Department
of Energy &
Climate Change

The Future of Heating: Meeting the challenge

Executive Summary

March 2013

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This publication can be found on the Government's website:
www.gov.uk/decc

Published by the Department of Energy and Climate Change.

Ministerial Foreword

In a world facing the threat of catastrophic climate change, it is the job of my department to lead the UK into a thriving low carbon economy, achieving our ambitious target of an 80% cut in greenhouse gas emissions by 2050.

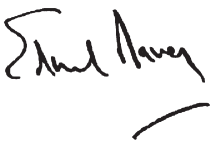
We are making excellent progress: on track to meet the first three carbon budgets, on track to meet our EU target for renewable energy, in the midst of some fundamental reforms to our electricity markets via the Energy Bill, and having just launched the ground-breaking Green Deal programme to help drive energy efficiency across the country. In the coming years, every home will be supplied with a smart meter, and consumers will be much better placed to make informed choices about their energy needs and where to get their energy from.

But that is not enough. As we stated last year, there has been a historic failure to get to grips with one enormous part of the energy jigsaw; the supply of low carbon heat. Energy efficiency and better informed consumers help to tackle the demand for heat, and market reforms are helping to decarbonise the supply of electricity. We have, however inherited a big hole where there should be policy for finding alternatives to fossil fuel for the supply of heat.

This document plugs that hole. It deals systematically with all the different heating requirements in the UK; and there are many. In a country like ours, and for obvious reasons, we require a lot of heat: a consequence of our geography, our housing stock and the scale of our industrial activity.

As a country, we spend £32 billion a year on heating. It accounts for around a third of our greenhouse gas emissions. Without changing the way we produce and consume heat, we will not meet our long-term climate change target. To get there, we are going to have to change the way we generate, distribute and use heat in buildings and industry. And we are going to need those changes to take place in an orderly, cost-effective way that ensures a vibrant, low carbon economy and a supply of affordable energy for all consumers.

I am delighted to be able to report on our progress in meeting the challenge.



Edward Davey
Secretary of State for Energy and Climate Change

Executive Summary

1. Last year the Government published *The Future of Heating: A strategic framework for low carbon heat in the UK*, 'the Strategic Framework', a document which set out for the first time a framework for solving the problem of ensuring there is affordable, secure and low carbon heating up to 2050.

2. This year we are publishing the follow-up, entitled *The Future of Heating: Meeting the challenge*. This Executive Summary provides the key highlights of the four chapters, which deal with four different aspects of the heat challenge: industrial heat; networked heat; heat in buildings; and grids and infrastructure.

The Shard, which houses retail outlets, offices, restaurants, a five-star hotel, residences and viewing galleries, is heated by a Combined Heat and Power system with a network taking heat around the whole building. It has been awarded an "Excellent" rating under the BREEAM green building certification.

Chapter 1: Efficient Low Carbon Heat in Industry

The situation

3. UK industry consumes very large amounts of energy. Over 70% of that energy is used to provide heat, often at very high temperatures. Most of the heat is obtained by burning fossil fuels (predominantly gas, but also some coal and oil). 64% of energy demand for heat is from six key industrial sectors: oil refineries, basic metals, food and drink, pulp and paper, non-metallic minerals (including ceramics, cement and glass), and chemicals. These sectors form the central focus of the first chapter.

4. In the Strategic Framework document, DECC considered the challenge of reducing emissions from heat in industry. It concluded that this could be done through more efficient processes and equipment; switching to lower carbon fuels; and Carbon Capture and Storage (CCS). In addition, industries which consume large amounts of heat will often install a Combined Heat and Power (CHP) scheme, which provides them with electricity to use and often an excess to sell on to the national grid.

5. Options for decarbonisation vary by industry-specific processes, size, age and location of each particular plant. There are some industrial processes which, by virtue of the chemical reactions required for production, will continue to emit CO_2. Industrial CCS will be required in some cases to decarbonise the heat supply. While the energy efficiency market is more developed in energy intensive industries, in part due to higher levels of awareness, there are still commercial and technical barriers, and challenges related to delivery.

The barriers we need to overcome

6. Energy-intensive industries already put significant effort into process efficiency since fuel costs are a significant part of their overall costs, in some cases larger than the cost of the raw materials themselves. This means that there are few easy ways of saving significant amounts of carbon through further efficiency improvements to existing processes. The major reductions will come from switching fuels or capturing carbon. But short-term pressures mean industry itself is unlikely to devote many resources to considering these longer-term options, the things which will need to happen in coming decades if carbon targets are to be met. Moreover, the technical feasibility and cost of various low carbon options vary considerably between sectors, and between processes. One significant barrier is therefore that industry, government and academia do not know enough about the abatement potential on a sector-specific basis between the options.

