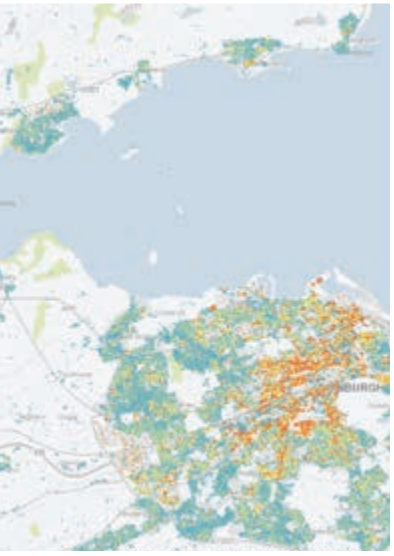


The Scottish Government
Riaghaltas na h-Alba

TOWARDS DECARBONISING HEAT: MAXIMISING THE OPPORTUNITIES FOR SCOTLAND

DRAFT HEAT GENERATION POLICY STATEMENT FOR CONSULTATION

Ministerial Foreword

A modern vibrant economy, operating in a cool, wet climate, needs to have access to appropriate warmth to thrive. We are an energy-rich nation where heat accounts for over half of all the energy we use, with an estimated £2.6 billion a year being spent on heating and cooling in Scotland.

We are facing unprecedented challenges to the ways in which we generate and use energy for heating and cooling which have developed over the last decade.

In 2009, the Scottish Parliament unanimously set Scotland ambitious climate change targets, including a minimum of an 80% reduction in greenhouse gas emissions by 2050 and a world leading 42% reduction by 2020. We have also seen households and businesses face rapidly rising energy costs due to changes, primarily, in the wholesale gas market. The imperative to seize opportunities to boost economic growth and ensure more affordable warm homes by exploiting the opportunity for more productive use of energy for heating and cooling grows. And whilst we expect a mix of heat sources moving forward we will see a move to reduce our reliance on fossil fuels and growing proportions of low carbon and renewable generation.

We have made significant progress in reducing greenhouse gas emissions and reducing the need for heat. For example, we have committed nearly a quarter of a billion pounds of funding to tackle fuel poverty over a 3 year period. However there is far more still to be achieved to meet our long-term targets. This document sets out the Scottish Government's developing heat generation policy for delivering solutions to these challenges. It sets out the approach that will deliver an affordable and effective heating and cooling framework for Scotland through to 2050.

We can meet these challenges in a way that will deliver commercially viable, diverse systems of heat generation and use for Scotland; and which supports a competitive business and industry base, provides affordable warmth for householders, addresses climate change imperatives and tackles our over-reliance on fossil fuels. These aims can only be achieved in close collaboration with a wide range of public, private and community stakeholders.

We must seize the opportunity of additional powers in an independent Scotland. An independent Scotland will be free to design a new means of funding and delivering energy efficiency improvements to Scottish homes that is fairer and better suited to our needs. The current Westminster scheme to address fuel poverty and improve

energy efficiency is operated through energy companies. The costs of programmes like the Energy Company Obligation (ECO) are met by householders through their energy bills irrespective of income. We plan to permanently transfer responsibility for ECO and Warm Homes Discount from energy companies to the Scottish Government - and to meet the costs from central resources. By passing on these cost reductions to their consumers, energy companies will be able to reduce bills on a long-term basis. This change will be made at an appropriate point to ensure continuity of work for Scottish businesses in the energy efficiency provider sector and for households and landlords arranging for improvement works.

Moving to a largely decarbonised heat sector by 2050 requires action by householders, business and the public sector across Scotland. We will continue to encourage householders and business across Scotland to reduce their demand, and use lower carbon options through our support programmes. New and emerging initiatives covered within this document include:

- a national heat map, a new data base tool that will help visualise opportunities and support Scottish heat planning and projects. We will support the use of recoverable heat by ensuring the planning system and our enterprise agencies support the co-location of relevant industrial plant.

