Verco

Warm homes, not warm words

Report for WWF-UK on how the UK can move to a low carbon heat system

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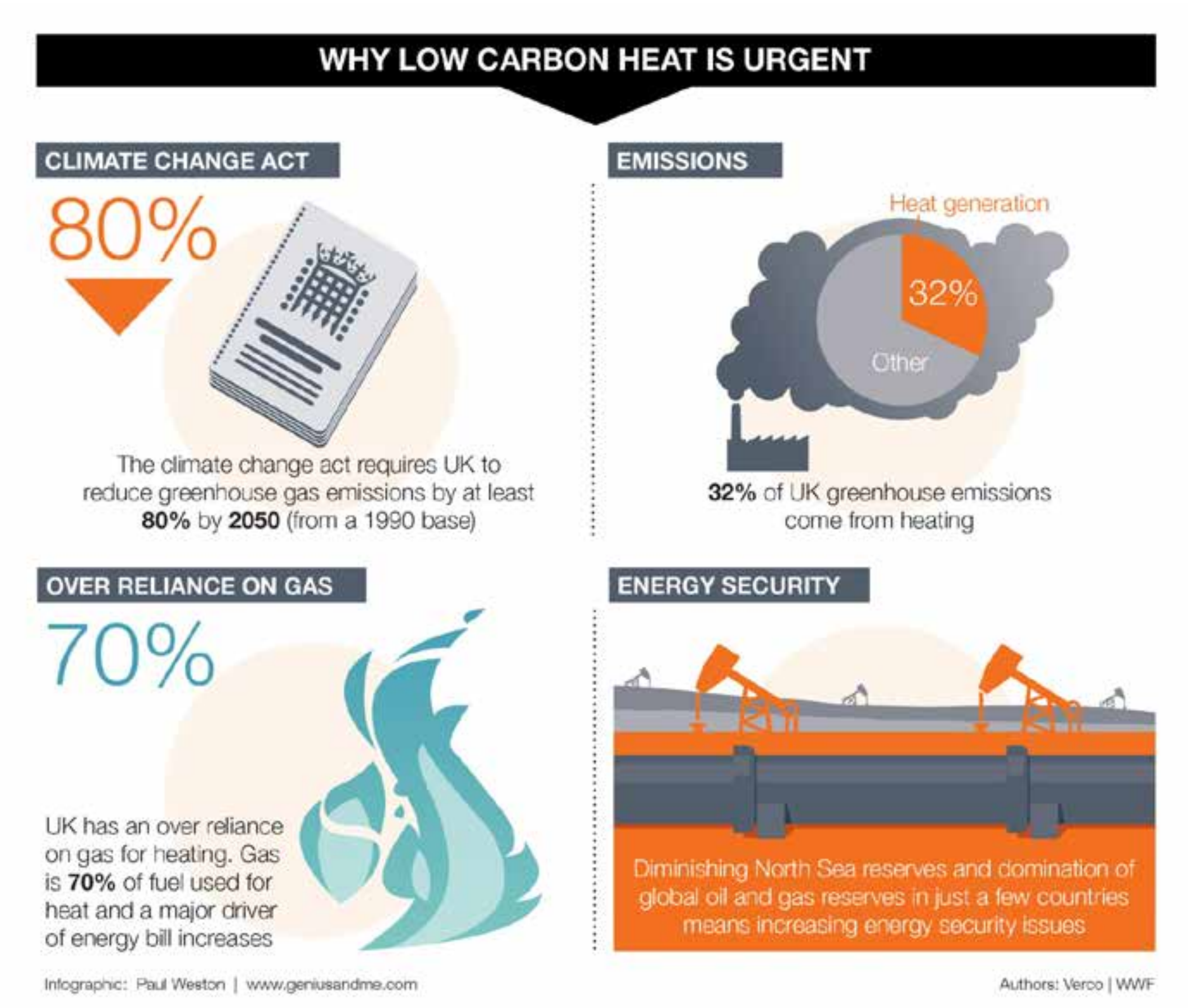
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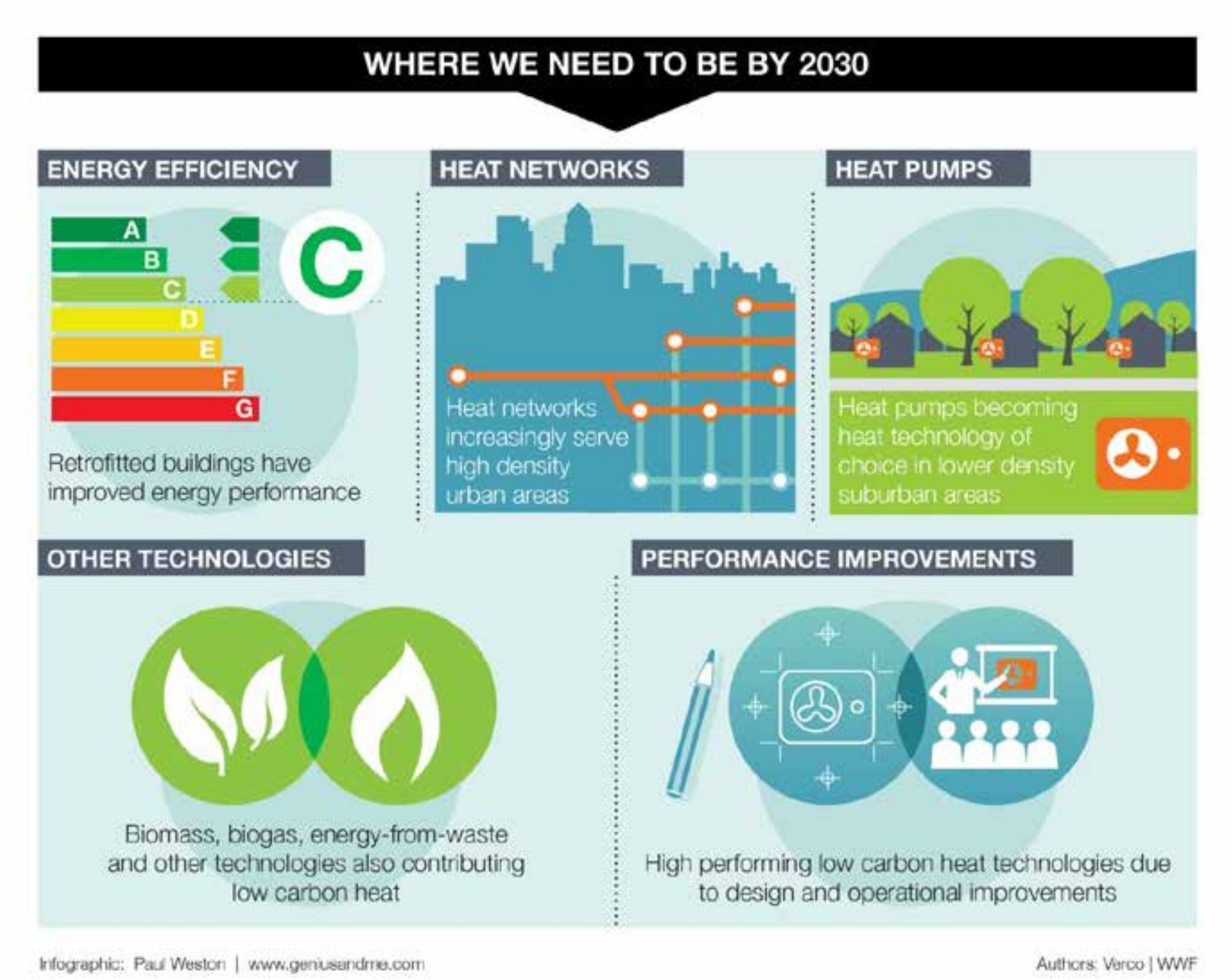
Infographic: Paul Weston | www.geniusandme.com
Authors: Verco | WWF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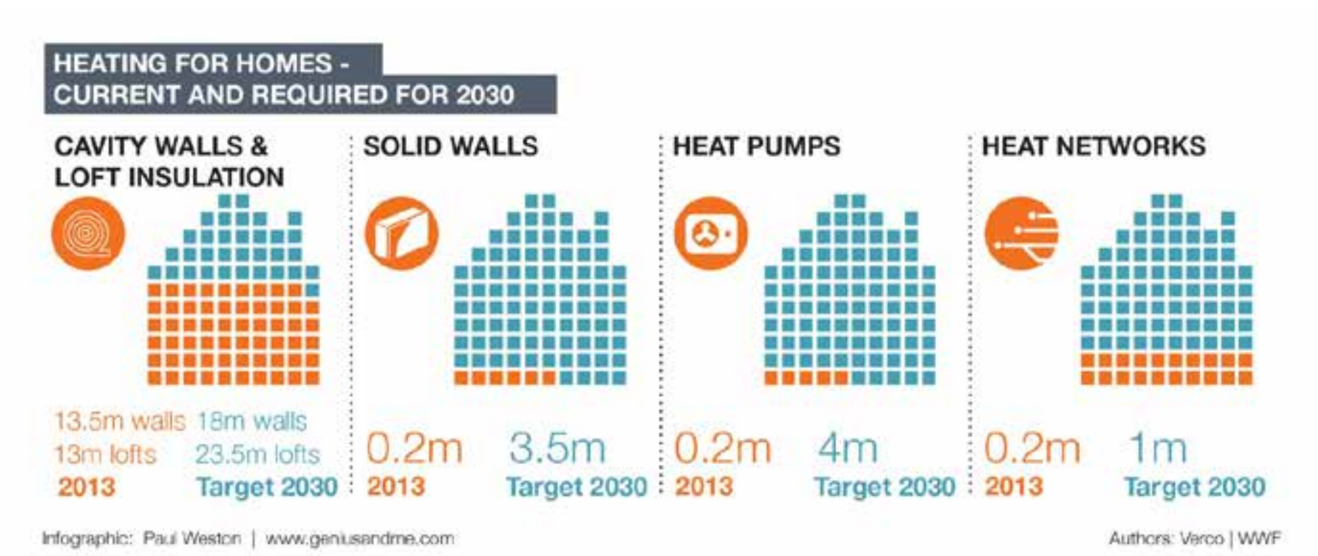
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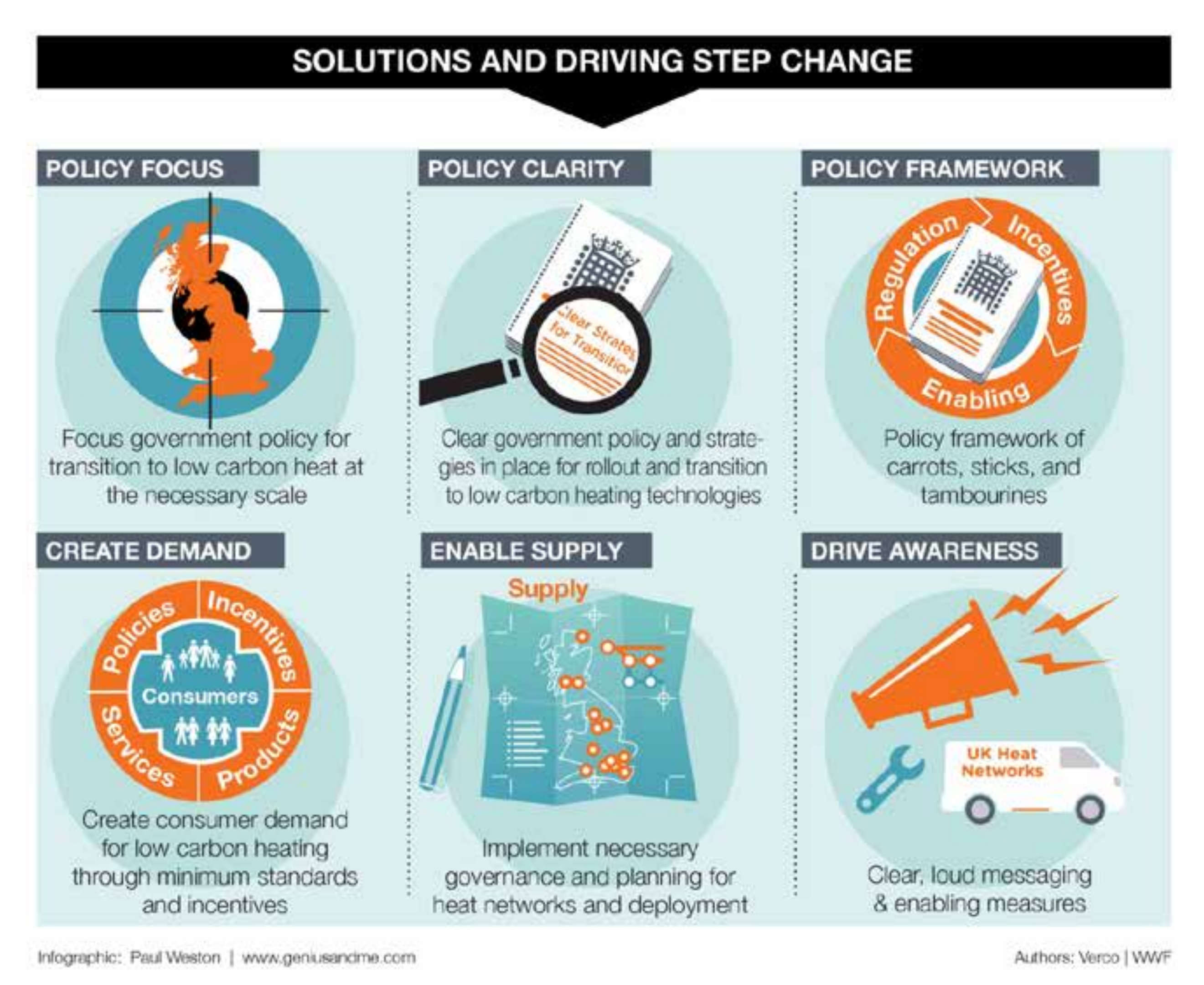
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Executive Summary

The transition to a low carbon heat system is urgent

The Climate Change Act requires the UK to reduce greenhouse gas emissions by at least 80% by 2050 compared to 1990 levels to play its part in preventing the worst impacts of climate change. The rapid reduction of emissions from energy production and use is critical in achieving this objective. To date, the debate around climate change and energy in the UK has mainly centred on the generation of electricity, with less attention paid to the provision of heat. Yet, **with 32% of UK greenhouse gas emissions coming from heat-related activities[1], significantly reducing the share of natural gas in the provision of heat and rapidly rolling out low carbon heating technologies will be core to the UK's efforts to meet its commitment under the Climate Change Act**.

The need to reduce carbon emissions isn't the only issue necessitating change in the way the UK heats its buildings. Rising energy costs, and in particular rising heating costs, are putting a strain on household expenditure with energy constituting a core element of rising living costs. **Fossil fuel costs, and subsequently heating costs, are set to continue to rise over future years.** Energy security concerns are also a key political issue with UK dependence on gas carrying risks of over-reliance on gas imports in the near future, with a small number of countries beginning to dominate global gas reserves. Meanwhile, analysis of UK shale gas resources suggests that they are unlikely to have a material impact on the levels of gas imports coming into the UK and the price of gas in the UK[2][3].

With these issues in mind, WWF-UK commissioned Verco, with the support of an industry wide working group, to review (i) what the UK's low carbon heating goals should be out to 2030, (ii) how the UK is currently fairing towards meeting these goals and (iii) what needs to be done to put the UK firmly on track to have the affordable and low carbon heating system it urgently needs. **This project has considered the provision of space heating and hot water for buildings, and does not cover industrial process heat.**

The UK has a poorly insulated building stock and is currently over-reliant on gas heating

Heat is the main energy demand in the UK constituting 44% of all end-use energy consumption[4][5]. Gas is the main heating fuel with 70% of heat currently coming from natural gas, although electricity and oil

[1] DECC, 2012, Emissions from Heat: Statistical Summary
[2] House of Commons Energy and Climate Change Committee, May 2011, Shale Gas - Fifth Report of Session 2010–12
[3] House of Commons Energy and Climate Change Committee, April 2013, The Impact of Shale Gas on Energy Markets - Seventh Report of Session 2012–13
[4] DECC, 2013, The Future of Heating: Meeting the Challenge
[5] This project considers the provision of space heating and hot water for buildings, and does not cover industrial process heat. However the UK energy consumption figures presented include energy used for industrial process heat which requires different technical solutions to space heating and water heating. Industrial process heat accounts for approximately a quarter of the energy used for heating (with space and water heating accounting for three quarters) – Energy Consumption in the UK, DECC 2013 (ECUK).

also have key roles providing 15% and 7% respectively[6]. The gas network is therefore effectively the primary national infrastructure underpinning our current heat system.