7. Among these potential options there are some that are relatively well-established like CHP. Here, the barrier is the large initial capital investment required, and the fact that competing investment opportunities are often more profitable.

8. Other options are more innovative, such as CCS, and capturing waste heat to re-use in lower temperature processes such as heat networks. Here, the barriers are around the need for innovation, and a lack of incentive for industry to pursue these options.

Next steps

9. In light of this analysis, the Government proposes the following next steps:

- DECC and BIS will work with industry to develop a decarbonisation 'roadmap' for each industrial sector for the long term, focusing on the sectors that use the greatest amount of heat and represent the greatest CO_2 emissions.

- DECC and BIS will work together over the remainder of the year to identify how to further support development of CCS technologies for industrial emitters as part of the Government's wider efforts on CCS.
- New DECC commissioned research is underway to assess the technical and economic potential for re-use of recovered heat as a low carbon energy source. DECC will then use this evidence to explore the scope for extra incentives for use of recovered 'waste' heat from industry, in particular alongside the non-domestic RHI review in 2014.
- DECC will work on developing a bespoke policy to support new natural gas-fired CHP capacity, subject to confirmation that this will not displace low carbon generation. This policy will aim to reflect the range of different scales, technologies and commercial motivations in the CHP market.
- BIS and DECC will explore the use of European Regional Development funding to support CHP and waste heat recovery by Local Enterprise Partnerships.

Chapter 2: Heat Networks

The situation

10. In the UK, we commonly think about heat as something generated on-site in individual buildings; the most common sources of space heating being gas boilers, electric heaters, and oil boilers. However, in many parts of the world it is common to have networks (district heating) to transport heat to consumers through insulated pipes, so that the source of the heat is not within the building and is on a larger scale. These do exist in the UK (typical examples can be found on university campuses, in new inner city mixed commercial and residential developments, and in high-rise flats). The Government believes there is great potential to develop networks so that they can play a part in the move to low carbon heating. But a heat network is only a method of distribution; the carbon intensity of the heat depends on the source of the heat in the pipes.

11. This conclusion was spelled out in last year's Strategic Framework document: heat networks can allow us to benefit from many new sources of heat such as waste industrial heat; deep geothermal heat; and large-scale heat pumps. They also offer energy storage potential, which is important given the highly variable nature of demand for heat, and the growth in intermittent renewable electricity supplies.

12. Heat networks can be used to provide cooling alongside heating. In recent years the commercial sector has increasingly prioritised the need for cooling in offices and retail units. This is likely to increase further with more IT equipment in buildings and the anticipated effects of climate change itself. Where the heat supply is constant throughout the year, it is more efficient if it is also meeting cooling demand in the summer.

13. Since last year's document, Government has begun the process of supporting cities that already have plans to develop or expand low carbon networks, providing £1m to Manchester, Leeds, Newcastle, Sheffield and Nottingham as part of the wider 'City Deals' programme.

The barriers we need to overcome

14. Heat networks are major infrastructure projects, and financing them can be a significant barrier, though it is not the only one. Government has taken forward a programme of work over the last year to identify and find ways of addressing a whole range of barriers which are described in detail in the chapter. Stakeholders have contributed their ideas, and research and modelling has been carried out to better understand the current barriers and future potential of networks. There is broad consensus over the main barriers: projects struggle to get started because of difficulties that local authorities face in financing the early stage objective-setting, planning and feasibility

work; projects often face difficulties in attracting finance through development and reaching commercialisation; this in turn depends on a need to ensure a consistent return on investment. There are practical issues around identifying and implementing appropriate contract mechanisms as there are sometimes issues over consumer acceptability and protection. There is also a lack of understanding about low carbon alternatives to fossil fuel heat sources.

Next steps

15. In light of this analysis, the Government proposes the following next steps:

- DECC will support local authorities in developing heat networks by establishing a Heat Networks Delivery Unit (HNDU) within the Department that will work closely with project teams in individual authorities.
- DECC will provide funding over two years to contribute to local authorities' costs in carrying out early stage heat network development. This will enable local authorities to bring forward projects to the stage where they are suitable for investment by the Green Investment Bank and commercial lenders.
- DECC will seek to endorse an industry-led consumer protection scheme for heat network users later this year, and encourage the heat networks industry to work with consumer groups in developing this practice.
- DECC will implement Article 9 of the Energy Efficiency Directive, which covers heat metering. This will include a public consultation.
- DECC will work with the Low Carbon Innovation Coordination Group (including the Carbon Trust, BIS, the Energy Technology Institute, the Technology Strategy Board and the Scottish Government) to identify the key technological solutions that require innovation support.
- DECC will consider further how heat networks can be better supported as part of the next Renewable Heat Incentive policy review in 2014.