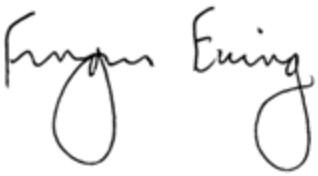
- a target for 40,000 more homes benefiting from affordable low carbon heat from district heating complementing our fuel poverty targets. This is part of a target of 1.5TWh of heat delivered by district heating by 2020 to both domestic and non-domestic properties.

- we will prioritise the development of the emerging district heating sector increasing funding for the District Heating Loans Fund by over £4 million, making a total of £8 million available over the two years 2014 to 2016. We will continue to support projects to come forward to secure Renewable Energy Investment Fund finance.

- new work on exploiting Scotland's geothermal heat resource. We will support the development of a geothermal industry initially through developing a call for a geothermal heat or heat and power demonstration projects. This is one of the key recommendations in our recently published report identifying significant geothermal energy potential in Scotland.

These initiatives demonstrate the direction of travel we wish to take to support a vibrant, commercially viable, low carbon heat sector in Scotland to 2050.

Fergus Ewing
Minister for Energy, Enterprise and Tourism



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Executive Summary

1. In 2009, the Scottish Parliament unanimously set Scotland's ambitious climate change targets, including a minimum 80% reduction in greenhouse gas emissions by 2050 and a world leading 42% reduction by 2020. The Scottish Government has set linked targets, including by 2020:

- an energy efficiency target to reduce total final energy consumption in Scotland by 12% (against a baseline of the average final energy consumption in 2005-7)
- delivery of 11% of non-electrical heat demand by renewable sources.

2. Reducing the carbon intensity of heat is central to achieving these targets. Modelling carried out on behalf of the Scottish Government by Arup suggested that, when looking at electrical and non-electrical heat use, over half the greenhouse gas emissions from heat in Scotland are from industry and over a third are from domestic properties.

3. This document explains the challenge facing Scotland in largely decarbonising its heat system by 2050, what the Scottish Government is doing with its partners to tackle this challenge, what the next steps are, and who is going to deliver them. It sets out the Scottish Government holistic policy for heat use, supply and generation, as part of our wider energy policy.

4. **Section 1** sets out what we mean by heat and the key challenges: to deliver solutions to the challenges of largely decarbonising our heat system, reducing reliance on fossil fuels, reducing the pressure on household energy bills, in particular for the fuel poor; and seizing the economic opportunities that are presented. It sets out the opportunities resulting from delivering a largely decarbonised heat system, our Heat Vision and our Heat Hierarchy: to reduce the need for heat, to supply heat efficiently and at low cost and to use renewable and low carbon heat to deliver the heat we need.

5. In **Section 2** we set out how heat, which is estimated to account for over half of all the energy we consume in Scotland (including energy for transport), is used. We outline the cost of heat to consumers and set out some of the **key actions to tackle fuel poverty** and support householders with energy costs.

6. **Section 3** sets out the **economic impacts of low carbon heat** and the work that has been carried out to improve the **evidence base** and some of the implications of the different illustrative routes. In order to develop robust heat policy, further evidence is needed to better understand the **options and trade-offs of different illustrative routes** to our use and generation of heat being largely decarbonised.

7. In **Section 4** we outline our existing policies and progress to reduce the need for heat through **encouraging and supporting individuals and business and industry to change behaviours, and investment in resource efficiency**. Demand reduction helps to minimise energy bills and realise wider economic

benefits. It helps to reduce fuel poverty and reliance on fossil fuels and is a major contributor to mitigating emissions from heat. As a result it sits at the top of both the Scottish Government Energy and Heat Hierarchies. It will require a significant change in the approach by the whole of Scottish society to energy use.

8. We are **making good progress towards our 2020 12% reduction target for energy efficiency**. In 2011, final energy consumption, including energy used for heat, power and transport, was 9.2% lower than the baseline (2005-2007). Non-electric heat demand has reduced by 10.6% over the same period[1].