Whilst energy efficiency measures are not heating technologies, they do have a direct impact on the heat demand of buildings and are a key solution in decarbonising heat. **The thermal performance of the UK building stock is still relatively poor, requiring a significant injection of heat to provide an adequate temperature, and there is still substantial scope for installing both basic and advanced energy efficiency measures**. A recent study[7] ranked the UK 11th out of 15 European countries in terms of housing energy performance and the UK had the highest percentage of households in fuel poverty out of the fifteen countries assessed. Set within the context of low carbon heat is the serious issue of fuel poverty and the difficulty faced by many UK householders in keeping their homes adequately warm. Fuel poverty levels are currently on the increase (due to pressures on household income, growing levels of inequality and increasing energy prices) with the number of fuel poor UK households expected to rise from 6.4 million in 2012 to 9.1million by 2016[8]. **Energy efficiency is therefore essential in the transition to low carbon heat to ensure that heating costs are controlled**.

A significant move away from gas and towards low-carbon technologies is urgently needed to meet the Fourth Carbon Budget

The UK Government's low carbon heat strategy[9] does not prescribe clear targets for different low carbon heat technologies[10] but it does suggest the following general direction for 2030: energy efficiency and behavioural change should continue to reduce demand for heat, heat networks should be rolled out in high density urban areas and heat pumps should be installed in low density rural areas (with biomass, solar water heating and other technologies playing a supporting role[11]). Whilst the Government's heat strategy indicates this general direction for heat, it does not commit to delivering this combination of solutions and merely states that modelling suggests this could be a possible cost effective approach. Consequently **Government does not provide clear volume targets for policy or a detailed overview of the numbers of buildings that should be supplied by different low carbon heat technologies by 2030**.

Clearly there are a number of alternative ways of meeting the UK's heating needs in 2030 with a range of possible different combinations of low carbon heat technologies. The precise technology mix that is most technically and economically desirable in 2030 depends upon a number of factors including the maturity of the technologies, their carbon performance, their cost and their ease of implementation. These factors will also be in a constant state of flux between now and 2030. However, the *Fourth Carbon Budget Review* published by the Committee on Climate Change (CCC)

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[6] DECC, 2012, The Future of Heating: A Strategic Framework for Low Carbon Heating in the UK
[7] Energy Bill Revolution, *Fact-file: The Cold Man of Europe*, March 2013
[8] Camco, *Energy Bill Revolution Campaign Report*, February 2012
[9] DECC, 2013, The Future of Heating: Meeting the Challenge
[10] The definition of low carbon heat adopted for this project is any technology or system that has a lower carbon intensity than conventional heating approaches
[11] The Future of Heating outlines the potentially important role of hybrid gas boilers and heat pump systems in facilitating the transition to heat pumps, and also the role of gas absorption heat pumps in addition to electric heat pumps. Biogas injected into the gas grid also has significant potential.

in December 2013[12] is underpinned by a scenario for low carbon heat which provides a good basis for evaluating the roles of different low carbon heat technologies in meeting the Fourth Carbon Budget. **The CCC scenario suggests that low carbon heat could cost-effectively provide 25% of domestic heating demand and 63% of non-domestic heating demand by 2030[13].** These low carbon heat penetration rates are delivered through a combination of energy efficiency improvements and the large scale installation of low carbon heat technologies across the UK building stock. Heat pumps are the key solution in the scenario and provide approximately half the low carbon heat required across both the domestic and non-domestic sectors, with biogas and heat networks also playing major roles. Converting the modelled heat outputs for each of these technologies into numbers of buildings supplied with heat, suggests that **4 million homes would have heat pumps, 300,000 homes would have biomass boilers and approximately one million homes would be connected to low carbon heat networks**[14].

The CCC modelling uses a social discount rate of 3.5% in line with Treasury Green Book rules to evaluate cost effectiveness (and subsequent uptake) of the various low carbon heat technologies between now and 2030. However, when a higher private discount rate is applied to their modelling[15] they find that the potential uptake of low carbon heat drops-away substantially with a resulting fall in carbon reductions from the buildings sector with serious implications for the Fourth Carbon Budget. **This demonstrates the need for Government to design a policy framework that ensures building owners apply low discount rates in their decision-making for low carbon heat investment, such as by de-risking investment in low carbon heat infrastructure and driving householder demand for low carbon heat.** In addition, if future carbon prices are lower than those projected by DECC (and hence comparison with higher carbon conventional heating systems less favourable) then the potential uptake of low carbon heat will also be correspondingly lower than the scenario suggests is possible.

A recent UK Energy Research Centre report[16] also considered options for low carbon heat for 2030 and came to the conclusion that although energy efficiency, heat pumps and heat networks (with a low-carbon heat source) are likely to be the main solutions, it is not possible to accurately quantify their contributions in 2030 due to a range of uncertainties about their technical performance and deployment issues. UKERC's main conclusion is that **although a number of uncertainties remain to be resolved, it is clear that natural gas dependence needs to be reduced, and these key options for replacing gas need to be demonstrated, evaluated and deployed immediately**.

Nonetheless, the CCC's scenario represents a robust assessment of the potential contributions from the key technologies and provides an appropriate mix of low carbon heat technologies for 2030 for guiding policy. The CCC scenario demonstrates that **a step change is needed in the roll-out of energy efficiency, heat networks and heat pumps over the next fifteen years** in order to meet the Fourth Carbon Budget.

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[12] Committee on Climate Change, Fourth Carbon Budget Review – technical report, December 2013: http://www.theccc.org.uk/wp-content/uploads/2013/12/1785b-CCC_TechRep_Singles_Book_1.pdf
[13] The CCC use scenarios to inform their carbon budget analysis and these scenarios are not intended to be prescriptive but to provide a basis for assessing carbon abatement potential and costs. Within the scenarios cost-effectiveness of measures is judged by reference to DECC carbon price projections.
[14] Analysis carried out by Verco using the CCC scenario heat output numbers
[15] The CCC tested sensitivity to a private discount rate of 12% for commercial and public sector buildings and of 16% for housing
[16] UK Energy Research Centre, UK Energy Strategies Under Uncertainty: Synthesis Report, April 2014

Government policy must focus on improving the performance of low carbon heat technologies

The **large scale roll-out of heat pumps and low-carbon heat networks will need to be accompanied by improvements in their technical performance in order to guarantee the level of carbon savings expected**. In addition to a continued drive for technical improvements, industry practice will need to ensure high quality and appropriate installations. Buildings need to be highly energy efficient before heat pumps are installed and the building occupants need to understand how to operate the low temperature heating system. **Successful decarbonisation of the electricity grid over the next few decades is also essential for ensuring that heat pumps have the capability to generate low carbon heat.** The current grid electricity carbon factor is 490gCO_2 per kWh[17] whereas the 2030 grid electricity carbon factor assumed in the CCC (central scenario) modelling is 50 to 100g of CO_2 per kWh[18]. If the electricity grid does not decarbonise in line with this projection then heat pumps will deliver lower carbon savings.

Heat networks are essentially a (heat) energy distribution technology which can facilitate utilisation of a large number of alternative heat sources as any number of heat sources can be fed into a heat network. They also enable large point sources of heat to be used for heating buildings, such as waste heat from thermal power plant or industrial plant using process heat, energy-from-waste plant and combined heat and power plant. Once heat network infrastructure is in place, it can also potentially facilitate a highly flexible approach to the supply of low carbon heat; a relatively small number of large scale low carbon heat sources can be built to supply a heat network as opposed to the need to replace heating installations in every individual building. However, heat networks will only deliver carbon reductions as long as low carbon heat sources are adequately developed alongside the development of heat network infrastructure itself. **Low carbon heat generation plant will need to be successfully incentivised to ensure that future (and existing) heat networks are adequately fed with low carbon heat.** The design and management of heat networks will also need to maximise system efficiency so as to maximise carbon reductions.

The deployment of low carbon heat is currently at low levels and must urgently be ramped up

The current penetration of low carbon heat technologies is at very low levels compared with the scale of deployment in the CCC low carbon heat scenario for 2030. The scale of the infrastructure challenge is huge and it is estimated that one home retrofit per minute is required between now and 2050 to achieve our carbon reduction targets (due to the need to improve the energy performance of the majority of the housing stock).[19]

The following activity is required between now and 2030 to deliver the CCC scenario:

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[17] DEFRA, 2014, Government conversion factors for company reporting (http://www.ukconversionfactorscarbonsmart.co.uk/)
[18] The CCC modelling used DECC's electricity decarbonisation scenarios to identify electricity carbon factors for 2030
[19] Energy Saving Trust and Centre for Low Carbon Futures, *The Retrofit Challenge: Delivering Low Carbon Buildings*, 2011 – this primarily refers to energy efficiency improvements but it also includes low carbon heat technologies where appropriate

- 4.5 million cavity walls and 10.3 million lofts need to be insulated[20]
- 3.3 million solid walls need to be insulated (only ~200,000 solid walls are currently insulated and the CCC scenario has 3.5 million insulated solid walls which equates to almost 50% of the total number of UK solid walled properties)
- The heat network deployment rate will need to increase 32 fold (with 25,000 homes being connected to heat networks over the past 13 years and a need for 800,000 new connections over next 15 years)
- 4.2 million heat pumps need to be installed (the estimated ~400,000 heat pumps currently installed in homes and non-domestic buildings is some way off the 4.6 million in the CCC scenario[21])

Some key challenges to the delivery of low carbon heat must be addressed

Three priority challenges affect the deployment of low carbon heat:

- **Lack of Government policy focus to drive low carbon heat deployment at the necessary scale**
    - energy policy has traditionally focused on electricity rather than heat (whilst recognising the positive impact of the Supplier Obligation in improving energy efficiency in housing through loft and cavity wall insulation)
    - the market for low carbon heat is yet to receive a policy equivalent to the scale and focus delivered by the Renewables Obligation or the Electricity Market Reform
    - the current policy framework is yet to provide market certainty for investment in low carbon heat, with policies such as ECO being subject to constant change and review
    - The Future of Heating does not address the scale and magnitude of what is required, and relies too heavily on the RHI to drive the transition to low carbon heating
    - the mutually exclusive nature of the main technical solutions for low carbon heat needs to be recognised. In areas that are targeted for heat networks it will be essential to ensure that the majority of buildings connect to the network so that the infrastructure is cost-effective and efficiently used (and the expected levels of carbon savings are delivered). Investment in building-integrated low carbon heat technologies, such as heat pumps, will therefore need to be limited in high density urban areas.

[20] This includes all the remaining uninsulated cavity walls, lofts and loft top-ups. The majority of remaining cavities are hard-to-treat and the majority of remaining loft insulation opportunities are loft top-ups.
[21] The estimate of 4.6 million buildings requiring heat pumps consists of CCC's stated 4 million homes combined with Verco's estimate of 600,000 non-domestic buildings based on CCC's heat output numbers

- **Lack of consumer demand for low carbon heat technologies**

Consumer awareness of low carbon technologies is undeveloped and there is very low consumer demand for energy efficiency and low carbon heat. Current policy is failing to address the following issues which underlie the poor consumer demand for low carbon heat:

  - High upfront capital costs which are prohibitive for many consumers
  - Significant hassle factors associated with undertaking retrofit work
  - Long payback periods (even when supported by Green Deal and RHI)
  - Lack of confidence in new heating systems and the fact that gas boilers are considered by consumers to be reliable and effective
  - Replacement of heating is often a stressed purchase (as a resultant of breakdown) and people typically opt for direct replacement

- **Lack of governance and planning for heat network deployment**

  The construction of heat networks at the scale envisaged constitutes a huge, long term infrastructure project but it is currently lacking an adequate governance structure. Key barriers to heat networks that are not currently addressed include:

  - Lack of local authority resource to instigate schemes – local authorities are currently coping with substantial budget cuts and are not able to allocate adequate levels of officer expertise to enable them to instigate and deliver heat networks
  - Reliability of customer heat demand – it is extremely difficult for heat network developers to guarantee heat sales when seeking to finance heat networks
  - Reliable heat sources – it can be difficult for heat network developers/ owners to purchase guaranteed reliable low carbon heat supplies
  - Financing to cover the upfront capital cost – the construction of heat networks requires low cost capital which is not readily available to private developers of heat networks
  - Customer scepticism of the technology – the public's awareness of heat networks is very low and often based upon limited experience of older systems that were difficult to control

It's time to drive a step change in the provision of low carbon heat

Driving a step change in the provision of low carbon heat requires the following key actions:

- **Improving understanding of the low carbon heat transition** – ensuring that central government, local government, policy-makers, building managers and investors, householders and businesses all have complementary goals for low carbon heat is an essential prerequisite to developing a coherent and focused policy framework that can drive deployment at the necessary scale. This will require:
  - Government to demonstrate vision and leadership on low carbon heat with a clear timeline for action

  - Industry and the public to be made aware of the goals for low carbon heat and the key actions in getting there
  - A strategy that adequately deals with the mutually exclusive nature of the main technical solutions and in particular the need to ensure that in those areas which are targeted for heat networks there is limited investment in alternative building-integrated low carbon heat technologies (such as heat pumps).

- **Driving action on low carbon heat –** the lack of consumer demand for energy efficiency and low carbon heating is severely hampering the ability of policy incentives such as the RHI to drive the uptake of low carbon heat technologies. There is an **urgent need for a 'carrots, sticks and tambourines' approach to heat policy that provides a combination of regulation, incentives and awareness raising** that will ensure the necessary movement in the market[22]. This will require:
  - Government to adopt a comprehensive policy framework that both requires and encourages the uptake of low carbon heat technologies (through a package of 'carrots, sticks and tambourines')
  - Integration of energy efficiency and low carbon heat policy to drive an holistic approach to low carbon retrofit and ensure that the most appropriate heat technology is installed in any specific building
  - Legislation that sets a timeline for mandatory improvements in energy efficiency and low carbon heating (with long lead-in times to complement investment cycles and enable building owners to respond)
  - Certain sectors, such as social housing, to act as early movers in retrofit activity to demonstrate what is possible and to kick-start the low carbon heating industry

- **Establishing a much stronger approach to delivering low carbon heat networks** - connecting just under a million homes to heat networks over the next fifteen years is a massive infrastructure project which needs clear governance and planning to make it happen. **Government needs to provide:**
  - **Strong leadership so there is a coherent plan for heat networks** to develop in a way that support meeting the UK's carbon budgets, including the introduction of low carbon heat sources
  - **Appropriate ownership and governance structures to ensure rapid delivery** of quality networks at scale that will deliver long term value to investors and customers: the roll-out of heat networks should learn from the delivery of other infrastructure projects such as the Olympics, High Speed Rail and land regeneration through the Homes and Communities Agency
  - **Greater project development resources** commensurate with the scale of the challenge: the recently formed Heat Networks Delivery Unit (HNDU) has been given £7million to allocate as development funding over 2014 and 2015 which is a fraction of

[22] Zero Carbon Homes is a good example of a carrots, sticks and tambourines policy framework. The Zero Carbon Homes policy has been effective in setting a fixed long term timeline for mandatory improvements in the carbon performance of new homes (embedded within the Building Regulations), supported by high levels of awareness and a programme of enabling analysis and industry support led through the Zero Carbon Hub.

the level of funding allocated to high profile infrastructure projects such as the Olympics (for example, £6.7 billion was made available to the Olympic Delivery Authority[23])

- **Low cost finance that leverages equity and debt funding** from public and private sources including EIB, GIB, banks, funds and private investors: it can be difficult to finance the construction of heat networks due to the high upfront capital costs and the risks of guaranteeing a customer base. The Government should help schemes obtain finance through mechanisms that alleviate this financing risk such as grants, equity and guarantee funds
- **Mechanisms that regulate building owners to connect to heat networks** that ensure locally appropriate connections with adequate industry safeguards to protect customers from high prices or poor service.

