Briefing: Decarbonising heat in buildings

December 2016

Key points

This briefing sets out the critical actions which need to be taken during this parliament to support an increased take up of low carbon heat solutions and ensure that a more comprehensive heat policy can be developed in the next parliament.

1. **A clear action plan is needed** to inspire confidence within the private sector to invest in low carbon heat solutions and pilot projects at an affordable cost, whilst allowing for the stable growth of a low carbon heat supply chain. This should start with the forthcoming emissions reduction plan (ERP).[1]

2. **Low regret solutions in the short term must be exploited**, such as converting homes off the gas grid to electric heat pumps. Taking achievable actions now will facilitate future decarbonisation.

3. **Energy efficiency must be treated as the first step**. Greater efficiency reduces heating demand and improves performance of heat systems. Estimates suggest that there are still up to 2.3m low cost opportunities to install cavity wall insulation[2] and these should be targeted as a matter of priority.

4. **Standards in new builds should be introduced** that require high levels of energy efficiency and compatibility with the future installation of low carbon heat systems. This will help prevent lock in of emissions and avoid expensive retrofitting at a later date. Up to eight million new homes may be built by 2050[3] and they must be future ready.

5. **Local governments must be encouraged to plan for their area**. Local coordination can provide a natural forum for public engagement, helping secure a local mandate for low carbon heat infrastructure.

6. **A clear strategy, timetable and budget for projects piloting new technologies must be put in place** this decade and into the early 2020s so that low carbon heat solutions can be deployed at a much greater scale from the middle of the next decade. Trials can improve our understanding of best practice, skill up the workforce, spread consumer understanding and develop governance principles, all of which ultimately lower risk and by extension the cost of finance.

[1] See the Aldersgate Group's briefing note on the emission reduction plan at www.aldersgategroup.org.uk/latest
[2] As per a forthcoming Energy Saving Trust study for BEIS, as quoted in Committee on Climate Change (October 2016) *The future of heating UK buildings*
[3] Committee on Climate Change (October 2016) *The future of heating in UK buildings*

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BACKGROUND

Decarbonising heat is widely recognised as one the greatest challenges we face, as the UK works to cut carbon emissions by at least 80% by 2050 compared to 1990 levels, as required by the Climate Change Act 2008.

Heat is a complex and whole-system problem, which cannot be solved by considering one part of the solution in isolation. There are different property categories and end-users, with different concerns for the fuel poor compared to households in the 'able to pay' markets, and the domestic compared to the commercial or other non-domestic markets. Policy must take a tailored approach.

Integral to the issue of heat is the improvement of energy efficiency. Greater building energy efficiency reduces the need for additional electricity generation and ensures heat demand is as manageable as possible.

20% **Of the UK's GHGs come from heating for buildings**

The scale of the challenge

The challenge is vast. Heating and hot water for buildings make up 40% of energy use and 20% of greenhouse gas emissions in the UK. Two thirds of this is from housing, with the rest from commercial, industrial and public premises.[4] In 2015, 88% of UK homes were heated by a fossil-fuelled boiler[5] and successful decarbonisation of domestic properties would require the conversion of 20,000 homes per week over 25 years.[6]

Timing

Decisions on heat systems can have an impact for 10 or more years, thanks to heating product lifetimes, while decisions on heating infrastructure can have a 20- to 50-year impact.

These timings mean that it is crucial that planning starts now, to allow for pilot and demonstration projects over the next decade, evidence and learnings to be gathered, an agreed pathway finalised in the 2020s and low carbon heat infrastructure to be put in place by 2035, to meet the 2050 decarbonisation commitment.[7]

Heat policy to date

The Renewable Heat Incentive (RHI) has been the principal tool for increasing renewable heat deployment, although take up for domestic and non-domestic schemes has been low. By the end of 2021, the government expects that the RHI will have supported the installation of renewable heat solutions to warm over 500,000 homes,[8] or 2% of UK households.

On the demand side, policy drivers have sought to improve energy efficiency by tightening standards on Energy Performance Certificates (EPCs), setting minimum efficiency standards for rented accommodation and by providing support to the fuel poor through the Energy Company Obligation (ECO). However, able-to-pay households, such as the owner-occupied properties that represent 59% of all English homes, lack mechanisms to encourage energy efficiency improvements and this has severely limited the improvements to the residential building stock.

