore, most vulnerable to increases in the unit cost of energy and least able to bear such increases.

4.5 Securing value for money

4.5.1 The challenge

The investment in energy services and decarbonisation will be very substantial over the period to 2050. For example, modelling the three pilot areas showed the following total discounted cumulative costs to 2050 of energy and energy-related capital (networks, energy centres, building energy performance upgrades and heating system replacement) for a local carbon target and business as usual scenario[50].

Figure 13: Energy system costs to 2050 – business-as-usual versus deep decarbonisation

Discounted Costs 2015- 2050 £billion	Total cost[51] Business as usual[52]	Total cost Deep decarbonisation	Difference Deep decarbonisation Versus BAU
Newcastle	£10.4	£11.8	£1.4
Bridgend	£6.6	£7.4	£0.8
Bury	£7.1	£8.2	£1.1
Total 3 areas	£24.1	£27.5	£3.4

The table illustrates the very large-scale of the costs involved, even in the difference between the decarbonisation and business-as-usual (which assume no local carbon target and current policies remain) estimates. For the three areas, with a combined population of 620,000 (just less than 1% of the UK population), the variation in cost between business-as-usual and decarbonisation is £3.4 billion present value 2015 to 2050.

Equally national estimates for the total cost of heat decarbonisation are very substantial. Research commissioned by the National Infrastructure Commission[53] has found that:

> *All heat decarbonisation options studied are significantly more costly than the Status Quo under all scenarios. The cumulative additional cost to 2050 versus Status Quo (discounted at 3.5%) is in the range £120-300 billion under the Central cost assumptions. Under the Best case assumptions, the corresponding range is £100- 200 billion and in the Worst case assumptions £150-450 billion. The average annual cost of heating per household is found to be £100-300 higher in 2050 than in the Status Quo.*

[50] EnergyPath Network modelling data, personal communication from Grant Tuff, Energy Systems Catapult, 27 April 2018.
[51] Total cost includes the cost of energy supplied, network enhancements, energy centres, building energy performance upgrades and retrofit.
[52] "Business-as-usual" assumes no specific local target, but implies grid electricity carbon intensity falls on a trajectory consistent with the Climate Change Act targets and that low carbon technologies are deployed at sufficient scale elsewhere that their cost and performance still follows a predicted trajectory this is based widescale uptake.
[53] Element Energy Limited and E4Tech, Cost analysis of future heat infrastructure, Report for the National Infrastructure Commission (UK). 17 May 2018.
https://www.nic.org.uk/publications/cost-analysis-of-future-heat-infrastructure/

The commitment to decarbonise heat is very large in its scale of ambition. Taking the mid-point of the central cost assumption range above (£210 billion) as a point estimate, the heating decarbonisation investment is almost four times the projected full costs of the high-speed train project, HS2, of £55.7 billion[54], or about 1.8 times the annual spend, given that HS2 estimates assume it completes in 2033, and the heating decarbonisation costs are to 2050.

It is important then to consider what disciplines are available to ensure this very large public, private and consumer commitment is implemented with high efficiency and good value for money. For high-speed rail, the level of planning and cost scrutiny in the project is very substantial and the pursuit of efficiencies is central to its business case. A major housing and heating infrastructure upgrade of greater scale is highly diffuse, involving thousands of small and semi-autonomous investments. There is, however, no economic rationale for a less rigorous approach to efficiencies and delivery than there is for high-speed rail. But bringing these disciplines to a diffuse programme presents challenges, to which local area energy planning forms part of a response.

4.5.2 Role of local area energy planning

A major constraint on decarbonisation is the cost to consumers: in energy bills, housing costs, or equipment upgrades. Consumers as citizens can ultimately reject measures (or vote out politicians) if they feel their current welfare is being compromised for distant and diffuse benefits far into the future. The implicit 'social contract' underpinning decarbonisation should make cost-effectiveness a central concern. This means the whole system in an area, including network and housing investments, must be considered holistically to find the most cost-effective pathways – taking account of a range of scenarios that address constraints not under local control.

Very small improvements in the efficiency and optimisation of this expenditure would create large benefits that far exceed the costs. shows that the difference in costs between business-as-usual and deep decarbonisation for the three pilot areas averages £1.1 billion in present value terms per area.

Experience from the pilots suggests that the planning-related proportion would be a small fraction of this cost. In Bury, the latest of the pilot studies to be undertaken and the most reflective of the expected costs of scaling, the cost was £570k. However, this includes a number of one-off costs and scope for efficiencies (for example, reduced data collection and processing costs through standardisation, consultancy fees incurred in the pilot study for software development and support and engineering consultancy services).

It is anticipated that for scale-up across a large number of local areas in the UK a structured process of local area energy planning would have an average cost in the range of £100k-£250k per local area across the UK. If the plan was refreshed every five years and annual costs of staff and resources were £60k, the total cost to 2050 would be £3.4 million (£2.4 million discounted) – or around one-quarter of one percent of the £1 billion cost of meeting the carbon target compared to business as usual. Local area energy planning should be able to extract efficiencies that far outweigh its costs.