9. Moving forward:

- We have **committed to providing nearly a quarter of a billion pounds** of funding **to tackle fuel poverty and improve domestic energy efficiency**, including providing heating systems, **over a 3 year period**.
- We are developing proposals with key stakeholders for draft regulations that would set minimum standards for energy efficiency in private sector housing, consulting in Spring 2015.
- We are working to ensure UK wide programmes such as ECO and Green Deal are being streamlined and improved to increase uptake in benefits in Scotland
- We will continue to **support business, industry and the public sector through our £7.3m Resource Efficient Scotland programme and SME loans scheme**.
- With our partners, we will deliver a skills system that is responsive to the future skills challenges which new technologies and business growth opportunities present.
- We will apply **Energy Performance Regulations** under development to large non-domestic buildings which are subject to sale or to a new lease.

10. In **Section 5** we outline our existing policies and progress to support **efficient heat supply through district heating and thermal storage**. Supplying heat efficiently will help to reduce costs to consumers and reduce emissions from heat and our reliance on fossil fuels. Efficiency supply options have been shown to reduce fuel poverty and there is a significant economic opportunity presented by efficient supply, particularly when coupled with other low carbon and renewable technologies.

11. Moving forward:

- We will publish the **Scotland heat map in Spring 2014** and make heat map **datasets available to Scottish local authorities** from April 2014 to support local strategic heat planning.
- We will **set a target for district heating**. We propose an overall target of 1.5 TWh of heat to be delivered by district heating by 2020.
- We propose a target of 40,000 homes to be supplied with affordable, low carbon heat through heat networks and communal heating by 2020.

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[1] Energy in Scotland 2014, a statistical compendium: http://www.scotland.gov.uk/Topics/Statistics/Browse/Business/Energy/Compendium2014

- We are **increasing funding for the District Heating Loans Fund by over £4 million**, making a total of £8 million available over the two years 2014 to 2016. This is **part of a £10.5 million package** of support for heat policy over the next two years.
- We have initiated research to provide the basis for future policy development in thermal storage.

12. In **Section 6** we consider the opportunities for using low carbon technologies and renewables to provide our heat source, an important aspect of the heat hierarchy. Low carbon and renewable heat technologies can support emissions reductions and can offer significant economic opportunities to reduce industry and householder costs and enable new or emerging sectors to develop products and services for use around the world. Some of these technologies can also reduce our reliance on fossil fuels.

13. Section 6 also outlines existing policies and progress to support low carbon and renewable heat technologies through financial incentives such as the renewable heat incentive and the Warm Homes Fund, the SME Loans Scheme and in depth advice programmes for householders.

14. Moving forward:

- We will **support Scottish based industries** to develop individual **sector 'roadmaps' for decarbonisation**.
- Through the Scottish Environment Protection Agency (SEPA) we will encourage industry to identify sources of unused excess heat so that benefits from this can be maximised.
- The Scotland heat map and heat map datasets offered to each local authority will also support identification of low carbon and renewable energy projects.
- **We will support the uptake of the Renewable Heat Incentive** by continuation and, where necessary, adjustment of existing activities that support the uptake of renewable energy such as the SME loans scheme and in-depth renewable energy advice.
- Work closely with industry, academia and Scottish Enterprise, Scottish Development International and other public sector partners to **develop a call for geothermal demonstration projects.**

15. This document is a **consultation draft** and seeks responses from a wide range of stakeholders. It builds on initial stakeholder workshops held on the evidence available in the development stage of the modelling used to inform this document. We will be actively seeking stakeholder views as we move through the consultation period and revising the statement on the back of those comments and any further evidence which comes to light.

1. Introduction

1.1 In this document we use the term 'heat' in a broad sense We use heat to keep our homes and where we work or study warm. We use energy to cool them in hot weather. We also use heat or cooling to provide us with hot water, to cook our food, and to manufacture goods on which our economy depends. Currently, most of our heat comes from gas, oil, coal, biomass and electricity.