[23] Olympic Delivery Authority, Annual Report and Accounts 2012–13

Glossary

ASHP	Air Source Heat pump
ASHP ATA	Air to Air (Air Source Heat Pump)
ASHP ATW	Air to Water (Air Source Heat Pump)
CCC	Committee on Climate Change
CCL	Climate Change Levy
CHP	Combined Heat and Power
CoP	Coefficient of Performance
CRC	Carbon Reduction Commitment
DECC	Department of Energy and Climate Change
ECA	Enhanced Capital Allowances
ECO	Energy Company Obligation
EIB	European Investment Bank
EMR	Electricity Market Reform
EPC	Energy Performance Certificate
FiT	Feed-In Tariff
GIB	Green Investment Bank
GSHP	Ground Source Heat Pump
HNDU	Heat Network Delivery Unit
HTT	Hard-to-treat (cavity wall)
ICT	Information and Communications Technology
LPG	Liquefied Petroleum Gas
PV	Photovoltaics
RHI	Renewable Heat Incentive
SAP	Standard Assessment Procedure
SPF	Seasonal Performance Factor

SWI	Solid Wall Insulation
TRV	Thermostatic Radiator Valve
UKGBC	UK Green Building Council

1. Introduction

1.1 Objectives of the project

The Climate Change Act requires the UK to reduce greenhouse gas emissions by at least 80% by 2050 compared to 1990 levels to play its part in preventing the worst impacts of climate change. As 32% of UK greenhouse gas emissions come from heat-related activities[24], the roll-out of low carbon heating will be core to the UK's efforts to meet its commitment under the Climate Change Act. WWF-UK appointed Verco in December 2013 to deliver a Low Carbon Heat project that undertakes a high level review of low carbon heat solutions for the UK building stock and how best to deliver them. The project has evaluated low carbon heating goals for 2030 as a key interim date in the delivery of the 2050 carbon target, with a focus on how to deliver reliable and affordable heating whilst meeting the requirements of the Climate Change Act. This project has considered the provision of space heating and hot water for buildings, and does not cover industrial process heat. The definition of low carbon heat adopted for this project is any technology or system that has a lower carbon intensity than conventional heating approaches.

A core element of the project has been the establishment of a Low Carbon Heat Roundtable formed of a wide range of stakeholder experts to review the key options for a low carbon heating system, identify delivery challenges, and suggest potential delivery solutions. The Roundtable met twice during February and April 2014.

This report presents the findings of the analysis, which has been informed by the Roundtable's discussions, and presents conclusions on the key actions for decarbonising heat in the UK.

1.2 Approach to the project

In undertaking a high level review of the current heat system and of the low carbon solutions needed to drive carbon emissions in the heat sector, we have proceeded through the following steps:

- assembled a well-known group of experts to enable a co-production process of critical evaluation
- looked at the scale of the challenge for decarbonising heat
- critically assessed where we are currently
- questioned and tested whether the existing policies are likely to get us to where we need to be (evaluation of current policies and progress towards low carbon heat)
- come up with a priority set of ideas for further examination and development
- identified priority actions and high level policy recommendations which form a vision of what is required.

This approach has helped highlight where there are gaps in the policy framework, identified priority areas for action and provided initial ideas for policy solutions.

A key element of the approach has been the use of the scenario analysis that the Committee on Climate Change (CCC) has carried out to inform their Fourth Carbon Budget analysis. The CCC central scenario for buildings presents a mix of energy efficiency and heat technologies that would

[24] DECC, 2012, Emissions from Heat: Statistical Summary

achieve the requirements of the Fourth Carbon Budget. This CCC low carbon heat scenario provides an excellent basis for considering a 2030 goal for heat and the issues involved in delivering low carbon heat.

1.3 Structure of the low carbon heat roundtable

The low carbon heat roundtable was made up of a cross section of stakeholder experts from the energy industry, housing, property management, academia and the policy community as outlined in Table 1-1.

Table 1-1: Low Carbon Heat Roundtable membership

Name	Organisation
Jenny Hill	Committee on Climate Change
Ute Collier	Committee on Climate Change
Jenny Holland	Association for the Conservation of Energy
Doug Parr	Greenpeace UK
Keith Maclean	Scottish and Southern Energy
Rupert Fausset	Forum for the Future
Francis Li	UCL Energy Institute
Ben Coombes	Affinity Sutton
Peter North	Greater London Authority (GLA)
Louise Strong	Which?
Liz Lainé	Consumer Futures now Citizens Advice
Nick Eyre	Environmental Change Institute, Oxford University
Rebecca Beeson	Quintain Estates and Development
Kirsty Rice	National Trust
Nick Molho	WWF UK
Zoe Leader	WWF UK

The roundtable met twice during February 2014 and April 2014. The roundtable events were conducted as Chatham House style open discussion fora, within a structured framework. The first roundtable event looked at how heat is currently provided across the UK and considered a suitable vision for 2030 that can provide a key stepping point between now and 2050. The workshop used the Committee on Climate Change's (CCC) 2030 central scenario of low carbon heat as a springboard for discussion and identified the key challenges to the delivery of low carbon heat.

The second roundtable event considered the impact of current low carbon heat policy, progress towards the 2030 goals and considered policy solutions for delivering low carbon heat at the necessary scale.

2. How heating is currently provided in the UK

2.1 How we currently heat our buildings

Heat[25] constitutes the main energy demand in the UK with 44% of all end-use energy consumption being used for heat[26]. Transport in comparison accounts for 41% of energy use. Gas is the main heating fuel with 70% of heat currently coming from natural gas, although electricity and oil also have key roles providing 15% and 7% respectively[27]. The gas network is therefore effectively the primary national infrastructure underpinning our current heat system.

The thermal performance of our building stock and its ability to keep us adequately warm is key to the consideration of low carbon heat. Arguably buildings should be considered the most important component of our heat infrastructure as one of their key purposes is to provide us with a comfortable internal temperature. However, even though the Supplier Obligation[28] has driven substantial investment in loft and cavity wall insulation over the past ten years, the thermal performance of the UK building stock is still relatively poor, requiring a significant injection of heat to provide an adequate temperature. A recent study[29] ranked the UK 11th out of 15 European countries in terms of housing energy performance and the UK had the highest percentage of households in fuel poverty out of the fifteen countries assessed. The Standard Assessment Procedure (SAP) is the Government's approved method for rating the energy performance of homes. The average SAP rating of UK homes is currently 59, which equates to an EPC Band of D, whereas a SAP score of 81 (an EPC Band of B) is needed to future-proof homes against fuel poverty (due to a substantially reduced heat demand).

Whilst energy efficiency measures are not heating technologies, they do have a direct impact on the heat demand of buildings and are a key solution in decarbonising heat. There is still great scope for installing basic measures, such as loft and cavity wall insulation (up to 4.5 million cavity walls and 10.3 million lofts still remain uninsulated[30]). Very few properties have the so-called deeper retrofit measures, such as solid wall insulation, air-tightness measures and floor insulation which can play a big role in reducing heating demand in buildings (only 209,000[31] of the 7.5 million solid walled homes in the UK currently have solid wall insulation).

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[25] This project considers the provision of space heating and hot water, and does not cover industrial process heat. However the UK energy consumption percentages in the paragraph below include energy used for industrial process heat which requires different technical solutions to space heating and water heating. Industrial process heat accounts for approximately a quarter of the energy used for heating (with space and water heating accounting for three quarters) – Energy Consumption in the UK, DECC 2013 (ECUK).

[26] DECC, 2013, The Future of Heating: Meeting the Challenge

[27] DECC, 2012, The Future of Heating: A Strategic Framework for Low Carbon Heating in the UK

[28] The Government's energy efficiency Supplier Obligation has consisted of ECO and the predecessor programmes CERT/ CESP, EEC and EESoP

[29] Energy Bill Revolution, *Fact-file: The Cold Man of Europe*, March 2013

[30] This includes all the remaining uninsulated cavity walls, lofts and loft top-ups. The majority of remaining cavities are hard-to-treat and the majority of remaining loft insulation opportunities are loft top-ups. Data source is the CCC, *Fourth Carbon Budget Review – technical report,* December 2013

[31] DECC, *Estimates of Home Insulation Levels in Great Britain: July 2013*, 2013

2.2 A 'simple guide' to heat in buildings

'Heating' is principally about providing a comfortable internal temperature in our buildings and adequate hot water supplies for our kitchens and bathrooms. The amount of heating that is required for a particular building is determined by a number of factors but size, thermal efficiency and occupant behaviour are the key influences.

There are a number of different ways of providing this relatively simple need for warmth and hot water, and as a result the 'heat system' in the UK has many different components and complexities. Table 2-1 provides a 'simple guide to heat' by outlining the range of different issues and approaches to supplying heat to our building stock.

Table 2-1: 'Simple guide to heat'

Heating system characteristic	Description
Type of heat demand	Heat demand in buildings is split between **space heating and water heating**. Hot water requires higher temperature heat (referred to as higher-grade heat) than space heating which means that some technologies that are suitable for space heating are not suitable for hot water provision (and vice-versa). For example, for electrically heated homes, electric immersion heaters often provide hot water whereas electric storage heaters may provide space heating.
Type of heat customer	Heat needs to be provided to **homes and businesses** (domestic and non-domestic buildings) which have differing characteristics and needs. Domestic space heating is dominated by individual gas boilers, whereas non-domestic space heating has a larger component of electrically provided heating. The timing of heat demand for domestic and non-domestic buildings is also often offset to different times of the day. Homes typically consume heat in the morning and evening, whereas businesses typically consume heat during the day. Buildings in **urban and rural** locations will often have different fuel sources available to them due to the lower density of buildings in rural areas. For example, gas networks are not available in low density rural areas.
Energy sources (heating 'fuels')	The main heating fuels for buildings in the UK are gas, electricity and oil (although electricity isn't actually a fuel or an energy source but an energy carrier). The current breakdown of heat supply is:[32] • **Gas** - 71% (89% of homes are connected to the gas grid) • **Electricity** - 15% • **Oil** - 7% • Other – 7% (includes, LPG, coal[33] & some biomass)
Main heating technologies	• **Gas boilers** are the predominant heating technology in the UK, supplying both space heating and hot water to homes and non-domestic buildings • **Electric heating** is common in flats, commercial buildings and in off

[32] DECC, *Energy consumption in the UK – Overall data table 1.07*, 2012
[33] Approximately 0.5 million homes have LPG or coal heating. Data source: Consumer Focus 2011, Off-gas consumers - Information on households without mains gas heating

	gas grid properties. **43%** of off-gas grid properties have electric heating.[34] Electric heating comes in the form of convection heaters, fan heaters, storage heaters and radiative heaters. Immersion heaters are commonly used for heating hot water. • **Oil boilers** are the main heating technology for large off-gas grid properties, although **LPG gas boilers** are also used • Coal boilers are still used in some locations and biomass boilers (wood chip or pellet) are increasing in use • **Solar water heating** provides a top up hot water supply for many homes
Scale of heating scheme	The majority of heating is provided at the **individual building level.** However a small percentage of homes and non-domestic buildings are connected to **communal heating schemes (also known as district heating)**. Although individual building level technologies, such as gas boilers and electric heating are based in one specific location, supplying heat to one building, they interact with national infrastructure by drawing gas or electricity from the grid. Communal heating schemes connect a number of buildings to a central boiler or other heat source through a pipe network (hot water in insulated pipework). Although most communal heating schemes are relatively small in size, supplying a single block of flats or housing estate, there are some much larger schemes that supply whole neighbourhoods, and some European countries have city-wide schemes.
Different components of our 'heating system'	Most of our heating technologies, such as electric heaters and district heating schemes, are underpinned by a number of different system stages (supplying the end-of-system provision of heat): • **Primary energy source**: For example, coal, natural gas and nuclear provide the main energy sources for our electricity generating plant. District heating networks can be supplied by a range of heating sources including gas, biomass or energy-from-waste. • **Generation**: generation plant can take a number of different forms, even for the same fuel (for example, natural gas can generate electricity in a power-only plant or a Combined Heat and Power (CHP) plant • **Transmission/ distribution**: for example, the electricity grid, the gas grid and heat networks (hot water pipes) • **Final heat supply**: For example, gas boilers, electric heaters and heat exchangers in the home.
'Enabling' technologies	There are a range of supporting technologies, particularly IT based technologies, which enable heat provision in our buildings (and can have a growing role in the future): • **Heating controls (at building level)** – even simple timer and thermostatic controls play a vital role in the provision of heating and thermal comfort. However, internet based controls are now allowing

[34] Consumer Focus, *Off-gas consumers – Technical Annex*, 2011

	people to manage their heating remotely. Non-domestic buildings have highly advanced zonal, timer and thermostatic controls • **ICT and smart controls of electricity demand (demand side response)**: allowing the 'shut-down' of non-priority electricity consuming equipment (such as fridges) at periods of high power demand so that priority needs can be met (e.g. in mornings and evenings) • **Heat, gas and electricity storage**: heat and electricity storage technologies can allow the electricity grid and heat networks to meet peak heating demand periods (by allowing electricity, gas and heat to be stored for peak demand times)

2.3 Significant reliance on gas heating

As outlined above, natural gas is the UK's predominant heating fuel for space heating, water heating, and cooking:[35] Gas provides:

- **80%** of the heat demand for the domestic sector with 89% of homes connected to the gas grid
- **66%** of the heat demand for non-domestic buildings.

The gas grid and gas boilers are therefore well entrenched within the UK's 'heat system', and due to the sunk costs within the gas grid, gas heating constitutes a relatively low cost heating option (when compared to the mainstream alternatives of conventional electric heating, oil, LPG or coal)[36]. Consumers are also accustomed to the highly responsive, easy to use, nature of gas boilers which requires behavioural adjustments when changing to a less responsive low temperature heat pump system.

A step change is therefore required if we are to move heating away from natural gas combustion towards a lower carbon future which is essential to both reduce our over-reliance on gas as well as meet our carbon obligations. The technologies exist for making this transition but a more robust policy framework is required to their drive their uptake.

2.4 Building thermal performance and the growing problem of fuel poverty

Set within the context of low carbon heat is the serious issue of fuel poverty and the difficulty faced by many UK householders in keeping their homes adequately warm. Fuel poverty, and the inability to afford heating bills, is caused by a combination of poor thermal performance, household income and energy prices. Although low household income levels are a key driving factor, the poor energy performance of UK homes is also largely to blame for fuel poverty which illustrates the vital importance of energy efficiency in ensuring 'heat affordability' for UK households (regardless of whether the heat supply is high carbon or low carbon).

[35] DECC, *Energy consumption in the UK – Overall data table 1.07*, 2012
[36] Although the cost of gas has increased substantially over the past ten years, the cost of the fossil fuel alternatives has also increased.

Fuel poverty levels are currently on the increase due to pressure on household income from the recession, growing levels of inequality and increasing energy prices. The number of UK households in fuel poverty is expected to rise from 6.4 million in 2012 to 9.1million by 2016[37]. The transition to low carbon heat will not necessarily reduce heating costs in the short to medium term (although these technologies have the potential to reduce heating costs in the long-term through reducing our exposure to volatile fossil fuel prices) which means that improvements in energy efficiency is essential to the delivery of low carbon heat.

[37] Camco, *Energy Bill Revolution Campaign Report*, February 2012

3. Where do we need to be in 2030?

3.1 What are the key solutions for low carbon heat?

There are a broad range of solutions for low carbon heat spanning primary energy sources, generation technologies, distribution solutions and supply-side infrastructure. The key short term and medium term solutions for low carbon heat provision in buildings include:

- Solar water heating
- Air-source heat pumps
- Ground-source heat pumps
- Hybrid heat pumps
- Gas absorption heat pumps
- Biomass boilers
- Heat networks
- Biogas
- Waste-to-energy (or energy-from-waste) plants

Table 3-1 provides a 'simple guide' to these key low carbon heat technologies.