Chapter 3: Heat and Cooling For Buildings

The situation

16. By ensuring that the UK's homes and buildings are more energy efficient and better insulated, demand for heat can be significantly reduced, cutting energy bills and carbon emissions. That is why the Government has introduced the Green Deal, and is rolling out smart electricity and gas meters into homes and smaller businesses by 2019.

17. But there will always be demand for heat in buildings, and in the future that will need to be met as far as possible without burning any fossil fuels. The Carbon Plan explained that by 2050 carbon emissions from heating and cooling buildings will need to be nearly zero to meet the overall target of cutting greenhouse gas emissions by 80%. This means finding less carbon intensive ways over the long-term to heat not just those buildings which rely on oil or coal, but also all those currently using natural gas (the majority of homes and buildings).

18. The Strategic Framework suggested a combination of an increase in heat networks in urban areas and promoting the uptake of renewable heat in rural off-gas grid areas in the short to medium-term, whilst planning ahead for the changes to gas heating which will be required in the decades to come.

19. Since last year, further consumer research and modelling, including updated costs, has suggested a number of options for new policies in the medium to long-term.

The barriers we need to overcome

20. New research – and schemes such as Renewable Heat Premium Payments – have helped Government to understand the key barriers preventing mass uptake of new heating technologies. As well as the upfront cost (most renewable heating solutions currently cost considerably more than a condensing gas boiler, though they can be cheaper to run once installed), there is a lack of awareness of the different technologies. Consumers are also wary of the disruption of installing new technologies and have concerns about reliability. DECC is also building the evidence base around how consumers can reduce energy use by changing routine behaviour in their homes. There is a need to develop the supply chain, including installer skills, and a need for greater certainty over standards.

Next steps

- The Government will extend the Renewable Heat Premium Payment scheme. The extended scheme will run until the end of March 2014.
- DECC will introduce a voucher scheme for installer training to build up the installer base in preparation for the domestic Renewable Heat Incentive.
- DECC will pilot a green apprenticeship scheme over the coming year, with the aim of offering 100 places in the renewable heat sector.
- DECC will support development of a new consumer guide produced by industry and consumer organisations, improving the way low carbon heating is communicated to consumers and providing advice to installers and intermediaries such as local authorities.
- DECC will explore what role tighter standards on building emissions and heating systems could play in achieving the goal of decarbonising heat in all buildings between 2020 and 2050.

Chapter 4: Grids and Infrastructure

The situation

21. Following a pathway to low carbon heat will, over time, mean significant change for energy infrastructure. It will have impacts on existing gas and electricity networks; lead to the emergence of new infrastructure like heat networks and heat storage infrastructure, and potentially also new infrastructure to support hydrogen use and to take carbon dioxide away. The most recent economic modelling on the future scenarios for heat supply, consistent with emissions reduction goals, suggests a much more diversified range of heat technologies in the future. This includes roles for electric heating, and gas and hybrid heat pumps and heat networks (with a range of heat sources) for buildings, and fuel switching and technological innovation for industrial heat, including CCS.

22. Decisions on the different elements of the UK's infrastructure cannot be taken in isolation. There will be a number of economic and technical trade-offs and constraints that will impact on the respective scale and pace of infrastructure development across the whole energy system in the coming decades.

The barriers we need to overcome

23. Addressing consumers' and businesses' attitudes to the supply of heat and new heat technologies will be central to the low carbon transition. There will be commercial, regulatory, financial and practical challenges in designing and steering the commercial deployment of new technologies, their supporting infrastructure and the re-purposing or decommissioning of existing infrastructure. For example, this will include the practicalities of building new networks and migrating customers to these new networks.

24. There are a number of investment challenges required to unlock the funding needed to achieve the scale of change required.

Network investments have a long lifespan and require detailed forward planning to ensure they are cost-effective. There is also the risk of investing in potentially sub-optimal solutions, where this may result in stranded assets.