[4] Committee on Climate Change (October 2016) *Next steps for UK Heat Policy*
[5] POST http://researchbriefings.parliament.uk/ResearchBriefing/Summary/POST-PN-0523#fullreport
[6] Energy Technologies Institute (2015) *Smart Systems and Heat: Decarbonising Heat for UK Homes*
[7] The Committee on Climate Change (October 2016) *Next steps for UK heat policy*
[8] DECC (July 2016) Single departmental plan: 2015 to 2020

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THE MAIN CHALLENGES

Cost

Meeting the required rollout of energy efficiency and low carbon heat through the 2020s could cost an estimated £1.5-2.5bn a year[9] and will require considerable investment from the public and private sectors. But public finances are constrained and the lack of clarity and perceived high risk of UK low carbon heat policy are a barrier to greater private investment.

Structural variability

The demand for heat is variable, peaking in the morning and evening on the coldest days of the year. This means heat demand fluctuates significantly, which will create challenges in the future if low carbon heat is increasingly powered by electricity.

Low awareness

Low awareness of non-gas boiler technology among consumers and suppliers contributes to low take-up. The perception of alternative technologies being 'too new' can result in a lack of trust in different systems, compounded by a workforce that lacks the skills to install new low carbon heat systems properly.

Consumer behaviour and mandating change

Consumer behaviour favours incumbent technologies. Consumers are sensitive to the high upfront costs of switching heating methods, affected by the fact that new boilers are often 'crisis purchases' (as opposed to planned, considered investments), and are averse to disruption. In non-domestic buildings, the Carbon Trust has identified a barrier which it refers to as the "circle of blame", whereby funders, owner/developers, contractors and consumers or tenants each attribute their own lack of action to lack of demand from one another.[10]

Particularly in households, working with and providing clear information to consumers will be key to support an increased take up of low carbon heat technologies. However, the government must also be aware that there may be instances in the future where technological upgrades may need to be mandated (as in Denmark – see p6) in order to deploy low carbon heat solutions in a way that is most cost effective.

Case study: Addressing consumer challenges

Wilmott Dixon built and designed a retrofit scheme replacing electrical heating in two tower blocks in Leeds with district biomass heating. As a retrofit scheme, they required access to occupied homes to remove existing appliances and install new pipe work, which posed a number of challenges with legal and access issues. A local resident liaison officer was appointed to act as the first port of call for residents' concerns.

The project connected 221 of the 230 dwellings, with pipe work laid and capped off for properties that couldn't be connected, ready for later connection when appropriate.

Willmott Dixon now suggest at least a three month monitoring period during the pre-specification stages of a heat network, including a detailed building assessment which can be used to optimise the design and future growth of a scheme.[11]

[9] Committee on Climate Change (October 2016) *The future of heating UK buildings*
[10] Referenced in UCL Energy Institute (13th October 2016) *A new approach to non-domestic energy efficiency policy*
[11] CBx (November 2016) *Low Carbon Heat Networks: How to Optimise an Existing System for Improving Performance*

The time for trials

Recent research has delivered a broad consensus on the most practical technologies available. The theoretical evidence base must now be built upon with pilot schemes to trial options such as hydrogen and roll out of district heat networks and electric heat pumps.

The results will allow the government to make an informed decision about the most practical and cost effective way to decarbonise heat, whilst identifying where regulatory oversight is needed. For instance there are currently no governance arrangements for heat networks.

AVAILABLE TECHNOLOGIES

There are three technologies available now, which are likely to form the basis of a decarbonised heat system. None is a silver bullet and each will be most appropriate in different scenarios.

Therefore, the aim of UK low carbon heat policy should be to provide a broad range of solutions available to address diverse heating needs and constraints.

1. **Electrification (e.g. heat pumps):** Electrically driven heat pumps harness ambient heat from the environment (i.e. the ground, air or water) and use a compression and evaporation cycle to increase the source temperature. The carbon footprint is dependent upon the source of electricity used. See Table 1.

2. **Greening gas networks (e.g. hydrogen and biogas)**: The current gas system could be converted to run on zero carbon hydrogen. Hydrogen can be produced via electrolysis or conversion from methane. In the short term, there is also the option of injecting biomethane into gas grids. This eliminates disruption to consumers and provides a route for capture and use of methane emissions from biodegradable waste. However, supply of sustainable feedstock limits its potential. See Table 2.

3. **District heating (aka heat networks):** District heating is a network of pipes that carry heat from a centralised location via hot water or steam to buildings in the vicinity. It can supply heat very efficiently and at low cost, but there are currently only a few sources of low carbon heat production, even at limited scale. See Table 3.