These heat technologies are supported by a range of other measures and infrastructure that will have a critical role in delivering low carbon heat, including:

- **Energy efficiency improvements**, including low cost measures (such as loft and cavity wall insulation) and higher cost measures (such as solid wall insulation and floor insulation)
- **Smart systems and storage solutions** which enable control and optimisation of low carbon heat infrastructure, particularly heat networks.

Table 3-1: Simple guide to key low carbon heat technologies

Heating technology	Key information	Further description
Solar water heating	**Hot water generated from solar energy.** Solar water heating panels provide supplementary hot water to homes or commercial buildings. They are typically able to provide 50-60% of annual hot water demand and a standard boiler or immersion heater is therefore still needed.	Consideration needs to be given to orientation, tilt and minimising shading from adjoining properties. The cost effectiveness of the system is dependent, among other factors, on the type and efficiency of collectors and the plumbing configuration of the development. There are two main types of solar collectors used for solar water heating systems: evacuated tubes and flat plat collectors. Evacuated tube collectors are more efficient and more costly than flat plate collectors, while un-vented systems (or pressurised hot water systems) are generally more expensive than open vented systems. The technology is highly modular and as such it is easy to design a system to meet a specific hot water load at peak operating conditions.

		
Air-source heat pump	**Heat supplied to buildings by absorbing heat energy from the air outside.** Heat pumps are essentially fridges operating in reverse using the chemical properties of a refrigerant that absorbs heat when it evaporates and then releases heat when it is pressurised (and condenses). They absorb heat from outside the building and supply low grade heat to radiators or underfloor heating systems. An air source heat pump takes heat from the outside air in the same way that a fridge takes heat from its inside. Heat pumps need electricity to run, but the amount of heat supplied is 2 or 3 times greater than the electricity used to run the heat pump.	Heat pumps work best in thermally efficient buildings as they are a low temperature heating system using under-floor heating or oversized radiators. Air-source heat pumps have a lower capital cost than ground-source heat pumps due to not requiring a geological survey, or bore-hole excavation. As electricity is the primary fuel, they are most effective as a carbon saving measure when used as a replacement for other less efficient electrically driven technologies or when replacing high carbon fuels such as oil or LPG. Heat pumps have the potential to be a very low carbon heating source in the future under the Government's projections for a decarbonised electricity grid. Air-source heat pumps are less disruptive to install than their ground-source counterparts. 
Ground-source heat pump	**Heat supplied to buildings by absorbing heat energy from the ground outside.** Heat pumps are essentially fridges operating in reverse using the chemical properties of a refrigerant that absorbs heat when it evaporates and then releases heat when it is pressurised (and condenses). They absorb heat from outside	Prerequisite to the installation of GSHPs is a geological survey. Based on this a length of pipe is buried in the ground, either in a borehole or a horizontal trench. Where sufficient land is available the cheaper option of laying horizontal trenches is possible. Heat pumps work best in thermally efficient buildings as they are a low temperature heating system using under-floor heating or oversized radiators. Ground source heat pumps offer the advantage of a totally concealed system with no visual impact. However, smaller systems are typically not cost effective due to high capital costs. As electricity is the primary fuel, they are most effective as a carbon saving measure when used as a replacement for other less efficient electrically driven technologies or when replacing high carbon fuels such as oil or LPG. Heat pumps have the potential to be a very low carbon heating source in the future under the Government's projections

	the building and supply low grade heat to radiators or underfloor heating systems. Ground source heat pumps are typically more efficient than air source as they take heat from a warmer source, but they are more expensive to install.	for a decarbonised electricity grid. 
Hybrid heat pumps	**A hybrid heat pump system integrates an air-to-water heat pump with another non-renewable** **heat source, such as a condensing gas boiler,** to enable installation in a wider range of circumstances than heat pump only system (and thereby enable a direct replacement for a gas boiler without requiring changes to the radiator system).	A hybrid heat pump system can produce water flow temperatures from 25°C up to 80°C, making it suitable for any type of heat emitter, including underfloor heating and radiators. The heat pump operates for the majority of the time with the gas boiler being called upon during the coldest winter months to provide higher temperature space heating. The gas boiler also contributes to hot water requirements. This combination leads to higher overall efficiencies than those obtained from a heat pump only system (which operates less efficiently when producing high temperature heating). The hybrid system requires a gas boiler and a heat pump which can lead to higher installation costs but it can be possible to use an existing gas boiler which can help reduce the overall installation costs.
Gas absorption heat pumps	**Absorption heat pumps are essentially air-source heat pumps driven not by electricity, but by a heat source such as natural gas, propane, solar-heated water, or geothermal-heated water.**	Although mainly used in industrial or commercial settings, absorption coolers are now commercially available for large residential homes, and absorption heat pumps are under development. Although the coefficient of performance tends to be lower than for electrically driven heat pumps, gas has a lower carbon factor than grid electricity which can bring the efficiency more into line with conventional electric heat pumps.

Waste-to-energy (or energy-from-waste)	**Generating heat (and power) from municipal waste through combustion or an advanced conversion process such as gasification or pyrolysis.**	Energy from waste plants are typically planned on a regional scale in order to benefit from the economy of scale of waste collection and large scale generation plants. They can provide heat to large scale heat networks that distribute heating to a mix of domestic and non-domestic buildings. 
Biomass boiler	**Biomass heating systems are typically fuelled by burning wood pellets, chips or logs to provide warmth in a single room or to power central heating and hot water boilers.**	Biomass boilers use woodchips or pellets. Biomass systems require space for both the boiler and the fuel store (delivered by road). The wood fuel is sourced from energy crops, agricultural arisings, forestry residues or waste wood. Some bioenergy feedstocks have environmental impacts and it is important to ensure sustainable sourcing of material. Air quality regulations can restrict their use in urban areas due to sulphur and nitrogen oxides in the waste gases. A stove burns logs or pellets to heat a single room - and may be fitted with a back boiler to provide water heating as well. A boiler burns logs, pellets or chips, and is connected to a central heating and hot water system. Biomass boilers work most efficiently when they are operating continually (rather than frequently switching on and off, like typical gas boilers). This is because the heat response rate of a biomass boiler is slower. Therefore buffer tanks must be supplied as thermal stores. 

Heat networks	**Heat networks (or district heating) supply heat, generated at a central source, directly to buildings through a network of pipes carrying hot water.** This means that individual buildings do not need to generate their own heat on-site. The heat source for a heat network can include combined heat and power plants, biomass, energy from waste, large-scale electric heat pumps or even waste heat from national grid power stations.	
Biogas	**Biogas refers to a mixture of gases generated by the breakdown of organic matter or waste, such as manure, sewage, food waste, and plant material.** Biogas can be compressed and stored like natural gas. It can be injected into the gas grid and adds a renewable percentage to the gas grid	Biogas is generated through anaerobic digestion which breaks down biodegradable waste in the absence of air. Food waste, sewage sludge and slurry are the main feedstocks but bioenergy crops can also be used. 

3.2 Identifying a vision of low carbon heat for 2030

The Government's low carbon heat strategy[38] does not prescribe clear targets for different low carbon heat technologies but modelling work that underpins the strategy does suggest the following general direction for 2030[39]:

- energy efficiency and behavioural change should continue to reduce demand for heat
- heat networks should be rolled out in high density urban areas which have the density of heat demand to support heat networks – this accounts for 22% of the housing stock
- heat pumps should be installed in low density rural areas, particularly those off the gas grid – this accounts for 19% of the housing stock

[38] DECC, 2013, The Future of Heating: Meeting the Challenge
[39] The Future of Heating outlines this potential strategy for housing rather than the whole building stock

- conventional gas heating should continue to dominate medium density suburban areas, but with hybrid heat pump/ gas boiler systems increasingly playing a role as a transitional technology – this accounts for 59% of the housing stock

Whilst recognising the role that biomass, solar water heating and other low carbon heat and enabling technologies can play, the Government therefore identifies energy efficiency, heat pumps and heat networks as the key solutions in the short to medium term.

Although the Government's heat strategy indicates this general direction for heat, it does not commit to delivering this combination of solutions and merely states that modelling suggests this could be a possible cost effective approach. There is therefore a lack of sufficiently detailed direction when it comes to the UK's heating policy. In order to both guide policy and evaluate progress in decarbonising the heat sector, a more detailed vision or roadmap is required. 2030 is the key interim step to the 2050 decarbonisation target; it is only one investment cycle away and a clearer idea of the direction of travel is therefore urgently needed. A clearer idea is also necessary of the infrastructural requirements involved in delivering the key solutions for low carbon heat as planning for infrastructure is a long-term process.

3.3 Committee on Climate Change low carbon heat scenario for 2030

3.3.1 Background to the CCC scenario analysis

The *Fourth Carbon Budget Review* published by the Committee on Climate Change (CCC) in December 2013[40], offers a sectorial analysis of the cost-effective path to the 2050 UK carbon reduction target, covering the period 2023-27. The central scenario provides a useful basis for evaluating the roles of different technologies in delivering low carbon heat in the UK and the development of a potential vision of low carbon heat for 2030.

The CCC use scenarios to inform their carbon budget analysis and these scenarios are not intended to be prescriptive but to provide a basis for assessing carbon abatement potential and costs. The general approach that CCC follows in the development of scenarios, and the approach behind the central scenario for buildings for the *Fourth Carbon Budget Review,* is outlined in Table 3-2 below.

[40] Committee on Climate Change, Fourth Carbon Budget Review – technical report, December 2013: http://www.theccc.org.uk/wp-content/uploads/2013/12/1785b-CCC_TechRep_Singles_Book_1.pdf

Table 3-2: Background to the CCC's use of scenarios for informing the carbon budgets

Context to the CCC central scenario (of low carbon heat in buildings)
1. **The scenario was developed to inform the carbon budgets.** The scenario identifies the socially optimal level of decarbonisation (defined as the level of abatement which is either cheaper than the reference carbon price over the lifetime of a measure or which is required for meeting the 2050 target). The scenario analysis also considers how costs are likely to reduce over time and how potential deployment rates of key technologies are likely to increase correspondingly, thereby creating a wider range of options to reduce emissions in the long term[41].
2. Within the scenarios, **cost-effectiveness of measures is judged with reference to carbon price projections** (DECC carbon price projections from now to 2050)[42].
3. **The scenario is not prescriptive.** The scenario is not a definitive plan, but rather a basis for assessing abatement potential and costs and a springboard for discussion. It is also constantly evolving: for the fourth carbon budget review, the evidence on heat pumps and district heating was updated, and new estimates of cost-effective energy efficiency potential were incorporated (including lower expected savings from solid wall insulation and its reduced cost effectiveness). The modelling is currently being redeveloped to integrate new technologies (such as gas absorption heat pumps, water source heat pumps in heat networks and increased waste heat recovery).
4. Modelling of the scenario included consideration of the **suitability of each technology** to each heat load based on the heat grade, physical space and other factors.
5. **The heat scenario was developed in tandem with detailed power sector scenario analysis,** including sensitivities on the level of electricity decarbonisation and costs. The increased demand from heat pumps at peak times and variability of load throughout the year was initially considered in 2010 (see 2010 NERA/AEA report pp.36-44), and then again in much greater detail for the fourth carbon budget review (2013).
6. The **heat loads** used in the modelling for the fourth carbon budget review were calibrated to the most recent DECC energy demand projections and factor in the new evidence on energy efficiency measures (e.g. lower savings from solid wall insulation – see Fourth Carbon budget review, part 2 Technical report pp.62-68). The heat demand projections will be reviewed in more depth over the coming year.

3.3.2 Overview of the CCC low carbon heat scenario

The CCC central scenario suggests that **low carbon heat can provide 25% of the domestic sector's heat demand** and **63% of the non-domestic sector's heat demand by 2030**. These low carbon heat penetration rates are delivered through a combination of energy efficiency improvements and the large scale installation of low carbon heat technologies across the UK building stock.

Energy efficiency measures are expected to reduce heat demand in the domestic sector by 11.5% and in the non-domestic sector by 20% compared to a projected baseline heat load. The domestic sector energy efficiency measures include the following:

- All remaining 4.5 million cavity walls insulated (composed of 1.6 million standard cavity walls, and 2.9 million hard-to-treat (HTT) cavity walls)
- All remaining 10.3 million lofts insulated, the majority of which (80%) are loft insulation top-ups

[41] For more detail on this approach see CCC, 2013, Fourth Carbon Budget Review: part 1 pp.70-80.
[42] For more detail on the carbon prices used see CCC 2013, Fourth Carbon Budget Review: part 1 pp.70-80.

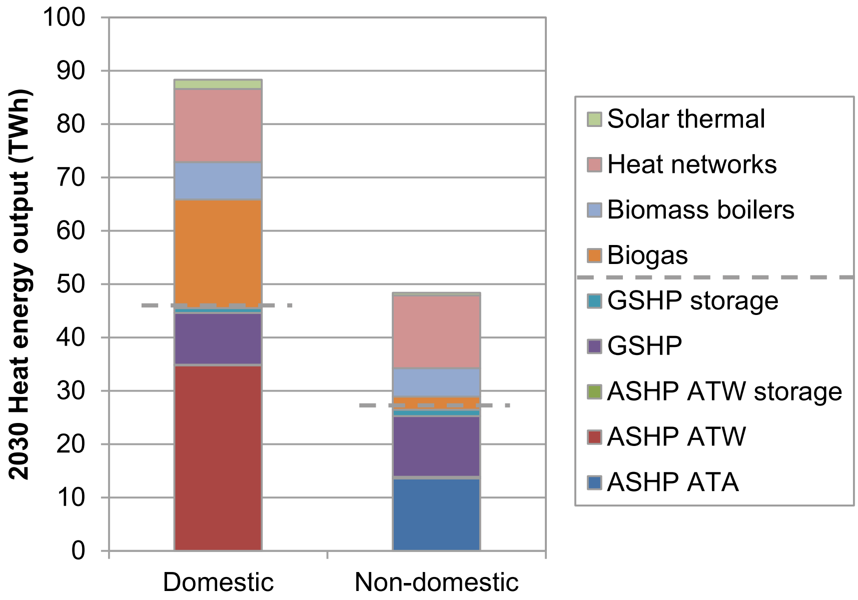
- 3.5 million solid walls insulated (approximately 40% of the UK's solid wall housing stock)
- Comprehensive installation of heating controls (includes central heating system controls, water heating controls, thermostats, Thermostatic Radiator Valves (TRVs) and wide-spread adoption of 1 degree reduction in heating temperature)

The reduction in heat demand for the non-domestic stock is delivered through a mix of cost effective fabric measures and energy management activity[43].

The role of each low-carbon technology in supplying low-carbon heat in 2030 is shown in Figure 3-1 and Table 3-3.

Heat pumps are the key solution in the scenario and provide approximately half the low carbon heat across both the domestic and non-domestic sectors (as shown by the dotted lines), with biogas and low carbon heat networks also playing major roles. At these levels of output, heat pumps would supply 13% and 33% of the total heat demand of the domestic and non-domestic sectors respectively by 2030.

Figure 3-1: Role of each technology in supplying low-carbon heat in 2030 under CCC scenario



[43] The CCC acknowledges that the evidence base for reducing energy consumption in non-domestic buildings is weaker than that which is available for housing due to data and model limitations. They refer to the current DECC project – Building Energy Efficiency Survey – which aims to improve the data on energy consumption and energy efficiency opportunities in non-domestic buildings.

Table 3-3: Role of each technology in supplying low carbon heat in 2030

	Percentage of domestic heat energy output in 2030	Percentage of non-domestic heat energy output in 2030
Residual	**75%**	**37%**
Solar thermal	0.5%	1%
Low carbon heat networks	4%	18%
Biomass boilers	2%	7%
Biogas	6%	3%
GSHP storage	0.2%	2%
GSHP	3%	15%
ASHP ATW storage	0.04%	0.4%
ASHP ATW	10%	n/a
ASHP ATA	n/a	18%

3.3.3 The number of installations associated with the CCC low carbon heat scenario

An illustration of the numbers of homes and non-domestic buildings that each technology would need to supply in order to achieve these levels of heat output is provided in Table 3-4. The scenario suggests that 4 million homes would have heat pumps, 300,000 homes would have biomass boilers and almost 1 million homes would be connected to low carbon heat networks.