1.2 This document explains the challenges facing Scotland in largely decarbonising our heat system by 2050; the actions being taken by the Scottish Government with its partners to tackle them; and the next steps and who will need to take them. As part of our wider policy to decarbonise our energy system, we set out our policy for heat use, supply and generation in order to reduce our reliance on fossil fuels, to reduce household energy bills - for the fuel poor in particular - and to seize the economic opportunities presented by the effective and efficient use of heat.

1.3 In addition, we set out the approach that will deliver an affordable and effective heating and cooling framework for Scotland through to 2050. The delivery of this policy statement will only be achieved through close collaborative working between a wide range of public, private and community stakeholders.

1.4 This draft policy statement sits alongside a number of other key documents, including the Electricity Generation Policy Statement and Scotland's Sustainable Housing Strategy, published in 2012 and 2013 respectively.

1.5 This document is a consultation draft and seeks responses from a wide range of stakeholders. It builds on initial stakeholder workshops held during the development of the modelling used to inform this document. We will take account of stakeholder views in the development of our final policy statement.

How to respond

1.6 Full details on how to respond to this consultation are set out at Annex C. All responses should be returned by **9 June 2014** on the questionnaire provided.

1.7 Views are also invited on the Interim Equality Impact Assessment and Strategic Environmental Assessment which accompany this draft Policy Statement. All documents are available on the Scottish Government web-site.

Challenges and opportunities

1.8 Our policy aims to deliver solutions to address four key challenges. These are:

- largely decarbonising our heat system to reduce greenhouse gas emissions;
- diversifying our sources of heat to reduce our reliance on fossil fuels, which have significantly increased in price, and support a resilient heat supply;
- reducing the pressure on household energy bills, in particular supporting the fuel poor; and
- seizing the economic opportunities that this transformation offers.

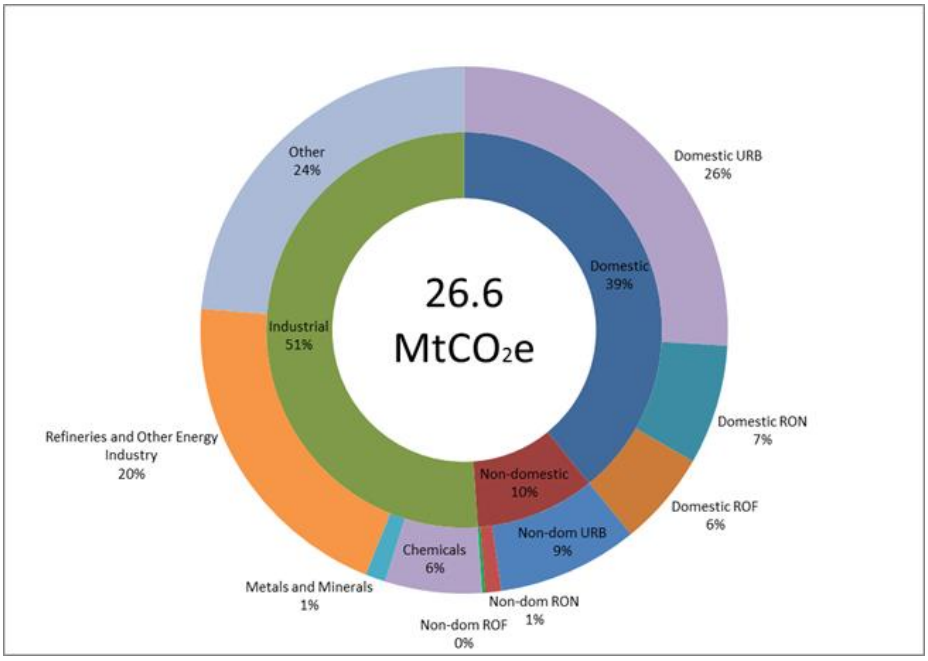
1.9 In 2009, the Scottish Parliament unanimously set Scotland's ambitious climate change targets, including an 80% reduction in greenhouse gas emissions by 2050. In addition, the Scottish Government has set linked targets, including that by 2020:

- total final energy consumption in Scotland is reduced by 12% (against a baseline of the average final energy consumption in 2005-07); and

- 11% of non-electrical heat demand is delivered by renewable sources.