A local area energy plan drives efficiencies by identifying the homes to target for upgrade and propose the cost-effective ways to improve them, individually or collectively. It could be used in partnership with utilities to focus utility-based schemes like the Energy Company Obligation. Local authorities could promote retrofit schemes and build greater confidence in proposed programmes,

[54] HS2 estimated cost is £55.7 billion by 2033. Department of Transport, High Speed 2: Phase 2 Financial case. July 2017 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/629165/high-speed-two-phase-two-financial-case.pdf

with changes in energy use becoming ‘normalised’ as community activity rather than atomised as individual activity.

Experience suggests that building retrofits to raise energy performance can be very expensive per dwelling, but that with co-ordination, targeting and area-wide schemes, considerable cost reductions through economies of scale are attainable – and hence the number of homes for which a retrofit is cost-effective would be increased[55].

4.6 Addressing co-ordination challenges

4.6.1 The challenge

Introducing a new heat network, for example, clearly involves co-ordination challenges – ensuring there are sufficient customers located with sufficient density, fitting distribution pipework within buildings, agreeing on contingency and resilience measures, allocating space for networks and possible access to public land and co-ordination with existing utility providers. If there is an industrial waste heat provider or biomass source, then some collective purchasing power may be necessary to secure the resources and justify capital investment. A substantial increase in the use of electric heat pumps may require grid strengthening or deployment of ‘smart’ techniques to manage load and costs.

The rise of electric vehicles (EVs) also creates co-ordination challenges and opportunities. An electricity network upgrade to handle an anticipated increase in demand for EVs may be more cost effective if it is also upgraded at the same time to support future transition to electric heating and increased deployment of heat pumps in a local area. The marginal cost of accommodating a heat load within an EV-based upgrade would be substantially larger if planned in isolation of the EV upgrade. Delivering the Clean Growth Strategy objectives for 2030 or the fifth carbon budget will require a sustained process of change with year-on-year increments building to a working solution.

4.6.2 The role of local area energy planning

Co-ordination challenges are an aspect of market failure and require a planning and co-ordinating function to overcome them. An optimum approach requires a whole-system perspective but based on the particular characteristics of an area – its buildings, existing infrastructure, opportunities for clean energy production, and spatial constraints on energy developments. It should establish a pathway that blends direction-setting and flexibility – allowing market-based decisions where appropriate. Such a pathway would recognise both the advantage and value of keeping options open to take advantage of innovation or variations in cost as they arise within a periodically evolving plan. However, a balance has to be struck between flexibility and commitment especially for infrastructure development which has long lead times.

A planning function allows pragmatic trade-offs between commitment and flexibility and signals *when* commitments, for example to heat network development, need to be made allowing options to be kept open for as long as possible.

[55] Energy Technologies Institute, Housing Retrofits – A new start. 15 November 2016. http://www.eti.co.uk/insights/housing-retrofits-a-new-start

4.7 Finding 'the consumer voice' – overcoming information asymmetries

4.7.1 The challenge

Many consultations and energy systems development processes call for engagement with the consumer. For example, in its RIIO-2 consultation, Ofgem promises "to give the consumer a stronger voice"[56].

Consumers also present a potential barrier to decarbonisation. According to Energy Technologies Institute consumer research[57]:

> *…the options currently available to make further reductions [in emissions from domestic heating] would require households to endure more disruption for less obvious benefits. Policy makers are likely to be reluctant to force changes in people's homes that are widely unpopular.*

The ETI calls for an approach that stresses the household advantages of low-carbon heating, drawing on three themes:

1. Improve low carbon heating experiences.
2. Make low carbon heating simple to prepare for and install.
3. Make heating easy to control.

However, the prospect of consumer resistance also suggests a need for leadership, advocacy and a narrative about the purpose and imperatives of changing heating systems.

4.7.2 The role of local area planning

For the consumer voice to play more than a perfunctory role, it is necessary to address the imbalance of information and experience between consumers and industry professionals. One option, therefore, is for local authorities to be a voice for the consumer and citizen interest and to engage locally through the process of local area energy planning. At the heart of the decarbonisation challenge is securing citizen, business and public sector buy-in to creating a world that is different and more sustainable by 2050 and beyond, but with some costs and burdens to face on the path to reach it. Local government is well-placed to lead a 'hearts and minds' approach to decarbonisation locally in the way that central government or national agencies cannot. Though an intangible benefit, it is important to have a visible plan with accessible data such as maps and postcode related-information. These can show the direction and that changes required in the shorter term are not just arbitrary gestures, but amount to a rational and important contribution to the longer-term goal. Linked to this is the idea of confidence-building for network operators, project investors and building-owners, whose decisions will shape the future of the energy system.