Table 3-4: Illustrative number of homes and non-domestic buildings supplied by each technology (based on 100% substitution of heat demand)[44]

	Number of domestic buildings supplied by low carbon heat in 2030	Number of non-domestic buildings supplied by low carbon heat in 2030
ASHP ATA	0	318,000
ASHP ATW	3,056,000	0
ASHP ATW Storage	14,000	7,000
GSHP storage	78,000	29,000
GSHP	852,000	267,000
Biomass boilers	300,000	124,000
Solar Thermal	910,000	11,000
Biogas	866,000	58,000
Low carbon heat networks	1,000,000	321,000
Number of buildings with low carbon heat	**7,076,000**	**1,135,000**
Total number of buildings in the UK	**26,414,000**[45]	**1,795,000**

[44] Calculated by Verco based on the TWh outputs from the CCC central scenario
[45] Office for National Statistics, UK Families and Households 2013 (http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-328237)

3.3.4 Impact of a higher discount rate and lower future carbon price on the (modelled) uptake of low carbon heat

The CCC modelling uses a social discount rate of 3.5% to evaluate cost effectiveness (and subsequent uptake) of the various low carbon heat technologies between now and 2030. However, when a higher private discount rate is applied to their modelling[46] they find that the potential uptake of low carbon heat drops away substantially with a resulting fall in carbon reductions from the buildings sector with serious implications for the Fourth Carbon Budget. This demonstrates the need for Government to design a policy framework that ensures building owners apply low discount rates in their decision-making for low carbon heat investment, such as by de-risking investment in low carbon heat infrastructure and driving householder demand for low carbon heat. In addition, if future carbon prices are lower than those projected by DECC (and hence comparison with higher carbon conventional heating systems is less favourable) then the potential uptake of low carbon heat will also be correspondingly lower than the scenario suggests is possible.

The CCC has also carried out sensitivity analysis of the implications for the carbon budget of failing to deliver these deployment levels. The CCC argues that a domestic sector heat pump uptake of 2.5 million homes by 2030 (as opposed to the 4 million homes in the central scenario) is the minimum uptake level required to keep open the option of decarbonising heat from heat pumps as the main technology within the low carbon heat scenario. Lower uptake of key solutions such as energy efficiency measures and heat pumps would of course need to be counteracted by increased activity elsewhere in order to ensure that the UK remains on a cost-effective path to meeting the carbon budget.

3.4 Conclusions on the necessary direction for low carbon heat in the UK

3.4.1 Consensus on key solutions for low carbon heat

The Government's heat strategy and the CCC's central low carbon heat scenario both identify energy efficiency, heat pumps and heat networks as the key solutions in decarbonising heat.[47] A recent UKERC report[48] has also considered options for heat for 2030 and come to the conclusion that a mixed solution for low carbon heat is required with key roles identified for energy efficiency, heat pumps and heat networks. The UKERC has come to the opinion that it is not possible at this moment in time to clearly specify the contributions that are needed from heat pumps and from heat networks even when looking at the relatively short time horizon of 2030 due to a range of uncertainties about the performance of these technologies, the ability to overcome their deployment problems and their interaction with energy efficiency performance. UKERC's main conclusion is that although a number of uncertainties remain to be resolved, it is clear that natural gas dependence needs to be reduced, and that a range of options to replace gas need to be demonstrated, evaluated and deployed between

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[46] The CCC tested sensitivity to a private discount rate of 12% for commercial and public sector buildings and of 16% for housing

[47] The Government's high level position has been informed by the RESOM model (Redpoint Energy System Optimisation Model) which is a whole energy system cost-optimisation model. The model has been used to help develop the Government's understanding of the carbon trade-offs between doing more or less to decarbonise heat as opposed to action in other sectors. Although the Government has not directly incorporated the outputs of the RESOM modelling in its heating strategy, the similarity in high level message between the Government and the CCC suggests that the outcomes of the RESOM modelling are broadly similar to the outcomes of the CCC model.

[48] UK Energy Research Centre, UK Energy Strategies Under Uncertainty: Synthesis Report, April 2014

now and 2030. They state that energy efficiency is the highest priority solution for heat in the short term as it has a key role in achieving the Fourth Carbon Budget and will reduce the burden on low carbon heat sources and can, in effect, buy time in overcoming the deployment barriers to the roll-out of low carbon heat.

3.4.2 Importance of setting targets or goals to guide policy

Although there are risks in setting targets, such as the concern that 'backing winners' can limit innovation or restrict future options, the risks of failing to set installation goals for retrofitting low carbon heat is arguably greater. The CCC low carbon heat scenario is helpful in illustrating the scale of the challenge that is required in order to meet the carbon budget and in highlighting the number of low carbon heating installations that will be required.

The CCC scenario is based on detailed analysis and it is relatively cautious in the way that it deals with future uncertainties over technology costs, installation barriers and technology change. Whilst uncertainties remain around take-up of heat pumps, including the acceptability to consumers and the role for hybrid heat pumps as a transitional technology in the 2020s and 2030s, constraints on limited bioenergy resources show that heat pumps are clearly a central part of the solution. The CCC scenario demonstrates that a step change is needed in the roll-out of energy efficiency, heat networks and heat pumps over the next fifteen years in order to meet the Fourth Carbon Budget cost effectively.

3.5 Ensuring performance improvements for low carbon heat technologies

The large scale roll-out of heat pumps and heat networks will need to be accompanied by improvements in the technical performance of the technology and wider energy systems in order to guarantee carbon savings. Heat pumps are affected by three key issues:

- **Average Coefficient of Performance** (or Seasonal Performance Factor) – monitoring data on the in-situ performance of domestic heat pumps[49] has showed that a significant proportion of installed heat pumps do not match the expected levels of efficiency. However, the monitoring research also demonstrated that minor interventions to correct the design and installation of a system and adjust customer behaviour has a substantial impact on correcting the performance levels.
- **Installation in suitable (energy efficient) buildings** - buildings need to be highly energy efficient before heat pumps are installed and the building occupants need to understand how to operate the low temperature heating system.
- **Decarbonisation of the electricity grid** - the successful decarbonisation of the electricity grid is also essential to the future carbon reductions projected for heat pumps within the CCC scenario. The current grid electricity carbon factor is 490gCO_2 per kWh[50] whereas the grid electricity carbon factor for 2030 used in the CCC (central scenario) modelling is 50 to 100g of

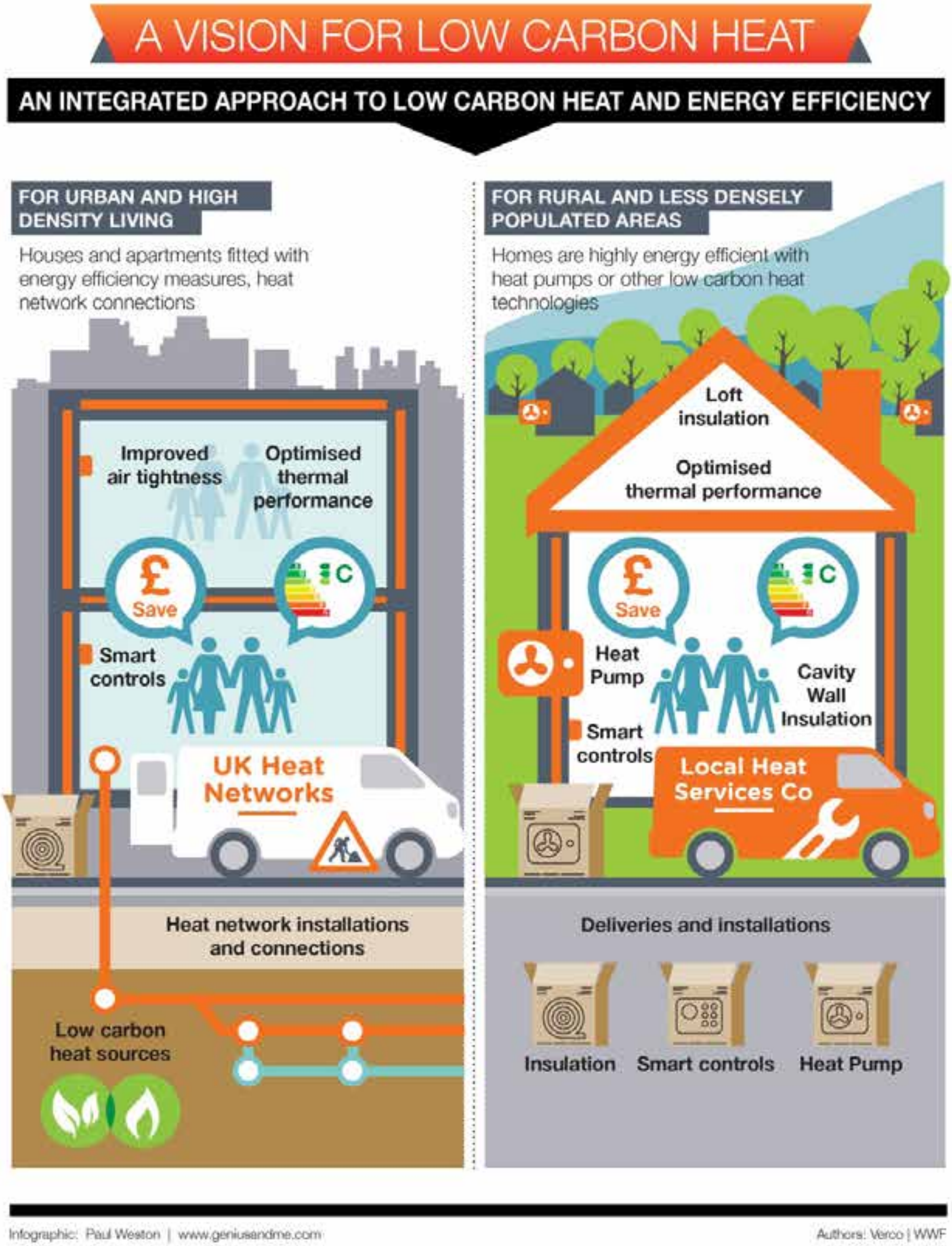
[49] Energy Saving Trust, *The heat is on: heat pump field trials – Phase 2*, August 2013
[50] DEFRA, 2014, Government conversion factors for company reporting (http://www.ukconversionfactorscarbonsmart.co.uk/)

CO_2 per kWh[51]. If the electricity grid does not decarbonise in line with this projection then heat pumps will deliver lower carbon savings.

The carbon performance of heat networks is affected by the following key issues:

- **System efficiency -** the design and management of heat networks needs to maximise system efficiency so as to maximise carbon reductions. Heat networks need to be actively managed to ensure that they operated efficiently. In addition to potential heat losses through pipework, the operation of the plant also influences carbon performance. A significant proportion of existing heat networks in the UK do not meter customers which has huge implications on heat consumption and carbon emissions (for example, on 1960s and 1970s social housing schemes).
- **Gas boiler heating source -** Low carbon heat generation plant will need to be successfully incentivised for heat networks as most existing heat networks are currently supplied by conventional gas boilers.

[51] The CCC modelling used DECC's electricity decarbonisation scenarios to identify electricity carbon factors for 2030



A VISION FOR LOW CARBON HEAT
AN INTEGRATED APPROACH TO LOW CARBON HEAT AND ENERGY EFFICIENCY
FOR URBAN AND HIGH DENSITY LIVING
Houses and apartments fitted with energy efficiency measures, heat network connections
Improved air tightness
Optimised thermal performance
Save
C
Smart controls
UK Heat Networks
Heat network installations and connections
Low carbon heat sources
FOR RURAL AND LESS DENSELY POPULATED AREAS
Homes are highly energy efficient with heat pumps or other low carbon heat technologies
Loft insulation
Optimised thermal performance
Save
C
Heat Pump
Cavity Wall Insulation
Smart controls
Local Heat Services Co
Deliveries and installations
Insulation
Smart controls
Heat Pump
Infographic: Paul Weston | www.geniusandme.com
Authors: Verco | WWF

4. Are we on track to deliver low carbon heating?

4.1 Current progress in the deployment of low carbon heat

The current deployment of energy efficiency and low carbon heat technologies is at very low levels compared to the scale of deployment in the CCC low carbon heat scenario for 2030. The scale of the infrastructure challenge is huge and it is estimated that one home retrofit per minute is required between now and 2050 to achieve our carbon reduction targets.[52] The size of the Green Deal market is only a fraction of that initially hoped for and the reduction of funding available under the Energy Company Obligation (ECO) will only make the situation worse. DECC expected the number of Green Deal installations during 2013 to reach about 130,000 properties[53]. However, during the sixteen month period from the launch of the Green Deal in January 2013 to the end of April 2014, the total number of households with Green Deal Plans was 2,439[54] (this includes Green Deal Plans at all stages of progress including those recently signed as well as those with installations in process or completed). Advanced energy efficiency measures, such as solid wall insulation, and the key low carbon heat technologies of heat pumps and heat networks, are still essentially niche technologies in the insulation and heating markets[55].

The Committee on Climate Change report, *Meeting Carbon Budgets – 2014 Progress Report to Parliament*[56] outlines that progress in energy efficiency has slowed down over the past year and that changes are therefore needed to improve the future outlook. This slowdown in activity comes after good progress prior to 2013 in the implementation of loft and cavity wall insulation and boiler replacement, whilst there has generally been slow progress in more advanced energy efficiency measures and low-carbon heat. The progress report states :

> *"After five years of good progress on many measures, there has been a slow-down in 2013, especially on home insulation. In the non-residential sector, data availability is poor but there are few signs of major energy efficiency performance improvements in the sector. Uptake [of loft, cavity wall and solid wall insulation] in 2013 was well below the rate needed to be on track with CCC indicators. Uptake was also below DECC's own estimated uptake levels, as set out in the ECO and the Green Deal Impact Assessment*
>
> *Despite the fact that the current instrument to incentivise low carbon heat – the Renewable Heat Incentive (RHI) – is very generous, take-up to date has been low. The appropriate response is not to increase the subsidy; rather it is to overcome financial and non-financial barriers to uptake."*

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[52] Energy Saving Trust and Centre for Low Carbon Futures, *The Retrofit Challenge: Delivering Low Carbon Buildings*, 2011

[53] Figures taken from the Green Deal uptake modelling in the Impact Assessment that accompanied the Green Deal and ECO Consultation in 2011, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43000/3603-green-deal-eco-ia.pdf

[54] DECC, 2014, Domestic Green Deal and Energy Company Obligation in Great Britain, Monthly report, 20 May 2014

[55] The reduction in funding available for solid wall insulation under the ECO due to the recent changes will impact negatively upon solid wall insulation progress

[56] CCC, *Meeting Carbon Budgets – 2014 Progress Report to Parliament*, July 2014

Table 4-1 compares the current levels of deployment of energy efficiency, heat pumps and heat networks in housing, with the numbers of installations suggested by the CCC in its low carbon heat scenario for 2030.

Table 4-1: Current levels of low carbon heat deployment compared to where we need to be in 2030

Technology	Current deployment	Comparison with CCC 2030 scenario
Energy efficiency[57]	• Up to 4.5 million cavity walls and 10.3 million lofts still remain uninsulated[58] • Solid wall insulation is a key energy efficiency challenge for the UK housing stock due to the 7.5 million solid walled homes in the UK, with only 209,000[59] of these homes currently insulated • Solid wall insulation (SWI) progress has been severely hampered by the reduction of the SWI requirement within ECO which will only fund 100,000 homes across the country between now and 2017.	• All lofts and cavities are insulated in the scenario • 209,000 currently insulated solid walls equates to only 6% of the total number in the CCC low carbon heat scenario • The 100,000 solid wall insulations that will be funded through ECO over the next three years only equates to 3% of the deployment level in the CCC scenario of 3.5 million installations.
Heat pumps	• The total UK heat pump market currently sees around 20,000 installations per year (domestic and non-domestic) or 406,000[60] in total installed to date. This compares to 1.6 million gas boilers per year.[61]	• It is estimated that the current number of heat pumps (domestic and non-domestic) installed in the UK, is less than 9% of the required deployment in the CCC scenario.
Heat networks[62]	• Research carried out by DECC in 2013[63] suggests that the current number of homes connected to heat networks is 193,000. However, 90% of these heat networks were built before 2000 with the majority being installed in the 1960s and 1970s. • The majority of the existing heat networks do not have a low carbon heat source, with 72% using gas boilers. 20% are supplied by energy-from-waste.[64] • Only 15% are supplied by a CHP plant [65]	• With just under 25,000 homes being connected to heat networks over the past 13 years, the rate of heat network deployment will need to increase 30 fold in order to deliver the level of deployment in the CCC low carbon heat scenario. • All heat networks are supplied by a low carbon source in the CCC scenario.