1.10 Reducing the carbon intensity of heat is central to achieving these targets. Modelling suggests that heat is responsible for 47% of total Scottish emissions[2]. The same modelling suggests that over half the greenhouse gas emissions from electrical and non-electrical heat in Scotland are industry-based and over a third are from domestic properties. [3]

Chart 1: The 2010 Scottish Heat Emissions (traded and non-traded) Baseline



URB = Urban, RON = Rural On-Gas Grid, ROF = Rural Off-Gas Grid.
Source: Arup, 2014

1.11 The Second Report on Proposals and Policies (RPP2)[4] sets out our ambition that by 2050 Scotland will have a largely decarbonised heat sector, with significant progress by 2030. In RPP2, with emissions reductions for other sectors at the levels indicated, this means total estimated abatement of 3 $MtCO_2e$ from the domestic and non-domestic sectors in 2027.

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[2] This includes both direct emissions such as a boiler in a building and indirect emissions for example from electricity use.
[3] Modelling carried out on behalf of the Scottish Government by Arup.
[4] Low Carbon Scotland: Meeting our Emissions Reduction Targets 2013-2027. The Second Report on Proposals and Policies, see: http://www.scotland.gov.uk/Publications/2013/06/6387

1.12 In order to better understand the potential for emissions abatement from the heat sector and inform this consultation document, the Scottish Government commissioned a heat model from Arup. This model is used in the report to identify illustrative pathways towards our objective of a largely decarbonised heat system by 2050. It is clear from the modelling that cost-effective delivery of an increasingly decarbonised heat system is possible but that it will require action on both the supply and demand side for heat. Energy efficiency will continue to have a central role in the delivery of low carbon heat. A range of possible pathways is examined in Section 3.

1.13 Better monitoring and building management, energy efficiency measures and behaviours present significant opportunities to reduce energy consumption with a positive impact on bills of both households and businesses. As well as through demand reduction measures, there is additionally an opportunity to **tackle high heating bills for households** by considering heat supply. This is particularly the case in multi-storey blocks where there are limited alternatives for affordable low carbon heat. Many of the district heating schemes that have developed in Scotland have reduced householders heating bills, in some schemes by almost a half[5].

1.14 The action taken to reduce emissions will **reduce our reliance on fossil fuels**. A key consideration through the development of our Heat Generation Policy Statement (HGPS) is ensuring we have a **resilient heat supply** through energy efficiency improvement, diversification of heat sources and increased storage capacity. This will give confidence to our economy as well as reducing consumer risk to energy market price fluctuations.

1.15 The transition to affordable low carbon heat across Scotland presents an opportunity for business given the diverse range of technologies required. This will require both innovation and appropriate skills, expertise and knowledge.

1.16 A focus on **innovation** in technology development may provide a means for short and medium term solutions to be engineered as enduring solutions in the future, as well as supporting development of new technologies. The UK Technology Innovation Needs Assessment[6] (TINA) identified that innovation in heat technologies has the potential to add £2-12bn to UK GDP to 2050.

1.17 Scotland is an energy-rich nation which has developed a **strong industry and skills base** benefiting from the resource available. We are seeing growing evidence of the opportunities available, for instance, in energy efficiency work in the construction sector, low carbon and renewable heat sectors and heat distribution and storage in the energy sector. For example, while currently a relatively low proportion of the 11,695 full time employees in the renewable energy industry are in renewable heat industry jobs[7], the Scottish Renewables Forum estimates that the renewable

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[5] See case study: on Aberdeen Heat and Power in Section 5.