[56] Ofgem, RIIO-2 Framework Consultation, 7 March 2018
https://www.ofgem.gov.uk/publications-and-updates/riio-2-framework-consultation
[57] Energy Technologies Institute, Smart Systems and Heat - Consumer challenges for low carbon heat, 2015.
http://www.eti.co.uk/library/smart-systems-and-heat-consumer-challenges-for-low-carbon-heat

4.8 Governance, performance and accountability

4.8.1 The challenge

In its Insight paper on local energy[58], Ofgem concludes that local energy development is welcome, but presents some governance and consumer protection challenges:

> *We conclude that the emergence of local energy is a welcome development and one that is likely to increase consumer engagement and choice. We recognise that local schemes need proportionate treatment and that regulatory arrangements should enable the emergence of business models that are in the long-run interests of consumers. But that should not be at the expense of customers who aren't included in a local scheme, and will need to provide appropriate protection (such as opportunities to switch) if service standards and value aren't maintained to the satisfaction of those customers.*

Ofgem has highlighted the importance of the role of decarbonisation of heat in the broader framework for decarbonisation, but also recognised that the possibility of some compulsion may be needed to require changes in the home – raising important governance challenges[59]:

> *The decarbonisation of heat is arguably the biggest challenge facing UK energy policy over the next few decades. The challenge for policy, compared to decarbonisation of electricity for example, is not limited to technological developments, new business models and system integration, but also extends to consumer acceptance of changes within their property, often on a mandatory basis. Coordinating decisions on a regional basis may require new governance arrangements and longer-term decisions to reduce the extent to which individual choices are superseded.*

4.8.2 The role of local area energy planning

A local area energy plan would provide the basis for transparency and to validate value for money and the consumer interest. In fact, achieving transparency and accountability *without* a local area energy plan would be much more difficult and potentially impossible to achieve. If the decarbonisation of heat does involve mandatory measures, then these will need to be justified as necessary and cost-effective and subject to consultation. A local area energy plan provides a framework for developing and justifying such measures against alternatives.

A plan allows stakeholders to identify requirements, monitor progress and manage delays or under-achievement. The availability of a plan is, in itself, a driver of successful implementation. Even though the fifth carbon budget begins in only 10 years – a short time in the development of energy systems - there is a danger that it appears a distant and abstract goal in political or public perception. By forming a plan with interim milestones and objectives, it will be possible to track progress in a way that is meaningful to voters, taxpayers, and utility customers.

[58] Ofgem, Future Insights paper 3: Local energy in a transforming energy system, 30 January 2017
https://www.ofgem.gov.uk/publications-and-updates/ofgem-future-insights-series-local-energy-transforming-energy-system
[59] Ofgem, Future Insights paper 2: The decarbonisation of heat, 14 November 2016
https://www.ofgem.gov.uk/publications-and-updates/ofgem-s-future-insights-paper-2-decarbonisation-heat

4.9 Systems approach for providing heat involves major choices

4.9.1 The challenge

The Clean Growth Strategy[60] recognises significant technology choices are still to be made and recognises that modelling of alternative pathways is necessary. According to BEIS:

> *There is a range of low carbon heating technologies with the potential to support the scale of change needed. These include the electrification of heating with households moving away from gas or oil boilers, to electric heat pumps; decarbonising the gas grid by substituting natural gas with low carbon gases like biogas and hydrogen; and heat networks (which are likely to be particularly effective in dense urban areas).*

These technologies are not 'drop-in' replacements for gas boilers but require integration with networks and, for maximum efficiency, parallel upgrades to building energy performance. In addition, there will be consumer awareness and buy-in challenges.

4.9.2 The role of local energy planning

The Clean Growth Strategy endorses the requirement for modelling to provide better insights into these costs and benefits of different approaches.

> *At present, it is not clear which approach will work best at scale and offer the most cost-effective, long term answer. We will work with industry, network operators, manufacturers, and consumers to achieve a clear and shared understanding of the potential as well as the costs and benefits and implications of different pathways for the long-term decarbonisation of heat. This includes modelling the costs and benefits of different approaches, establishing the likely level of change for households and demands on the electricity grid building on the work of others in this field.*

However, no single "*approach will work best at scale*", even if there are some large-scale decisions that must be taken, for example, related to the gas grid or 'smart' functionality to be developed in the electricity system. The approach that will work best at national scale is to optimise at local scale based on the particular circumstances of a local area. There may be some technologies that are consistently *cost-ineffective* and can be deprioritised nationally, but this would emerge from bottom-up modelling or simply from market forces – depending on the technology. Local area energy planning can assess the costs and benefits of different approaches and show how the energy system will evolve from the household and community perspective.

4.10 Decisions on the future of the gas grid

4.10.1 The challenge

The Clean Growth Strategy describes the challenge of heat and decisions that need to be made by 2025, with substantial groundwork in the life of this Parliament (i.e. by mid-2022):

[60] Department for Business, Energy and Industrial Strategy (BEIS), Clean Growth Strategy, 12 October 2017. Page 82, The Future of Heat Decarbonisation.
https://www.gov.uk/government/publications/clean-growth-strategy

> *Decarbonising heat is our most difficult policy and technology challenge to meet our carbon targets. We will therefore need to lay the groundwork this Parliament so we are ready to make decisions in the first half of the next decade about the long-term future of how we heat our homes, including the future of the gas grid.*

The Committee on Climate Change elaborates on the major strategic decision about gas infrastructure, with a consequential decision on the viability of carbon capture and storage (CCS).