[57] This reviews energy efficiency performance in housing only
[58] Data taken from the CCC, *Fourth Carbon Budget Review – technical report,* December 2013. The majority of remaining loft insulation opportunities are loft top-ups.
[59] DECC, *Estimates of Home Insulation Levels in Great Britain: July 2013*, 2013
[60] Inferred from Frontier Economics and Element Energy, Pathways to high penetration of heat pumps, October 2013 and BSRIA, *Heat pump markets, UK in Europe – IEA Heat Pump Workshop,* November 2012
[61] Frontier Economics and Element Energy, *Pathways to high penetration of heat pumps*, October 2013
[62] This reviews heat network connections in housing only
[63] DECC, *Summary evidence on District Heating Networks in the UK*, July 2013
[64] DECC – Heat Networks Delivery Unit, *Heat Strategy & Policy Team Roadshow Presentation*, July 2013
[65] DECC, *Summary evidence on District Heating Networks in the UK*, July 2013

4.2 Understanding the delivery context

4.2.1 Key challenges to the delivery of low carbon heat

The low carbon heat roundtable[66] identified a number of key challenges affecting the deployment of low carbon heat which were categorised into the following three priority issues:

- **Lack of Government policy focus to drive low carbon heat** deployment at the necessary scale
- **Lack of consumer demand** for low carbon heat technologies
- **Lack of governance and planning for heat network deployment**

The effectiveness of current Government policy in addressing these challenges and driving forward the deployment of low carbon heat has been assessed below.

Some of the specific deployment barriers associated with individual low carbon heat technologies are covered in Appendix 3 – Key challenges to the deployment of low carbon heat technologies.

4.2.2 Current UK policy framework for low carbon heat

The Future of Heating: Meeting the Challenge,[67] outlines key Government policies promoting low carbon heat up to 2050. The document brings together a wide range of Government instruments that influence energy and provide support for low carbon heat. The sections below assess the degree to which the Government's policy framework addresses the key challenges facing low carbon heat deployment.

The main policy instrument supporting low carbon heat is the Renewable Heat Incentive (RHI) which has been available to the non-domestic sector since 2011 and became available to the domestic sector in April 2014. So far, 96% of all support under the non-domestic RHI has been awarded to small and medium scale biomass installations, and the Government therefore recently increased the level of support available to a range of other technologies, including large scale biomass and GSHP. The domestic RHI will provide support for solar water heating, biomass boilers and stoves with back boilers, GSHP and ASHP.

The RHI is designed to cover the additional costs associated with a renewable heat installation compared to a conventional fossil fuel installation. Where a renewable heating system is being considered (e.g. ASHP, GSHP or biomass) the level of support helps to subsidise the extra cost (capital and operational) of these systems compared to installing a non-renewable off-grid heating system. Therefore the RHI only gives a favourable return where the existing heating system is due for replacement. The domestic RHI has been specifically designed to provide viable rates of return on investment in renewable energy installations for off-gas grid properties only, and it is not intended to drive the uptake of renewables in gas heated dwellings. Government is also implementing a range of initiatives to improve industry skills for renewable heat technologies.

[66] WWF-UK and Verco convened two low carbon heat roundtable events in February and April 2014
[67] Department of Energy and Climate Change, The Future of Heating: Meeting the Challenge, 2013 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/190149/16_04-DECC-The_Future_of_Heating_Accessible-10.pdf

There is also a range of Government mechanisms providing indirect support for low carbon heat in the non-domestic sector including for example Enhanced Capital Allowances (ECAs), the Carbon Reduction Commitment (CRC) and the Climate Change Levy (CCL).

The Government has established a Heat Network Delivery Unit (HNDU) in DECC to provide guidance to local authorities and developers setting up heat networks. The Government is also providing development funding for local authorities that wish to develop heat networks and is currently reviewing how the RHI can be better designed to support heat networks. The Green Investment Bank (GIB) has also identified heat networks as a potential capital investment area under their priority investment category of energy efficiency [68].

4.3 Barrier 1: Lack of Government policy focus to drive low carbon heat deployment at the necessary scale

4.3.1 Overview of the challenge

Historically, energy policy has focused on the electricity sector rather than the heat sector. Indeed, for many people, energy policy is synonymous with electricity policy. Aside from Building Regulation requirements, there have been relatively few policies and regulations directly targeting the environmental performance of heating technologies. Prior to the RHI coming into force, the April 2007 requirement that all new boilers are condensing boilers is one of the few low carbon heat policies influencing the existing built environment. The Government needs to change this situation so that heating policy gains the same level of attention as electricity policy, as heat accounts for 44% of end-use energy consumption in the UK[69]. The delivery of low carbon heating is a massive infrastructure and investment challenge. The transition to an energy efficient and low carbon heating system needs to acquire a much greater degree of importance and to become a key Government priority over the next few decades.

4.3.2 Does current policy address this challenge?

The current Government policy framework is not adequately focussed on driving low carbon heat deployment at the scale necessary to meet the challenge of reducing emissions at the rate called for by the CCC. Although the Government launched its heating strategy in 2013, it does not provide an adequate framework to drive a step change in the way that heat is produced and consumed:

- The market for heat has yet to receive a policy equivalent to the scale and focus delivered by the Renewables Obligation (which mandates renewable electricity supply) or the Electricity Market Reform
- The current policy framework has yet to provide market certainty for investment in low carbon heat, with policies such as ECO being subject to constant change and review
- The Future of Heating does not address the scale and magnitude of what is required, and relies too heavily on the RHI to drive the transition to low carbon heating

[68] The GIB has three key priority areas for investment: offshore wind, energy efficiency and waste & bio-energy. Heat networks are a sub-category under energy efficiency which the GIB may consider for investment.
[69] DECC, 2013, The Future of Heating: Meeting the Challenge

- There is not a strong enough interaction between energy efficiency policies and heat policies so as to drive a combined approach to low carbon heating.

4.4 Barrier 2: Lack of consumer demand for low carbon heat

4.4.1 Overview of the challenge

Two key issues influence consumer demand for low carbon heat in the UK:

- Undeveloped consumer awareness of low carbon technologies and substantial consumer inertia (although better consumer awareness by itself may not necessarily drive increased uptake of low carbon technologies, a very low level of awareness is a barrier to uptake and is indicative of low demand and a poorly performing market)
- Low consumer demand, with consumer culture generally not conducive to the sort of systems change that is implied by a transition to a low carbon heating system

DECC's Household Energy Management strategy in 2010[70] identified the problems affecting consumer demand for domestic low carbon retrofit, which included:

- (High) capital cost
- Lack of awareness
- Waiting for replacement of existing system or major renovation opportunity
- Hassle factors
- (Poor) payback period
- Lack of confidence in new system

Low carbon heat is essentially a sub-component of the retrofit market[71] as it incorporates energy efficiency and the installation of more efficient or new heating systems within buildings and these consumer issues affect the uptake of both energy efficiency and heating technologies. Government needs to address all of these issues in order to develop consumer demand for low carbon heating.

A number of studies have evaluated the low carbon retrofit market over recent years. The recent Green Construction Board report, *Low Carbon Routemap for the UK Built Environment*[72], illustrates that lack of consumer demand is a problem for non-domestic buildings as well as housing:

- The business case is often not strong enough to drive private sector demand (even with RHI)
- Asset replacement cycles drive decision-making but current policies are not aligned with this
- Perceived (and actual|) performance gaps undermine confidence in the technologies.

DECC provided a breakdown of consumers when developing Green Deal policy[73] which categorises consumers into six segments based on their likely response to Green Deal (and low carbon retrofit):

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[70] DECC, *Warm Homes, Greener Homes: A Strategy for Household Energy Management*, March 2010
[71] It's also important to note that low carbon heat technologies also need to be better incorporated within new build
[72] The Green Construction Board report, *Low Carbon Routemap for the UK Built Environment*, March 2013
[73] DECC (GfK NOP and Kantar Research) Green Deal Segmentation, 2012

- Carbon Savers - young professionals particularly interested in the environmentally friendly benefits of making their homes more energy efficient through the Green Deal.
- Convertibles - higher income working families who were already considering making energy efficiency improvements. The Green Deal could help them get over barriers including distrust of installers and confusion over conflicting information.
- Not on the Radar - average households for whom energy efficiency is not a priority at present.
- Disengaged Rejecters - older householders who are not planning on making their homes more energy efficient. They do not appear to want to consider the Green Deal at all.
- Overstretched - while they could potentially benefit from the Green Deal, this segment is strongly put off by the costs of improvements.
- Money Savers - families on low incomes who are especially interested in the cost-saving features of the Green Deal to help them make energy efficiency improvements.

This segmentation of the consumer market for Green Deal is equally relevant for low carbon heating, and illustrates that consumer demand is complex with many different motivations and factors affecting demand. It also shows that a significant proportion of the population is likely to exhibit a complete lack of interest in low carbon heating technologies regardless of any policy incentives.

4.4.2 Does current policy address this challenge?

Whilst RHI is a necessary and essential policy to address the additional cost of low carbon heat uptake, there are many other challenges that need to be addressed to drive large-scale uptake of low carbon heat technologies. There is a complex set of decision-making involved with installing a low carbon heating system and a lot of concerns need to be addressed. The evidence base suggests that RHI does not address all of the challenges.

DECC commissioned research on consumer attitudes to low carbon heat[74] when developing its heating strategy which identified the following issues when householders are considering low carbon heating as an option:

- Householders with gas heating systems are generally very satisfied with their system, but those with electric and oil heating are less satisfied[75]
- The main reason for replacing heating is when the current system has come to its end of life
- Key criteria for selecting heating system are knowledge of the technology, performance, purchase cost and running cost

This illustrates that:

- The roll-out of low carbon heating to homes with gas heating will be challenging as most households consider gas to be an effective heating system
- The speed of uptake is likely to be constrained by replacement cycles of heating technologies
- Consumers are only likely to install low carbon heating technologies if:
    - they are familiar with them
    - they are satisfied that the technology works well

[74] DECC, *Homeowners' Willingness to Take Up More Efficient Heating Systems*, March 2013
[75] A key reason for the lower popularity of oil and electric heating is that they have higher running costs than gas heating, and electric heating is generally less responsive than gas heating (e.g. electric storage heaters)

- the low carbon technology is no more expensive to install than conventional heating systems
- the low carbon technology is no more expensive to run than conventional heating systems

The attitude survey also found that the majority of households are unlikely to opt for a renewable heating system even if a tariff mechanism like the RHI is available or if an upfront grant is available.[76] This shows that there are a range of factors affecting uptake of low carbon heat technologies and that higher installation cost is not the only issue causing low consumer demand. Table 4-2 assesses how current policy is failing to address the low consumer demand for low carbon heat.

Table 4-2: Impact of current Government policy on addressing low consumer demand for low carbon heating

Challenge	Impact of current policy
High capital cost	Whilst the RHI assists with reducing the running costs of low carbon heat technologies, the payments are only received upon the generation of heat. This does not deal with the upfront cost that is prohibitive to market entry for many consumers, and although Green Deal finance can potentially be used, RHI income can't be used in the calculation of compliance with the Golden Rule. Note, DECC is currently examining whether or not to relax requirements to meet the Golden Rule.
Lack of awareness	RHI is a financial incentive for low carbon heating but has limited ability to drive increased awareness of low carbon heating technologies. CCL and the CRC indirectly have a small impact on raising awareness in the non-domestic sector. Unfortunately the low uptake of Green Deal Plans (and negative media coverage of Green Deal) has undermined the market and propagated the impression that low carbon retrofit constitutes a bad deal for consumers. The highly specific requirements around ECO (and the different funding streams) has led to confusion around the availability of grant funding (and thereby limits the benefits this might have had in driving demand). Government does not have a sophisticated marketing strategy with a segmented approach that enables movement beyond the early adopters[77].
Waiting for break-down of current heating or major renovation project	Boiler replacement is often a stressed purchase (i.e. need to quickly replace broken boiler in order to ensure heating in winter time). In such circumstances people opt for the technology that they know. Local heating engineers would need to push low carbon heating in order to address this issue. Local builders would need to push low carbon heating in order to address inclusion within refurbishment works - lack of consequential improvements policy for housing does not help this situation ('consequential improvements' refers to a requirement to install energy efficiency measures throughout all parts of an existing property when constructing a new extension or undertaking major works to one part of the building).
Hassle factors	Current policy does not overcome the significant hassle factors involved in undertaking retrofit work which constitute a significant barrier to undertaking works. Incentive mechanisms need to incorporate the extra cost of hassle factor and/ or policy needs to include softer influencing factors required to manage inconvenience and disruption associated with retrofit activity.
Payback period	Short term payback is more important to customers than the longer-term payback supported by current policies such as Green Deal and the RHI.

[76] Only 3.4% of respondents to the attitude survey stated that they would opt for a renewable heating system if a tariff mechanism like the RHI was available. Only 3.9% of respondents stated that they would opt for a renewable heating system even with a 100% upfront grant to cover installation costs.
[77] Whilst recognising that DECC has allocated budget towards marketing the RHI to the non-domestic sector

Lack of confidence in new systems	The current low awareness and low uptake levels mean that low carbon heating technologies are considered new and unproven by the general public. This is not being adequately addressed. Householders with gas heating systems are generally satisfied with their system, mainly due to gas heating being cheaper than conventional electric, oil, LPG or coal heating. RHI is likely to have only a limited impact in driving uptake of low carbon heating in homes that currently have gas heating.

4.5 Barrier 3: Lack of governance and planning for heat network deployment

4.5.1 Overview of the challenge

The construction of heat networks at the scale envisaged constitutes a huge and long term infrastructure project. The low carbon roundtable members identified a significant lack of governance for the roll-out of heat networks with the key question of who will take responsibility for leading the large scale construction of heat network infrastructure. There appears to be an implicit assumption that local authorities will lead the delivery of heat network infrastructure (through setting planning requirements for heat networks for new buildings and through directly leading schemes themselves in the existing built environment). However, they have not been specifically tasked with this role by Government and as a result there is a lack of a generally accepted and established role for local authorities. The Scottish Government has also identified a key role for local authorities in the delivery of heat networks, including the development of heat maps and supporting the development of heat network schemes (it is supporting local authorities to produce heat maps for their local area and is providing development funding but is not providing local authorities with additional internal resources to carry out this work) [78]. The Scottish Government has set a target for 40,000 homes to be supplied by low carbon heat from heat networks by 2020.

This key leadership barrier sits alongside the challenges of dealing with the high upfront infrastructure costs for heat networks, securing an adequate and secure customer base to underwrite investment and overcoming competition from the incumbent gas and electricity networks. There is also a challenge in developing low carbon fuel sources for heat networks as the majority of existing heat networks are currently supplied by gas boilers.

DECC commissioned the recent report *Research into barriers to deployment of district heating networks*[79] to identify the key challenges to establishing a heat network, which are summarised in Table 4-3.