[6] http://www.scottishrenewables.com/media/uploads/hidden_links/web_employment_in_renewable_energy_in_scotland_2013.pdf

[7] Scottish Renewable Employment Analysis 2013 http://www.scottishrenewables.com/media/uploads/hidden_links/web_employment_in_renewable_energy_in_scotland_2013.pdf

heat industry could generate turnover of £2.7 billion by 2020[8]. These sectors can build on that existing skill, expertise and knowledge.

1.18 We are keen to make sure that the Scottish workforce and industry are in a position to deliver and potentially export the technical solutions needed for this transition.

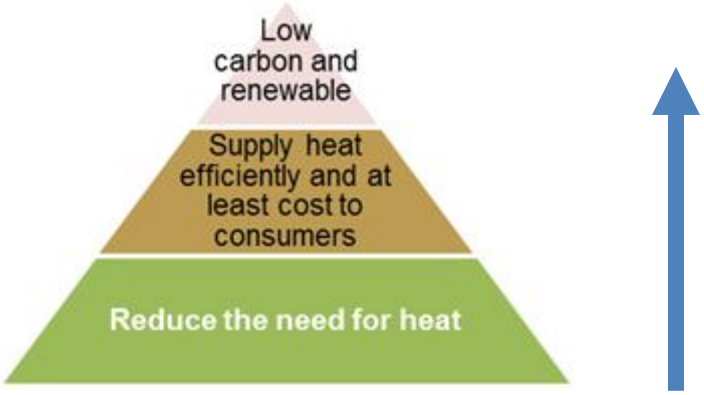
Our Heat Vision and Heat Hierarchy

1.19 We have further developed our heat vision, published in January 2013, to take account of the key role industry will play. Our Vision for heat is:

- a commercially viable, diverse industry delivering resource efficiency, low carbon and renewable heat to serve Scotland's heat needs. A heat system driven by the need for affordable warmth for our households and resilient heat supply, a system with a competitive business and industry base, which addresses climate change, and offers the potential for the low carbon economic opportunities supporting sustainable economic growth;

- a largely decarbonised heat system by 2050, with significant progress made by 2030. An ambition which will be realised through a number of means, reducing heat loss, increasing heat generation efficiency through systems such as district heating (where appropriate) and including renewables, An ambition, based on the fundamental first principles of keeping demand to a minimum, most efficient use of energy, recovering as much "unused excess" heat as practically possible, and at least cost to consumers.

1.20 Our **Heat hierarchy** is illustrated in the diagram below:



1.21 The rationale for these priorities is provided below:

1. Reduce the need for heat. Well insulated buildings and buildings that can take advantage of passive heating and cooling reduce demand for energy and consequently cost to consumer. However, understanding and influencing

[8] http://heatpoint.co.uk/PDF/Renewable_Heat_in_Scotland_2020_vision_its_HEATPOINTs_journey.pdf

consumer behaviours to lead to less energy use for heating remains a huge challenge.

2. Supply heat efficiently. Some efficiency improvements can be made within individual buildings, such as low temperature radiators, while other opportunities for efficiency depend on the relationships between buildings. Using the same source to heat several buildings, such as in a district heating network, can lead to a more efficient heat supply, as in the right circumstances it is generally more efficient than an individual boiler in each property. It will be important to develop the sector at least cost to the consumer to minimise impact on energy bills and mitigate fuel poverty.

3. Use renewable and low carbon heat resources to deliver low carbon heat efficiently.

1.22 We have set out above the key challenges which Scottish Government sees for the heat sector going forward and a heat vision and heat hierarchy which will shape the development of our heat policy going forward.

Question 1: Do you agree with the heat vision and heat hierarchy? And why?