25. The timing and scale of a transition to electric heating technologies raises implications for electricity capacity and balancing requirements, such as the impact on the electricity network of large numbers of electric heat pumps, particularly during the coldest winter months. A shift to electrification of heat also raises implications for rural distribution networks, for example in the costs associated with network reinforcement technologies. It will therefore be important to understand the trajectory and costs and deployment implications for networks and consumers.

Next steps

- DECC will take forward work to examine the strategic interaction between lower carbon electricity generation and heat production.
- Related to this, DECC will this year be commissioning further research to improve understanding of the role hydrogen could play across our energy system.
- DECC will shortly announce the successful Phase 2 demonstration projects for its Advanced Heat Storage competition. Projects will commence in the spring of 2013 for a twelve month period. The projects will trial prototypes of novel compact heat stores which can be integrated with low carbon technologies (such as heat pumps) to help balance peak loads on the electricity grid.
- In 2013 DECC is exploring with the industry how best to address the strategic questions facing the gas network.

Evidence Annex

26. This annex sets out new evidence that underpins the analysis and conclusions in this policy paper. The annex is divided into nine sections.

27. **Section one** describes the lower carbon heating technologies, and their characteristics. This includes existing technologies, as well as descriptions of technologies still in development or not yet used in the UK.

28. **Section two** describes the modelling DECC has commissioned to understand the possible pathways to decarbonising heating out to 2050. DECC has used two 2050 cost-optimisation models (RESOM and ESME) which deal in greater detail with the need for reductions in emissions from heat. As optimisation models they show the least cost mix of technologies to allow us to reach our 2050 emissions target. The RESOM core run shows a similar overall picture for 2050 as presented in the Carbon Plan with natural gas remaining the main fuel until the 2030s, but reducing thereafter. The new feature of the model is that it selects more frequently 'hybrid' systems in the domestic sector where gas boilers are used in conjunction with heat pumps. The ESME core run shows a diverse mix of technologies. The overall picture shows gas as the main fuel used to provide heat up until the 2040s, but then a rapid switch to other technologies by 2050. The results show a more limited role for gas in 2050, mainly in gas source heat pumps rather than in traditional gas boilers.

29. **Section three** describes the early stage development of DECC's Heat Networks modelling, which complements the Department's National Household Model. Provisional results confirm that heat networks can play a large role in domestic heating. Discount rates and payback periods are key because of the initial high capital cost of infrastructure. In the modelling, gas CHP heat networks appear to be the least cost heating solution in the majority of areas that it is considered to be suitable.

30. **Section four** reports findings of a qualitative research project commissioned to look at the barriers to the development of heat networks. The research also considers approaches that overcame these barriers. Barriers include difficulties with funding; the uncertainty of both heat demand and availability of heat supply; lack of transparent pricing structures, standard contract mechanisms and regulatory framework; and a skills and knowledge gap.

31. **Section five** reports the findings from various customer insight surveys. Key findings from the research include that there were wide variations in behaviours that affect gas consumption, but that no particular behaviour identified a consumer as a high or low gas user; and that education programmes provided at the same time as the adoption of new technology can act to help change more routine behaviours.

32. **Section six** summarises quantitative and qualitative research into homeowners' willingness to replace their heating systems. Key findings include: that on-gas grid homeowners were generally more satisfied than off-gas homeowners with their heating system; that there is a relatively low awareness of renewable and low carbon heating solutions; that technology preference is the biggest driver of choice; that a high proportion of people would only replace their heating system in an emergency; and in that emergency, they would choose a familiar technology.

33. **Section seven** sets out the economic modelling for gas CHP. It suggests a modest growth is projected in conventional (i.e. non-renewable) CHP capacity from 7.4 Gigawatts electrical (GWe) currently to 8.9 GWe by 2020. DECC will continue to refine the CHP model to improve its capability to model policy interventions.

34. **Section eight** presents the early findings from the evaluation of the first Renewable Heat Premium Payments (RHPP1) scheme. Early findings show that customers were predominately aged 45 or older and tended to have higher incomes than the national average. RHPP1 customers were more concerned about energy security and climate change than most consumers. The majority of households stated that 'saving money' was an important consideration. Distribution of uptake between the four types of renewable heating technology was relatively even. The preliminary data from the RHPP metering programme is still being verified but suggests that on average there has been a measurable but modest improvement in the Seasonal Performance Factor of heat pumps.

35. **Section nine** is a series of data sheets on heat-intensive industrial sectors, which have been worked up with the industries themselves:

- paper and pulp;
- cement;
- food and beverage products;
- glass;
- oil refined products;
- iron and steel;
- chemical products; and
- ceramics products.

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URN: 13D/075