> *This includes the future of the gas grid and the respective roles for heat pumps and hydrogen. The Government is beginning active preparations, including innovation support to test and bring down the cost of low-carbon heating technologies. Use of hydrogen would require deployment of CCS at scale.*

The decision(s) that must be made by the middle of the next decade demand modelling of future provision of heating at national level and testing different futures for the grid[61] and companies are beginning to discuss a future beyond the gas grid as we know it[62].

4.10.2 The role of local area energy planning

The future of the gas grid is one of the most significant decisions that will need to be taken on the long-term path to deep decarbonisation of heat, and the decisions need to be made by 2025. At present, gas plays a beneficial role in providing energy for heat for most households, and many households off the gas grid have been at a disadvantage as a result[63]. However, as the carbon budgets for the 2030s and beyond become more highly constrained, the space in the budget for natural gas combustion will be squeezed. In future, gas may become used mainly for peaking or balancing power in electricity generation, with heating provided by low-carbon electricity – mainly renewables, nuclear or gas with carbon capture and storage. In that scenario, the gas grid would be gradually decommissioned. The challenge is that fixed costs would fall on steadily a decreasing consumer user base. Alternatively, gas infrastructure could be retained, but available only in certain areas with a progression of decreasing coverage over time. Gas infrastructure could also be used to transport conventional natural gas mixed with zero-carbon hydrogen gas produced from low-carbon electricity.

Different future gas grid scenarios could be 'forced' into local area energy system modelling and the consequences assessed under a range of assumptions. It may be that there is no single answer to the question about the future of the grid, but that it will vary by geography and the cost-effectiveness of alternatives, and that it will vary over time as the carbon constraint tightens. Without modelling such scenarios in real-world situations, it will be difficult to make informed, evidence-based judgements about the appropriate approach.

Given the decisions about the gas grid need to be made in within seven years and the analysis must precede that, the case for local area energy planning to contribute 'counterfactual' evidence to this decision is compelling.

[61] Dodds PE, McDowall W. The future of the UK gas network. *Energy Policy*. Elsevier; 2013 Sep 1;60:305–16. https://www.sciencedirect.com/science/article/pii/S0301421513003625
[62] Cadent. The future role of gas. Accessed 14 May 2018 https://cadentgas.com/about-us/the-future-role-of-gas
[63] Energy and Utilities Alliance, Fuel Poverty: Ending the vicious cycle of vulnerability 18 January 2018. https://eua.org.uk/resources/fuel-povertyending-the-vicious-cycle-of-vulnerability/

5 Implications for local government

This section briefly reviews the planning policy framework within which local area energy planning takes place. A more detailed assessment is available in a separate report from this project[64].

5.1 Role of local government leadership in local area energy planning

For England and Wales, there is a requirement in the Planning and Compulsory Purchase Act (2004) to account for energy and climate change mitigation in local development plans[65].

> *Development plan documents must (taken as a whole) include policies designed to secure that the development and use of land in the local planning authority's area contribute to the mitigation of, and adaptation to, climate change.*

For England, the guiding framework for local planning is the National Planning Policy Framework (NPPF)[66]. It sets out the overarching objectives and principles underpinning the planning system. It includes a commitment to:

> *…support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change, and encourage the reuse of existing resources, including conversion of existing buildings, and encourage the use of renewable resources (for example, by the development of renewable energy)* (Core Planning Principles. Paragraph 17)

This general commitment is further elaborated at Section 10 of the NPPF, *Meeting the challenge of climate change, flooding and coastal change*, paragraphs 93-98. However, in 2016 an extensive survey by the Town and Country Planning Association found that local plans in England were not being used effectively to deliver climate change objectives[67].

> *The study found that local plans in England are not dealing with carbon dioxide emissions reduction effectively, nor are they consistently delivering the adaptation actions necessary to secure the long-term social and economic resilience of local communities. There was a wide variety of practice: there were some examples of positive responses, but, taken as a whole, it is clear that since 2012 climate change has been de-prioritised as a policy objective in the spatial planning system. The large-scale failure to implement the clear requirements of national planning policy is a striking finding, as is the reduced capacity of the local authority planning service and the reduced capacity of Environment Agency to support the long-term plan-making process.*

For Wales, Planning Policy Wales (PPW)[68] sets out the overarching spatial planning policy for Wales. Chapter 4: *Planning for Sustainability* and Chapter 12: *Infrastructure and Services*, make a range of commitments to low-carbon development, for example:

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[64] JLL consultants for the Energy Systems Catapult, Local area energy planning: Policy Drivers, Enablers and Barriers, April 2018.
[65] Planning and Compulsory Purchase Act (2004). Section 19 (1A)
https://www.legislation.gov.uk/ukpga/2004/5/section/19?view=extent
[66] Ministry of Housing, Communities & Local Government, National Planning Policy Framework, 27 March 2012.
https://www.gov.uk/government/publications/national-planning-policy-framework--2
[67] Town and Country Planning Association (TCPA), Planning for the climate challenge, November 2016
https://www.tcpa.org.uk/planning-for-the-climate-challenge
[68] Government of Wales. Planning Policy Wales (9th edition), November 2016.
http://gov.wales/topics/planning/policy/ppw/?lang=en

Planning policy at all levels should facilitate delivery of both the ambition set out in Energy Wales: A Low Carbon Transition.