[78] Scottish Government, March 2014, Towards Decarbonising Heat: Maximising the Opportunities for Scotland: Draft Heat Generation Policy Statement for Consultation. The Scottish Government has set a target for 40,000 homes to be supplied by low carbon heat from heat networks by 2020.
[79] BRE, University of Edinburgh, and the Centre for Sustainable Energy, *Research into barriers to deployment of district heating networks*, March 2013

Table 4-3: Challenges to the deployment of heat networks by local authorities and developers[80]

Project development stage	Challenge
Objective setting and mobilisation	Identifying internal resources to instigate the scheme and overcome the lack of knowledge
	Customer scepticism of the technology
Technical feasibility and financial viability	Obtaining finance for feasibility/viability work
	Identifying and selecting suitably qualified consultants
	Uncertainty regarding longevity and reliability of customer heat demand
	Uncertainty regarding reliable heat sources
	Lack of generally accepted contract mechanisms
Implementation and operation	Financing the upfront capital cost
	Obtaining finance for independent legal advice
	Lack of regulation and inconsistent pricing of heat
	Concluding agreement with energy services provider including obtaining a contribution to the capital cost
	Skills gaps

4.5.2 Does current policy address this challenge?

As outlined above, the main support mechanism for heat network deployment is the Heat Network Delivery Unit (HNDU) within DECC which provides technical advice and development funding for local authorities. It is also developing technical standards and an industry-led customer code of conduct, as well as examining the scope for extra financial support for heat networks through the RHI (as part of RHI review 2014).

HNDU is therefore helping to address the following barriers identified by the BRE study:

- Obtaining finance for feasibility/viability work – although the development funding available is just a fraction of the quantity required to enable *all* urban local authorities to develop networks (£7million of development funding to allocate over 2014 and 2015)[81]
- Identifying and selecting suitably qualified consultants
- Overcoming the lack of knowledge
- Lack of generally accepted contract mechanisms
- Obtaining finance for independent legal advice
- Lack of regulation and inconsistent pricing of heat
- Skills gaps

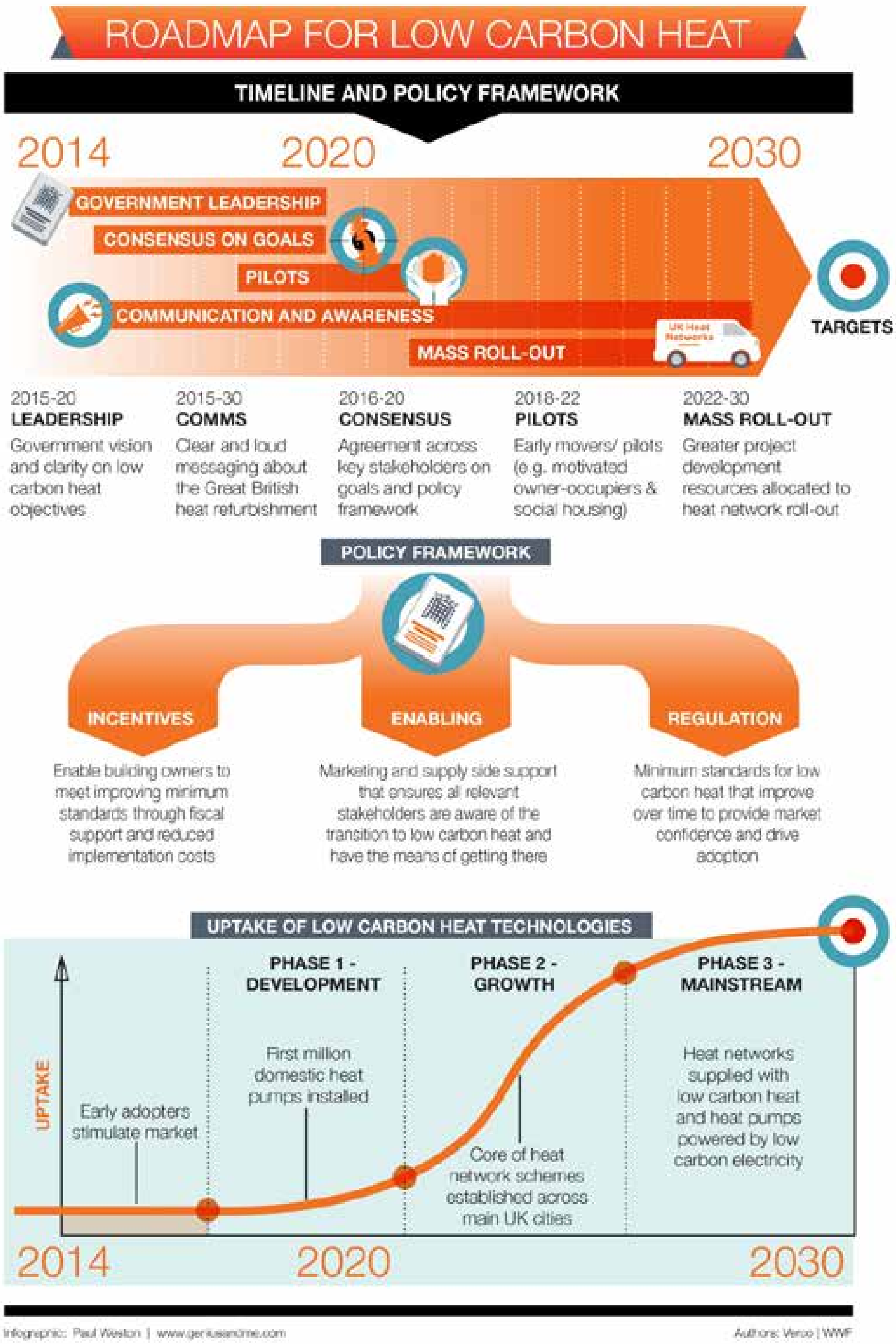
[80] BRE, University of Edinburgh, and the Centre for Sustainable Energy, *Research into barriers to deployment of district heating networks*, March 2013
[81] DECC May 2014, Heat Networks Delivery Unit: Overview of grant funding and guidance available to local authorities developing heat networks

However, **there are a number of challenges identified by the DECC study that are still unaddressed by HNDU**:

- **Enabling local authorities to identify internal resources to instigate the scheme** – local authorities currently have to juggle a large number of competing priorities in the face of huge budget cuts. It is extremely difficult for them to allocate resource towards developing adequate levels of officer expertise to enable them to instigate and deliver heat networks. In addition, it is very difficult for them to take the financial risk of investing in heat network delivery projects.
- **Uncertainty regarding longevity and reliability of customer heat demand** – secure heat sales are essential in order for developers of heat networks to be able to underwrite their investment in the capital works. It is extremely difficult to guarantee heat sales when rolling-out heat networks into the existing built environment (retrofitting heat networks).
- **Uncertainty regarding reliable heat sources** – when the heat source is under different ownership to the heat network, it can be difficult for a heat network developer to guarantee a reliable heat supply and in particular a reliable *low carbon* heat supply
- **Financing the upfront capital cost** – the construction of heat networks requires low cost capital which is not readily available to private developers of heat networks
- **Customer scepticism of the technology** – the public's awareness of heat networks is very low and is this is not currently being addressed

There are therefore a whole host of barriers to the deployment of heat networks that HNDU is not addressing. Although Government recognises that appropriate local bodies, such as local authorities, need to drive forward the construction of heat network infrastructure, they are not setting heat network delivery as a statutory requirement for local authorities with the necessary accompanying resources. In addition, **the current policy framework does not come anywhere near the scale of the challenge in terms of preparing the ground for a major infrastructure project to connect up to one million homes to a heat network over the next fifteen years**. Currently local authorities simply do not have the capacity or resources to deliver at this scale.

5. Driving a step change in the provision of low carbon heat



5.1 Introduction

The Low Carbon Heat Roundtable[82] reviewed the three priority challenges to low carbon heat outlined in Chapter 4, and identified the following key action areas for driving a step change in the provision of low carbon heat:

- **Improving understanding of the low carbon heat transition** – ensuring all main stakeholders have a common goal for low carbon heat is an essential prerequisite to developing a coherent and focused policy framework that can drive deployment at the necessary scale.
- **Driving action on low carbon heat** – the lack of consumer demand for energy efficiency and low carbon heating is severely hampering the ability of policy incentives such as the RHI to drive the uptake of low carbon heat technologies. A ‘carrots, sticks and tambourines’ approach to heat policy (i.e. a combination of regulation, incentives and awareness raising) is required to ensure movement in the market.
- **Elevating heat network roll-out to national infrastructure priority status** - connecting over half a million homes to a heat network over the next fifteen years is a massive infrastructure project which needs clear governance and planning to come to fruition.

5.2 Action 1: Improving understanding of the low carbon heat transition

As outlined in chapter 3, we need a national transition in building higher levels of thermal performance and low carbon heat provision, with discernible progress delivered by 2030 in order to meet the Fourth Carbon Budget. However, it will be difficult to drive deployment at the necessary scale without first developing an awareness of the challenge, a shared understanding of the desirability and goals for low carbon heat and clarity over the direction of travel. With an increased common awareness of the challenge, Government will have greater scope to develop a policy delivery framework that matches the scale and magnitude of what is required.

Table 5-1 outlines the key steps needed to improve understanding of low carbon heat goals, and highlights areas requiring further development.

[82] WWF-UK low carbon roundtable second workshop held on 3rd April 2014 at UK-GBC London office

Table 5-1: Key steps for driving awareness of the step change needed in energy efficiency and heat provision

Step	Overview
Government needs to demonstrate vision and leadership on low carbon heat with a clear timeline for action	Government needs to demonstrate real commitment in terms of communicating the scale of the change required by clearly articulating policy goals, the number of retrofits and low carbon heat installations required, and the speed and scale of delivery required
Government needs to obtain agreement across key stakeholders on the key goals for low carbon heat	Policy makers, industry and delivery agencies need to rally around the delivery of low carbon heat solutions in order to roll out energy efficiency, heat networks and heat pumps at scale.
Industry and the public to be made aware of the goals for low carbon heat and the key actions in getting there	People are not aware of the goals for low carbon heat, and are not familiar with the key low carbon heating technologies or the main energy efficiency measures. Unless awareness levels improve it will be difficult to generate a political mandate for delivery.
Education is required to increase confidence in low carbon heat technologies and ensuring consumers understand how to operate them	Need education of consumers and contractors due to low levels of awareness amongst the heating industry as well as building facilities management and the general public. For example, consumers need to understand that heat pumps provide low grade heat and are relatively unresponsive (in the same way as electric storage heaters) compared to gas or oil boilers.
Government policy needs to provide support for community approach and community energy projects (particularly heat network projects)	Community buy-in can play an important role in reducing opposition and driving uptake for infrastructure projects such as heat networks. Marketing community energy as a business opportunity that benefits the local community and economy might help to normalise heat networks in the same way that community owned solar PV or onshore wind projects have helped stimulate demand for renewable electricity projects across Europe..
Improve industry knowledge to ensure local installers have skills to install these technologies	Improved knowledge and skills amongst local builders and installers will help the roll out of low carbon heating (whilst recognising the chicken and egg challenge of industry undertaking training before there is any consumer demand, and the unnecessary costs this might place on industry). The Low Carbon Construction Innovation and Growth team[83] highlighted how the construction sector does not currently have adequate skills for the low carbon retrofit of the building stock.

5.3 Action 2: Driving action on low carbon heat

5.3.1 Overview of options for driving consumer demand

As outlined in chapter 4, the lack of consumer demand is a fundamental barrier to the large scale roll-out of low carbon heat solutions. The UK-GBC Retrofit Incentives Task Group[84] was convened at the end of 2012 to investigate a range of options for stimulating the market demand for domestic retrofit. It compiled a long list of potential incentive mechanisms for stimulating consumer demand (which are listed in Table 5-2) and then reviewed the list against fifteen selection criteria to identify the three most promising mechanisms.

[83] HM Government, Low Carbon Construction: Innovation and Growth Team, Autumn 2010
[84] UK-GBC Task Group report, Retrofit Incentives: Boosting take-up of energy efficiency measures in domestic properties, July 2013

Table 5-2: Long list of possible incentives for stimulating the UK retrofit market identified by the UK-GBC Retrofit Incentives Task Group[85]

Potential incentive mechanism	Task Group description
Cashback and grants	Grants and cashback reduce the cost of measures or provide them for free, thereby incentivising action. Grants schemes tend to be short-lived as they represent a direct cost to Government, and therefore they do not provide confidence to industry for planning long-term investments.
Variable Council Tax and rebates	Council Tax could be used to encourage retrofit either by linking rates to the energy efficiency or carbon performance of a property, or by offering a rebate when measures are installed.
Variable Stamp Duty	Stamp Duty could similarly be linked to the energy efficiency or carbon performance of a property. The mechanism could be designed to allow buyers to claim a rebate on Stamp Duty if they undertake retrofit work within a given period of purchasing. As with a variable Council Tax scheme, it could also be fiscally neutral for Government.
Minimum energy performance standards for the owner occupied sector	A direct regulation mechanism that imposes minimum standards to sales in the owner occupied sector. Over time, these new standards could be progressively and predictably increased in line with the improving overall state of UK properties, improvements to technology, and the Government's energy and climate objectives. To enable practical delivery of the policy, exceptions could be put in place related to the cost-effectiveness of improving properties.
Low interest loans	Low interest loans for retrofit measures, including a reduced interest rate for the Green Deal, could help to make retrofit more attractive by reducing overall cost. However, low interest loans constitute a direct cost to Government.
Salary sacrifice scheme	A salary sacrifice scheme – whereby employers provide tax free loans that are paid back through employees' salaries - could fund energy efficiency measures, in a similar way to the 'Cycle to Work' scheme. This type of mechanism is unlikely to finance extensive packages of energy efficiency measures and would also create a direct cost to Government through reduced income tax receipts.
Reduced VAT for energy efficiency	A range of energy efficiency measures are already eligible for a reduced VAT rate of 5 per cent, but this rate could be extended to a larger set of measures and the cost of installation to further reduce the cost of retrofit.
Energy efficiency Feed-in-Tariff	A system of payments to encourage reductions in energy use, following the same principle of renewable electricity feed-in tariffs. Payments could either be linked to deemed/ modelled savings or actual energy savings. However, the Government would face a political challenge in finding an acceptable approach to funding these payments.

[85] List of potential incentives and their description are taken from UK-GBC Retrofit Incentives Task Group report http://www.ukgbc.org/resources/publication/uk-gbc-task-group-report-retrofit-incentives

The UK-GBC prioritised this long list of potential mechanisms into the following three key incentive options:

- Variable stamp duty
- Variable council tax
- Energy efficiency feed-in tariff

These three short-listed policy mechanisms provide financial incentives to building owners to encourage them to undertake low carbon retrofit rather than directly mandating action. The UK-GBC task group did not include the minimum energy performance standard for owner occupied housing within their short-list as they argued that mandating minimum standards would be too difficult politically. They also decided that as a minimum EPC standard of E is being introduced for private rented housing and non-domestic buildings from 2018 onwards, this in effect will constitute a trial of the policy in the private rented sector with a corresponding delay likely before the Government would consider introducing the requirement to the owner occupied sector. However, the UK-GBC task group stated that it *is* conceivable that minimum standards could be applied to the social housing sector, where there is already a high level of regulation as to the standard of homes that can be offered to tenants.

The UK-GBC Task Group concluded that none of the three short-listed mechanisms should be considered a silver bullet, and their implementation would still need to be part of a wider package of measures, potentially including low interest loans, minimum standards and Consequential Improvements regulations in order to drive the necessary levels of activity. And that this wider package should, in turn, sit within a broader, coherent and long-term framework of low carbon retrofit policy.

5.3.2 Combining carrots and sticks to drive the uptake of low carbon heat

As highlighted in chapter 4, and argued by the UK-GBC[86], new policies are required to drive consumer demand for low carbon retrofit and low carbon heat. Although the RHI provides a financial incentive to encourage the installation of low carbon heat, the Government's policy framework does not address the other issues affecting consumer demand such as lack of awareness, hassle factors and general inertia. The low carbon heat roundtable[87] felt that a 'carrot, stick and tambourine' approach is needed to provide a comprehensive policy framework for delivering low carbon heat. Such an approach would provide a combination of regulation, incentives and awareness raising to ensure that there is movement in the market:

- 'Sticks' would set mandatory minimum standards for low carbon heat that improve over time to drive the adoption of low carbon heat (and help provide market confidence for industry investment in low carbon heat infrastructure)
- 'Carrots' would enable building owners to meet the improving minimum standards, through fiscal support, reduced implementation costs and other enabling mechanisms ('sweeten' the blow of the sticks and provide particular support to early adopters)

[86] UK-GBC Task Group report, Retrofit Incentives: Boosting take-up of energy efficiency measures in domestic properties, July 2013
[87] WWF-UK low carbon roundtable second workshop held on 3rd April 2014 at UK-GBC London office

- 'Tambourines' refers to marketing and promotional activity that ensures that all relevant stakeholders are aware of the transition to low carbon heat, the direction of travel and the means of getting there (and essentially understand the reason for the sticks and carrots).