TABLE 1. Pros and cons on electrification

Pros	Cons
Require less servicing than gas boilers	Installation requires disruption and high upfront cost to households
Suitable for off-grid areas as well as high-rise buildings with low space heating requirements. However, they are most effective in well-insulated properties	Greater electrification would increase demand on the electricity system, particularly at peak times, requiring an additional 40GW[12] capacity and potential reinforcing of local electricity networks
Three times more efficient than gas boilers	Requires additional generation capacity to be low carbon
	High running cost due to the cost of electricity versus gas (three times more expensive, at current energy values)

[12] Written evidence submitted by the UK Energy Research Centre to Energy and Climate Change Committee inquiry on the 2020 renewable heat and transport targets (April 2016)

TABLE 2. Pros and cons on greening gas networks

Pros	Cons
Upgrading existing network means no need for new infrastructure	Large scale, low cost hydrogen production facilities would be needed
No disruption in premises or from street works, and it has similar characteristics to natural gas in terms of responsiveness, ensuring simple customer experience	Electrolysis is very expensive and still at a small scale, whilst conversion from methane relies on CCS technology which the UK does not currently have
Hydrogen can be stored in similar facilities to natural gas	Requires a switch within households to hydrogen-compatible appliances
Potential co-benefits for decarbonising other sectors (e.g. seasonal power generation, HGVs, industrial processes)	

TABLE 3. Pros and cons on district heating

Pros	Cons
Very efficient and low cost means for heating – can make use of waste heat for example	Currently only limited sources of low carbon heat production exist
Suitable in dense, urban mixed-use areas with anchor clients, such as municipal buildings and leisure centres	Financing models are unattractive due to high perceived risk profile, and uncertain revenue
Networks can store heat, to help tackle system balancing issues and reduce seasonal fluctuations	Considerable local level disruption and logistical barriers
Easier to swap to low carbon generation at the source, rather than at individual household level	Less than 20% UK heating needs can be fulfilled by heat networks[13]

Case study: H21 Leeds City Gate Hydrogen feasibility study

Northern Gas Networks (NGN) has undertaken a feasibility study into converting the gas network in Leeds to make it the world's first hydrogen city within a decade. The study found that the plan is viable, delivering a 73% reduction of CO_2 (including electricity used for sequestration) with minimal disruption to customers. Hydrogen conversion could also be rolled out across the UK by 2050. The feasibility study also suggests that a hydrogen network could revolutionise potential for hydrogen vehicles and support a decentralised model of combined heat and power via fuel cells.[14]

NGN has received over £300,000 from Ofgem to fund this study. A pilot in the next decade will help to answer questions around financing a conversion of this scale, consumer behaviour, and mechanics. NGN is seeking an additional £55m to develop a roadmap with further studies.

[13] Poyry found in 2009 that district heating could fulfil 14% of the UK's needs if development is de-risked and a price on carbon is applied to gas. A report commissioned by the CCC found that networks could supply 18% of heat by 2050 according to their central scenario. Sources: Poyry (April 2009) *The potential and costs of district heating networks*; Frontier economics & Imperial College London (November 2015) *Research on district heating and local approaches to heat decarbonisation*

[14] Northern Gas Networks: H21 Leeds City Gate

NEXT STEPS FOR HEAT POLICY

The forthcoming emissions reduction plan (ERP) will be crucial in setting a clear timetable for developing the UK's heat strategy through to the 2030s[15]. A clear action plan setting stable policy drivers will be needed to leverage the scale of private investment needed to support low carbon heat.

Banks in Iceland and Denmark compete to loan to district heating projects thanks to perceived policy stability. The UK government is providing £320m in funding for local heat infrastructure over the next five years, looking to support heat for over 400,000 homes and to draw in an additional £2bn of investment. A step-by-step action plan will be key to making heat an investible prospect and there is plenty that can be tackled immediately.

Low regret options

The Committee on Climate Change has identified several sensible low regret options that the government can implement now:

- roll out heat pumps to homes off the gas grid
- establish heat networks in cities
- inject biomethane into the gas grid

Energy efficiency

Energy efficiency must be treated as the first step for any heat strategy, ensuring the increased electricity demand created by electrified heat is as manageable as possible. Policy support is urgently needed to drive energy efficiency improvements among the able-to-pay households. These could be targeted at natural points of change in a building's life, or 'trigger points' on consumer behaviour, such as through green mortgages or lowered stamp duty for energy efficient housing. In the non-domestic market, mandatory carbon reporting is important driving salience in energy efficiency at the board level.

Stricter boiler efficiency standards should be maintained to ensure the most efficient use of gas. There are still up to 11.5 million non-condensing boilers used in the UK and of these about five million are believed to be highly inefficient.