For Scotland, the highest-level planning statement is the National Planning Framework[69], which sets the objectives for 'a low carbon place' and for spatial planning, the Scottish Planning Policy(SPP)[70], which states that the planning system should:

…support the transformational change to a low carbon economy, consistent with national objectives and targets.

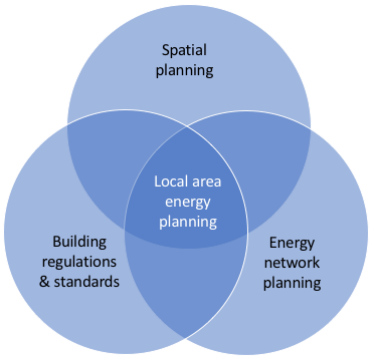
The SPP also focuses on the development of heat networks:

Local development plans should support the development of heat networks in as many locations as possible, even where they are initially reliant on carbon-based fuels if there is potential to convert them to run on renewable or low carbon sources of heat in the future.

There is much in common in the principles and objective applied across the different planning systems of the nations of the United Kingdom as they apply to energy. However, these commitments are primarily focussed on enabling low-carbon energy-related developments *in spatial planning* in which the focus is to balance demands for land use. This is conceptually different from *local area energy planning*, in which the focus is on achieving a balanced energy system while meeting social, economic and environmental objectives by taking a whole-system approach.

Local area energy planning is best understood as a fusion of spatial planning, the specification and upgrade of building energy performance standards and energy network planning, as represented in the figure below.

Figure 14: Local area energy planning - conceptual view



5.2 Current capabilities and activity in local area energy planning

Local Planning Authorities are not currently structured, resourced or tasked with local area energy planning in a meaningful way. Despite this, there is considerable interest in energy planning and a significant number of activities at local level across the UK. A survey of local authorities by the

[69] Scottish Government, National Planning Framework, 23 June 2014. See Section 3, *A Low Carbon Place* page 30-40. https://beta.gov.scot/publications/national-planning-framework-3/
[70] Scottish Government, Scottish Planning Policy, 23 June 2014. See *A Low Carbon Place* paragraphs 152-166 – page 36-38. https://beta.gov.scot/publications/scottish-planning-policy/

Energy Research Centre (ERC) provides insights into the energy-related activities of local authorities[71]. The table below shows the main findings.

Figure 15: Local Authority Engagement in UK Energy Systems - summary

- The majority of local authorities have ambitions for action on sustainable energy, and 82% of those researched are active to some degree
- Local authorities were more likely to have an Energy and Carbon Plan than investment in projects
- Local authority investment in energy was focused on infrastructures for combined heat and power alongside the improvement of energy efficiency in buildings
- Across the UK, Scotland had a higher proportion of leaders in providing low carbon systems - the leading local authorities in England were in Yorkshire and Humber, Greater London and the North East
- The scale of local authority energy projects in relation to overall energy systems remains limited
- Local authorities have very limited capacity for strategic energy management

A reasonable proxy for the level of interest in local area energy planning is the uptake of grants from the Heat Networks Delivery Unit for planning local heat networks and energy master planning in England and Wales. This shows considerable interest and coverage. There have so far been six rounds of grant awards, with 203 grants totalling £14 million made to 139 local authorities – and an average of approximately £68,000 per grant[72].

5.3 Local leadership emphasis in the Clean Growth Strategy

Given the focus on heat and building energy performance as described above, there is a strong emphasis on local leadership in the Clean Growth Strategy (page 118)[73].

> ***Local Leadership***
> *Moving to a productive low carbon economy cannot be achieved by central government alone; it is a shared responsibility across the country. Local areas are best placed to drive emission reductions through their unique position of managing policy on land, buildings, water, waste and transport. They can embed low carbon measures in strategic plans across areas such as health and social care, transport, and housing.*

Leadership is coming from within local government. The UK100 initiative[74] is a network of local government leaders, which aims to devise and implement plans for the transition to 100% clean energy by 2050, going beyond the national targets to reduce emissions. It has a strong focus on cost-effectiveness and securing buy-in from the public and business. UK100 has established a network of 85 leaders so far.

[71] UK Energy Research Centre (ERC), Local Authority Engagement in UK Energy Systems: Highlights from Early Findings, 24 April 2017.
http://www.ukerc.ac.uk/publications/local-authority-engagemnet-in-uk-energy-systems-highlights-from-early-findings-.html
[72] Heat Networks Delivery Unit, Local authorities supported by HNDU in round 1-6. Accessed 27 April 2018
https://www.gov.uk/guidance/heat-networks-delivery-unit#local-authorities-supported-by-hndu
[73] Department for Business, Energy and Industrial Strategy (BEIS), Clean Growth Strategy, 12 October 2017.
https://www.gov.uk/government/publications/clean-growth-strategy
[74] UK100 website https://www.uk100.org/

The Greater London Authority has established a suite of energy initiatives[75], including Energy for Londoners, which is the Mayor's programme to make London's homes warm, healthy and affordable, its workplaces more energy efficient, and to supply the capital with more local clean energy.