Incentives and regulations will have a key impact in driving consumer demand. Structured incentives such as a variable stamp duty as advocated by the UK-GBC Retrofit Incentives Task Group, are hardwired into the policy framework, providing long term market signals for investment in low carbon retrofit. However, these types of structured incentive do not actually mandate action by requiring building owners to improve the energy or carbon performance of their property or to install specific efficiency or heating technology. It should also be noted that the Government's cashback scheme [88] for households that invest in energy efficiency has been portrayed in some quarters as a stamp duty rebate but it is in fact a cashback scheme for people who have recently bought a home and it is only a short term policy mechanism currently planned to end after September 2014.

Although the UK-GBC has questioned the political feasibility of imposing minimum performance standards across the whole building stock, the evidence suggests a need for some form of regulation to drive consumer demand in order to achieve the scale of change this is required. The Zero Carbon Homes policy is a good example of directly regulating improvements; the timeline of increasing minimum standards for new build has been effective in driving improvements in the carbon performance of new homes. Regulations that drive action on low carbon heating for building owners over the coming decades can then be underpinned by incentive measures and supporting mechanisms, such as the three specific incentives recommended by UK-GBC. Table 5-3 outlines key steps towards regulating action on low carbon heat and highlights areas requiring further development.

Table 5-3: Key steps towards driving low carbon heat

Step	Overview
Government to adopt a comprehensive policy framework that both requires and encourages the uptake of low carbon heat technologies through a package of 'carrots, sticks and tambourines'	Government needs to demonstrate leadership in involving all stakeholders in debate over alternative packages of carrots, sticks and tambourines to drive uptake and ensure delivery of the carbon savings required under the Fourth Carbon Budget
Legislation that sets a timeline for regulating improvements in energy efficiency and low carbon heating (with long lead-in times to complement investment cycles and enable building owners to respond)	Review options for rising performance standards for the existing building stock for e.g. minimum EPC standard or minimum carbon performance or mandatory installation of certain heating technologies when existing heating system is nearing end of life
Certain sectors, such as social housing, to act as early movers in retrofit activity to demonstrate what is possible and to kick-start the low carbon heating industry	There is potential for social housing to have a faster timeline for minimum energy performance standards. This requirement should be combined with supportive funding in a similar way to the Decent Homes programme

[88] https://gdcashback.decc.gov.uk/

5.4 Establishing a much stronger approach to delivering low carbon heat networks

Chapter 4 highlights that a clear governance structure is required to assign responsibility for leading the large scale roll-out of heat network infrastructure across the UK. Dealing with the wide range of obstacles facing the roll-out of heat networks in the existing built environment, including the massive challenge of securing customer heat demand and addressing the high upfront capital costs, requires a suitably bold response from Government. Unless the roll out of heat networks in high density areas becomes a national infrastructure priority, the objectives for low carbon heating outlined in DECC's heating strategy are unlikely to be delivered.

The construction of heat networks at the scale required constitutes a massive infrastructure project and it should therefore be treated a national infrastructure priority in the same way as roads, railways, energy, telecommunications and flood defences which are all covered by the Government's National Infrastructure Plan. As the heat network industry is starting from a relatively small base, it could arguably benefit from the creation of a specific delivery authority in the same way as the Olympic Delivery Authority and HS2 Ltd were formed to drive forwards those projects.

Table 5-4 Table 5-4 outlines key steps involved in making the roll out of heat networks a national infrastructure priority and highlights areas requiring further development.

Table 5-4: Key steps involved in making the roll out of heat networks a national infrastructure priority

Step	Overview
Strong Government leadership so there is a coherent plan for heat networks	Government to compile a heat network delivery plan that drives heat network development in a way that supports meeting the UK's carbon budgets, including the introduction of low carbon heat sources
Development of appropriate ownership and governance structures to ensure rapid delivery of quality networks at scale	Government to develop appropriate ownership and governance structures that will deliver long term value to investors and customers: the roll-out of heat networks should learn from the delivery of other infrastructure projects such as the Olympics, High Speed Rail and land regeneration through the Homes and Communities Agency, and inclusion within the National Infrastructure Plan
Greater project development resources should be provided commensurate with the scale of the challenge	Government needs to allocate far greater resources to the roll-out of heat networks; the recently formed Heat Networks Delivery Unit (HNDU) has been given £7million to allocate as development funding over 2014 and 2015 which is a fraction of the level of funding allocated to high profile infrastructure projects such as the Olympics (for example, £6.7 billion of capital funding was made available to the Olympic Delivery Authority)
Low cost finance should be made available to leverage equity and debt funding from public and private sources including EIB, GIB, banks, funds and private investors	It can be difficult to finance the construction of heat networks due to the high upfront capital costs and the risks of guaranteeing a customer base. The Government should help schemes obtain finance through mechanisms that alleviate this financing risk such as grants, equity and guarantee funds
Develop mechanisms that ensure building owners connect to heat	Requires mechanism that ensures locally appropriate connections (as opposed to other heating options). Industry safeguards and

networks (domestic & non-domestic)	regulations will need to be mature and tested before mandatory connection is brought in[89].

[89] The Government is currently transposing the EU Energy Efficiency Directive requirements on metering and information into UK legislation which will improve the information and management around heat networks (DECC, Jan 2014, Implementing the Energy Efficiency Directive as it applies to the metering and billing of heating and cooling)

6. Appendices

6.1 Appendix 1 – Roundtable attendance

Attendance at roundtable workshop 1, UK-GBC offices, 20th February 2014:

1. Jenny Hill – Committee on Climate Change (CCC)
2. Jenny Holland – Association for the Conservation of Energy
3. Doug Parr – Greenpeace UK
4. Keith Maclean – SSE
5. Rupert Fausset – Forum for the Future
6. Francis Li – UCL Energy Institute
7. Ben Coombes – Affinity Sutton
8. Peter North – Greater London Authority (GLA)
9. Louise Strong – Which?
10. Nick Molho – WWF-UK
11. Zoe Leader – WWF-UK
12. Duncan Price – Verco
13. Daniel Archard – Verco
14. Max Goodman – Verco

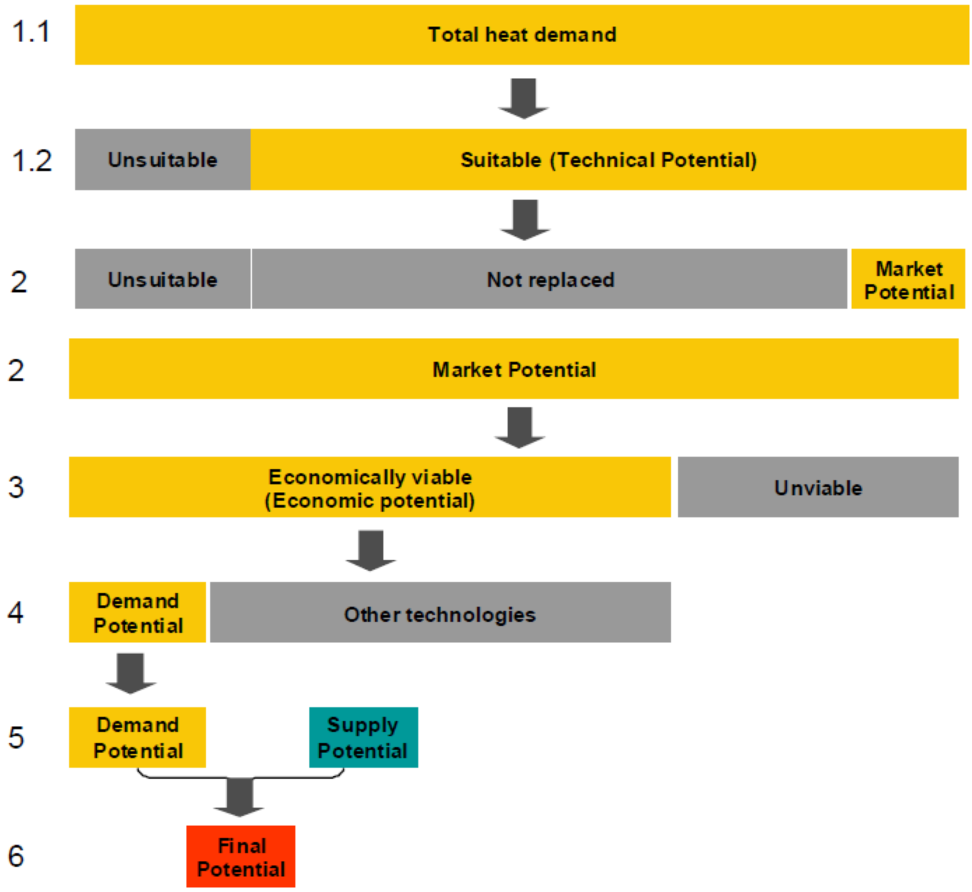
Attendance at roundtable workshop 2, UK-GBC offices, 3rd April 2014:

1. Ute Collier – The Committee on Climate Change (CCC)
2. Jenny Holland – Association for the Conservation of Energy
3. Doug Parr – Greenpeace UK
4. Keith Maclean – SSE
5. Francis Li – UCL Energy Institute
6. Ben Coombes – Affinity Sutton
7. Liz Lainé – Consumer Futures now Citizens Advice
8. Nick Eyre – Environmental Change Institute, Oxford University
9. Rebecca Beeson – Quintain Estates and Development
10. Kirsty Rice – National Trust
11. Rupert Fausset – Forum for the Future
12. Nick Molho – WWF-UK
13. Zoe Leader – WWF-UK
14. Duncan Price – Verco
15. Daniel Archard – Verco
16. Max Goodman – Verco

6.2 Appendix 2 – Modelling methodology behind the Committee on Climate Change low carbon heat scenario

The modelling methodology behind the Committee on Climate Change low carbon heat scenario is outlined in Figure 6-1.

Figure 6-1: Modelling methodology behind the Committee on Climate Change low carbon heat scenario



Key assumptions underpinning the scenario modelling

- Suitability of each technology to space heat applications – e.g. types of building, space availability, and grade of heat required
- Uptake rate constrained by 'stock' replacement rate (7% of heat demand per year)
- Starting point – 2020 projections for low carbon heat supply based on RHI scenario
- Uses DECC projections on fossil fuel price increases
- Supply chain growth is constrained
- Assumes technical improvements in performance of each technology, e.g. heat pump Seasonal Performance Factor reaching 3+ in 2030
- Assumes some reductions in capital cost
- 3.5% discount rate in the central scenario, based on HM Treasury Green Book accounting principles.

6.3 Appendix 3 – Key challenges to the deployment of low carbon heat technologies

6.3.1 Challenges to heat pump deployment

Challenges that are not specifically related to the performance and use of heat pumps are considered in DECC's *The Future of Heating: Meeting the challenge*, 2013:[90]

- **The necessity of increasing energy efficiency:** to drive down heat demand first. Large-scale roll-out of heat pumps is best suited to buildings with a good level of energy efficiency, as they require a lower grade of heat. However, the majority of the UK housing stock is inefficient and draughty, and currently requires higher grade heat.[91]
- **Cost of heat pumps:** gas boilers are a mature and cost effective technology, so a great challenge will be to get consumers to swap from their existing and trusted technology, to a technology with a higher upfront capital cost.
- **Lack of appeal or confidence in low carbon technologies** or understanding of the role of new technologies, such as hybrid heat pumps
- **Limited opportunities for replacing heating systems**
- **Lack of capacity in the supply chain**
- Space requirements for heat pumps & biomass boilers

The Energy Saving Trust heat pump field trials have done much to build the level of knowledge around the in-situ performance of heat pumps. The challenges the trials (and subsequent analysis) have highlighted, are as follows: [92] [93] [94] [95]

- **Many heat pumps underperform** when compared to technical specifications.
- **Heat pumps are sensitive to design and commissioning** but standards have improved, supported by the new Microgeneration Certification Standard (MCS) installer standards
- **Consumer understanding, behaviour, and control** have a big impact on system performance.
- **Driving consumer uptake is seen as a critical challenge**

Another challenge will be that of dealing with the additional pressure on the electricity grid, especially for the generation capacity for peak demand. Heat storage and hybrid heat pump technologies are among the key options for dealing with this challenge.

6.3.2 Challenges to biomass deployment

There are significant barriers to deployment of biomass boilers, throughout all stages of development. The barriers increase the risk and cost of capital of investing in biomass, and increase operating costs. Together these reduce the economic viability of biomass developments. The three main barriers for using biomass technology for generating heat are:[96]

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[90] DECC, *The Future of Heating: Meeting the challenge*, March 2013
[91] Energy Bill Revolution, *Fact-file: The Cold Man of Europe*, March 2013
[92] Energy Saving Trust, *Getting warmer: a field trial of heat pumps*, September 2010
[93] DECC, *Detailed analysis from the first phase of the Energy Saving Trust's heat pump field trial*, March 2012
[94] Energy Saving Trust, *The heat is on: heat pump field trials – Phase 2*, August 2013
[95] DECC, *Detailed analysis from the second phase of the Energy Saving Trust's heat pump field trial*, May 2013
[96] Carbon Trust, *Biomass sector review for the Carbon Trust*, October 2005

- **Market information:** The market for biomass fuel lacks track record, and information – identifying and coordinating large-scale supplies - is difficult to acquire.
- **Fuel supply risks:** The lack of a mature trading market for biomass means that supply risks (quality, price, or volume) introduce risk. The development of reliable feedstock supply chains at the scale required is a challenge, as energy crops constitute main resource potential and there is competition from other uses for land or the biomass feedstock. However, imports could supplement indigenous supply.
- **Planning:** Public opposition to large biomass plant can be strong and, and air quality implications can be an issue for the planning process. The technology also presents additional space requirements for the boiler, fuel store, and delivery of fuel.

Furthermore, the lack of awareness and understanding of biomass by customers leads to a perception of higher risk and poor availability of technical expertise (installation and maintenance).

6.3.3 Challenges to biogas deployment

The report *Barriers to renewable heat: analysis of biogas options*[97], discusses the conclusion that the use of biogas for direct or indirect firing is a technically feasible and financially competitive method for using biogas. However, due to the requirements of scale, flexibility, and land result in the likelihood that only niche industrial markets will be able to commission projects. The report highlights key challenges to overcome in driving uptake of biogas for industrial on-site use, and gas grid injection:

- Demand-side challenges:
  - Availability of food & agricultural waste
  - Lack of business-to-business awareness
  - Lack of public acceptance and awareness
  - Locality of gas grid to generation site
- Supply-side challenges:
  - Lack of quality assurance and enabling policy measures
  - The capital investment required in infrastructure upgrades
  - Gas grid connection equipment costly

In the report *Barriers to biogas use for renewable energy*[98], a range of other challenges (or perceived challenges) are highlighted, in terms of using biogas as a fuel for on-site CHP.

6.3.4 Challenges to the deployment of solar water heating

The report *Solar water heating as a climate protection strategy: the role for carbon finance*, [99] summarises key challenges for solar hot water systems:

- High upfront system cost when compared to conventional systems
- Lack of available financing for solar hot water businesses and consumers
- Lack of awareness about favourable lifetime economics of solar hot water technology, when compared to conventional water heaters

[97] Enviros Consulting, *Barriers to renewable heat: analysis of biogas options*, 2008
[98] Water Environment Research Foundation, *Barriers to biogas use for renewable energy*, 2012
[99] Green Markets International, *Solar water heating as a climate protection strategy: the role for carbon finance*, 2005

- Lack of quality control, which can undermine consumer confidence

In addition, solar water heating has the following challenges affecting its deployment:

- Requires space for large hot water tank
- High percentage of households with a combination boiler (i.e. without hot water tank)
- Requires roof space & less exciting than PV
- Can only provide top-up hot water & therefore seen as an add-on technology
- Relatively high cost in terms of £tCO2 (due to above)