Regulation

Building regulations must ensure the new building stock is future ready. Up to five million new homes may need to be built by 2030 and eight million by 2050. But current new-build regulations have lower energy efficiency targets than comparable standards in competitor countries such as Denmark and Germany and are not designed to drive low carbon heat take up. Building regulations should establish a timeline, aligned with commercial timescales, for tightening energy efficiency standards for new builds and require that new buildings either incorporate lower carbon heat technologies or are ready to do so at low cost in the future.

Local delivery

Heat favours a local approach to planning and delivery. Local authorities are often best placed to understand the needs and restrictions of their areas and to join up and support the chain of decision-makers (such as householders, social landlords, installers and suppliers). Coordination and support at a local level can also provide a natural forum for public engagement, which is vital for securing a local mandate for infrastructure and can help avoid costs and delay.

When establishing new heating infrastructure, consumers within a certain area frequently have to adopt the same technology in order to achieve economies of scale. Zoning has been introduced in Denmark, where heat networks supply over 60% of homes. This strict model of zoning requires mandatory connection to heat or natural gas networks and banning of heat pumps in collective supply areas.

[15] Read more: http://bit.ly/2geRYEi

Case study: District heating in London
The Greater London Authority has made it compulsory for developers in London to connect to a low carbon heat network if there is one in the vicinity and to future-proof new developments for connection at a later stage.[16]

The Bunhill Energy Centre, set up in November 2012, is a district heating system that uses waste heat from electricity production to heat 850 homes in council estates and a new housing development, alongside two leisure centres. Islington Council estimates that the initiative has generated a 60% CO_2 saving for the estates and leisure centres within the network, compared to previous heating systems.

The system was future-proofed with a flexible design to allow for expansion. Islington is currently extending the heat network to provide additional production capacity for a further 454 homes in the area, with the potential to supply a further 1,000 homes, capturing waste heat from the London Underground network.[17] A study by BuroHappold found that there is enough heat wasted in London alone to meet 70% of the city's heating needs.[18]

The Mayor's office has set a 25% target of heat from decentralised energy sources by 2025[19] and has produced an online heat map to help stakeholders identify opportunities. London is also implementing the Zero Carbon Homes standard in spite of its cancellation at a national level.

In the UK, Local Authorities should be involved in the planning and delivery of heating options and be given the power to introduce local-level regulations, such as bans on gas boilers where appropriate.

Pilot projects
The government must establish a clear action plan for pilot schemes across available and nascent technologies, with reliable timelines running from trial to deployment at scale by 2030. This will create a knowledge and skills foundation on which to base future policy decisions. For example, industry best practice and experience in delivering systems to date should inform future investment strategy in low carbon heat networks, to ensure that networks are based on actual (rather than modelled) efficiency levels in heating systems to deliver real carbon savings. Pilot projects can also draw out which governance relationships between BEIS and other stakeholders have yet to be created to ensure new systems and networks are operated efficiently. Taking an incremental development approach to this problem will avoid relying on a 'too little too late' solution in the 2030s.

Below we have set out the recommended timings for government action on low carbon heat.

[16] CCC (October 2016) *The future of heating UK buildings*
[17] Read more: http://www.isep.org.uk/wp-content/uploads/BUNHILL-case-study-2013.pdf & https://www.islington.gov.uk/environment/energy-services/bunhill-heat-power
[18] https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/031250 GLA Secondary Heat - Summary Report_0.pdf
[19] London Plan Chapter Five: London's Response To Climate Change (March 2016)

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PRIORITIES FOR THE GOVERNMENT

Short term
2016-2020

- Introduce higher product efficiency standards on heating systems, such as air pumps and gas boilers
- Address easy-to-treat retrofits
- Introduce building regulations for higher energy efficiency standards in new builds, ensuring that they are also suitable for low carbon heat technologies
- Introduce a new mechanism to incentivise energy efficiency upgrades in the able to pay market, particularly at key strategic points through green mortgages and stamp duty
- Roll out heat pumps for homes off the gas grid
- Establish infrastructure for heat networks in core cities, working with local authorities to create processes for zoning
- Major communications campaigns to prepare consumers
- Develop a clear timeline for pilot schemes working with local authorities and with business
- Research feasibility of low carbon hydrogen

Medium term
2020-2030

- Continue to increase efficiency standards in new builds and existing buildings, tackling harder to treat retrofits
- Develop communications with consumers
- Develop skills training for installers
- Run low carbon heat demonstration schemes
- Use learnings from pilot schemes to develop governance arrangements for new systems and networks
- Take a decision on the use of hydrogen and by extension, CCS

Long term
2030 – 2050

- Phase out of gas boilers
- Rapid deployment of new heating infrastructure

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