Greater Manchester has established a low carbon hub and held a Green Summit in March 2018 at which the Mayor announced a range of new initiatives to support local energy development and set a new aspiration to bring Greater Manchester's date for achieving carbon neutrality forward by at least a decade to 2040[76].

These, and many more, reflect a strong desire in local government to meet the challenge of climate change and to engage with local area energy planning.

5.4 Resourcing for local energy initiatives

The planning process does require resources, and austerity in local government funding has made it difficult to free resources for local area energy planning. A survey by the consultants Arup for RTPI (North West) found that by 2015, there had been a one-third reduction in planning staff overall since 2010, including a decrease on average of 37% in planning policy staff and 27% in development management staff[77].

However, this has been partly offset by central government funding. For example, local energy initiatives been backed by additional money to be invested through Local Enterprise Partnerships (LEPs). In the Clean Growth Strategy, the government highlight the potential for local energy developments to drive economic progress: (page 38).

> *We are committed to making the most of the diverse strengths of all of Britain's cities and regions, to grasp the opportunities that could drive faster growth and increased earning power in each of them. To support this, we have allocated an additional £1.8 billion from the Local Growth Fund for a new set of Growth Deals between Government and Local Enterprise Partnerships (LEPs). Each region of the UK differs in its local energy resources, its industrial and domestic energy needs, and its expertise. We will ensure that local communities and LEPs are empowered to make the best use of their local skills and resources, so that through the clean energy economy they can drive productivity, job creation and growth.*

The Department for Business, Energy and Industrial Strategy has been supporting LEPs to develop local energy strategies. In 2017, BEIS allocated £1.6m for energy strategy development by LEPs. One of the main outcomes of these energy strategies will be the identification of a pipeline of energy investment opportunities for each LEP area. BEIS allocated a further £2.7m to support the capacity of LEPs and local authorities by providing LEPs and local authorities with additional resources and expertise to undertake the initial stages of energy project development (feasibility studies and business cases), up to a point where they are able to attract capital investment and to support for the formation of five regional energy hubs[78]. In future, it is possible that the government's Devolution Deals[79] will decentralise more powers relevant to energy

[75] Greater London Authority, Energy web pages
https://www.london.gov.uk/what-we-do/environment/energy
[76] Greater Manchester, Green Summit heralds bold green future for Greater Manchester, 21 March 2018.
https://www.greatermanchester-ca.gov.uk/news/article/290/green_summit_heralds_bold_green_future_for_greater_manchester
[77] Royal Town Planning Institute (North West), Investing in Delivery: How we can respond to the pressures on local authority planning, October 2015.
http://www.rtpi.org.uk/knowledge/research/projects/national-and-regional-research-projects/investing-in-delivery/
[78] Department for Business, Energy and Industrial Strategy (BEIS), Letter to LEPs, Local Energy capacity support for LEPs and local authorities, August 2017. http://bit.ly/BEIS-Local-Energy
[79] Ministry for Housing, Communities and Local Government, Devolution and mayors: what does it mean? Accessed 6 May 2018.
https://www.gov.uk/government/publications/devolution-and-mayors-what-does-it-mean

development and devolve more funding to decision-makers in local government and Local Enterprise Partnerships.

5.5 Appropriate scale

Local government has quite complex structure and varying population – from a few tens of thousands in West Somerset (34,000) to over one million in Birmingham, the largest unitary authority (1.1m), with a local authority like Bridgend (143,000) being close to the median. In England, there are 353 local authorities, mostly but not all in a two-tier (county and district) configuration[80]:

Figure 16: Local government structure in England

Two-tier	
County councils	27
District councils	201
Single tier	
Unitary authorities	55
Metropolitan districts	36
London boroughs	32
City of London	1
Isles of Scilly	1
Total	**353**

Planning authorities overlap substantially with local government but are not always co-terminus. For example, national parks are distinct planning authorities, and in some areas planning responsibilities are split between tiers. In England, there are also 38 Local Enterprise Partnerships (LEPs) based on *economic* geography[81]. These could play a role, for example as hubs for expertise, but do not have the democratic 'public choice' credentials of local government and the planning system.

There are no hard and fast rules on the appropriate scale for local area energy planning. Larger scale may attract more involvement from energy network providers. A smaller scale may allow for higher resolution and more specific actionable decisions. Alignment with LEP boundaries may allow businesses to become more engaged. However, given the linkages, there are good arguments for aligning with *spatial planning authority* coverage where possible, as the local area energy plan would become an additional dimension to the local plan.

5.6 The Energy Company Obligation

The ECO is the government's flagship energy efficiency programme, covering Great Britain. Between 2017 and 2022, the ECO requires energy companies to make or fund £640 million annual investments in energy efficiency. The current scheme is transitional and extends to September 2018. A consultation on a longer-term scheme running through to 2022 is expected.

In this latest version of the ECO scheme, there is a much greater focus on heat and fuel poverty[82]. The Affordable warmth Obligation has been increased as a proportion of the overall scheme from around 36% to 70% of estimated supplier spend. The remaining 30%, the Carbon Emissions

[80] Ministry of Housing, Local Government and Communities, Local government structure and elections, as at 27 April 2018. In Wales the are 22 and in Scotland 32 unitary local authorities, but with significant responsibilities resting with the devolved administrations. https://www.gov.uk/guidance/local-government-structure-and-elections
[81] Local Enterprise Partnerships. Accessed 27 April 2018 https://www.lepnetwork.net/growth-hubs/
[82] Help to heat consultation: government response, 29 June 2016 https://www.gov.uk/government/consultations/energy-company-obligation-eco-help-to-heat

Reduction Obligation (CERO), focuses on hard-to-treat homes, for example through funding solid wall insulation and hard-to-treat cavity wall insulation, and rural homes.

Eligibility criteria have been simplified and better targeted on fuel poor households. Local authorities also have a role determining eligible households under the new 'flexible eligibility' mechanism[83]. Participating local authorities will have to ensure these are households in private tenure living either in fuel poverty or living on a low income and who are particularly vulnerable to the effects of living in the cold. Suppliers will be able to use this voluntarily for up to 10% of their Affordable Warmth obligation. Local area energy planning could provide a basis for participation in the eligibility mechanism by identifying which households might be vulnerable and what could be done to improve their energy performance. Local area energy planning could also provide a rationale for better defining the eligibility criteria in the next version of the ECO.

5.7 Network price controls and role of network operators

The operators of gas and electricity distribution networks have a potentially significant role to play in local area energy planning. The new price control process, RIIO-2, stresses 'whole system outcomes'[84].

> *The energy transition will necessitate changes in how the system operates, how the network is developed, and how users interact with energy. It is also likely to shift where investment is needed on the network and, additionally, blur the boundaries between traditionally distinct sectors (e.g. transmission and distribution networks). Given we expect this transition to require significant network development and ongoing investment, it will be important to ensure that the energy system as a whole is effectively coordinated to deliver best value for consumers ('whole system outcomes').*

The case for local area energy planning emerges from Ofgem's recognition that whole-system outcomes should be pursued where these are in the consumers' interest.

> *The price control should not create unnecessary barriers to whole system outcomes, and should actively facilitate these outcomes where this is in consumers' interests. There may exist coordination failures or spill over effects between parts of the energy system, linked to structural features of the current price control, or potentially the regulatory or statutory framework. This may lead to companies either not being incentivised, or not able to deliver optimised solutions, which are lowest cost for the system as a whole.*

The purpose of local area energy planning is exactly aligned with this imperative – to identify the consumers' interest in whole-system outcomes at the local level.

[83] Department of Business, Energy & Industrial Strategy, Energy Company Obligation (ECO): Help to Heat scheme - flexible eligibility, Guidance for local authorities on engaging with energy suppliers to identify households that would benefit from energy efficiency improvements, 11 April 2017.
https://www.gov.uk/government/publications/energy-company-obligation-eco-help-to-heat-scheme-flexible-eligibility
[84] Ofgem, RIIO-2 framework consultation. 7 March 2018. RIIO is the price control framework used to finance network development paid for through consumers' bills. RIIO stands for (Revenue = Incentives + Innovation + Outputs)
https://www.ofgem.gov.uk/publications-and-updates/riio-2-framework-consultation

6 Decisions for government

This section considers the options available to governments to stimulate and enable UK-wide uptake of local area energy planning as a means of implementing the Clean Growth Strategy and the equivalents in Scotland and Wales.

6.1 High level approach

There are broadly three options:

1. Do not pursue a whole-system approach as part of the implementation of the Clean Growth Strategy at the national level – allow local government and network operators to take the initiative as they see fit and let good practice spread informally.
2. Encourage and facilitate, but do not require, local government to undertake local area energy planning and provide central resources to offer specialist advice and to develop and disseminate good practice, establishing a cohort of leaders and body of expertise.
3. Require local government to undertake local area energy planning as part of a national effort to deliver the Clean Growth Strategy and fifth carbon budget.

The Energy Systems Catapult and the Energy Technologies Institute favour an evolutionary approach, with the initial emphasis on encouragement and facilitation and, if the case is compelling, moving to an obligatory approach in the mid-2020s.

6.2 Recommendations

Recommendation 1. *Rationalise planning system commitments to addressing climate change mitigation by taking a holistic whole-system approach to local area energy planning as a component of the Local Plan*.

This would involve rationalising the various commitments to decarbonisation and climate change mitigation made in key planning documents into a coherent local area energy plan, taking account of spatial planning, building energy performance and energy network investment. The process itself will realise significant benefits – better data and understanding of baseline conditions, improved stakeholder awareness of decarbonisation and the choice it involves and possibilities of ‘quick wins’.

Recommendation 2. *Create a new function within government to drive, support and co-fund whole-system local area energy planning and evaluate options for decentralising to regional energy hubs*.

This would build on the energy master planning experience of the Heat Network Delivery Unit, to support a whole-system approach, allowing consideration of wider heat and power infrastructure in tandem with building retrofit requirements to decarbonise. This could also become a co-ordinating point for multiple local energy initiatives, aiming to bring coherence based on whole-system local area energy planning. The option to have regionalised hubs based on Regional or Local Enterprise Partnership areas could develop this into a partially decentralised function.

Recommendation 3. *Energy network companies should actively participate in local area energy planning as part of their obligation to take a whole-system approach under the RIIO-2 framework*[85].

This would be one way the network companies could demonstrate they are taking a whole-system optimising approach and engaging with consumers. Ofgem could require the companies to support local area energy planning or demonstrate that they are meeting the obligation to take a whole-system approach in some other way.

Recommendation 4. *Align delivery of Energy Company Obligation and housing retrofit programmes with local area energy planning*.

Local authorities could play a more significant role in targeting Energy Company Obligation spending and assessing eligibility in the next phase of the scheme (from October 2018), especially if they adopt a local area energy plan with energy company participation. The delivery of energy investments under the Energy Company Obligation should fit into a whole-system plan, with targeting of the highest value investments. One option could be to allow companies to offset the cost of local energy planning against their obligations under the Energy Company Obligation obligations, or to broaden the obligations to include costs of participating in local area energy planning.

Recommendation 5. *Undertake national-level analysis and consolidation of insights from local area energy planning to build up a knowledge base to ensure local action aligns with and informs national strategy*.

This recommendation aims to exploit the aggregation of knowledge that can be drawn from multiple local area energy plans, ensuring that common themes are recognised, common errors identified, best practice shared and that a national picture can be developed from 'bottom up' insights'.

Recommendation 6. *Support and publish data gathering standards and requirements*.

The government should commission guidance on the appropriate data needed adequately to characterise a local area for the purpose of local area energy planning, with signposting to existing datasets and proposal for any changes needed to household surveys.

[85] Ofgem, What is the RIIO-2 price control? Accessed 28 May 2018. https://www.ofgem.gov.uk/network-regulation-riio-model/network-price-controls-2021-riio-2/what-riio-2-price-control

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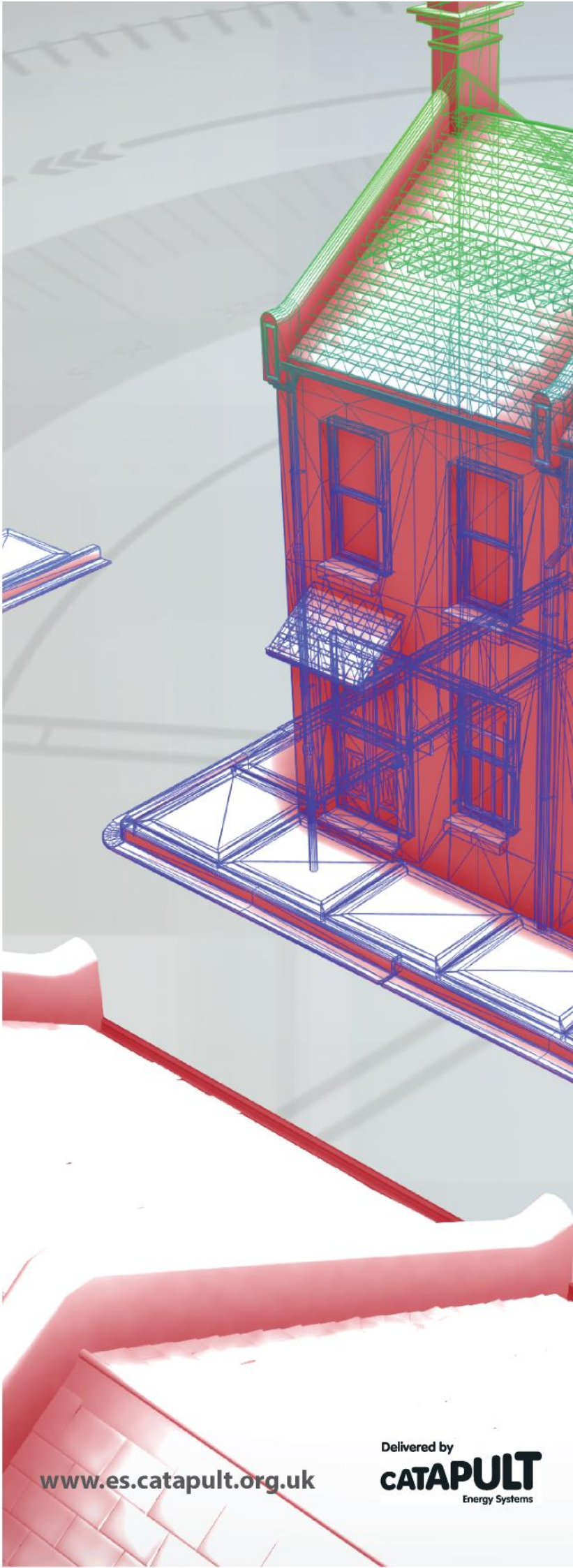
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