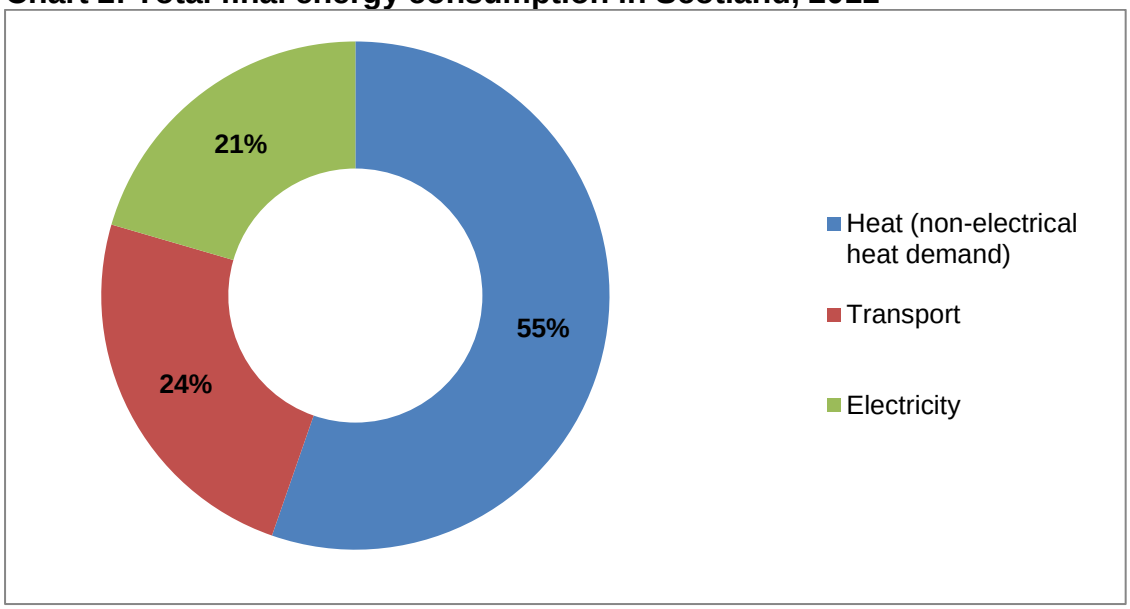
2. How heat is used and the cost of heat to consumers

How heat is used now

2.1 Heat is not generally bought and sold as a commodity in Scotland, unlike some other European countries. Instead we buy electricity or fuels such as gas, oil or solid fuels, including biomass and peat, and use on-site appliances such as boilers, kilns, furnaces, electric heaters and ventilation systems to provide heating or cooling.

2.2 Heat is estimated to account for over half of Scotland's total energy use. Chart 2 shows that non-electrical heat demand alone makes up over 55% of final energy consumption[9]. Of this, approximately 40% is consumed domestically and 60% in the industrial and commercial sectors. Some of this industrial heat is required at very high temperatures, such as up to 1450°C in a cement kiln.

Chart 2: Total final energy consumption in Scotland, 2011



Sources: 1) DECC, Total Final Energy Consumption Statistics (Sub-national): 2011
2) DECC, Electricity generation and supply figures for Scotland, Wales, Northern Ireland and England: 2004 to 2012

2.3 There is currently limited data available for Scotland about the amount of electricity that is used to provide heating or cooling in our homes, non-domestic buildings and industrial processes. The Scottish Household Condition Survey shows that a greater proportion of households in Scotland (14%) rely on electrical heating than in Great Britain as a whole (8%)[10].

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[9] Energy in Scotland 2014, Scottish Government
http://www.scotland.gov.uk/Topics/Statistics/Browse/Business/Energy/Compendium2014
[10] Great Britain energy fact file, DECC
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48195/3224-great-britains-housing-energy-fact-file-2011.pdf

2.4 Reducing the need for heat is key. By reducing heat loss from buildings and processes we can minimise the level of energy we require to heat our homes and commercial and non-domestic premises, thereby reducing the pressure on rising fuel bills for consumers and business.

2.5 Improving the energy efficiency of homes is also a key factor in reducing fuel poverty[11], a vital social issue affecting families across Scotland. There are three major factors which affect fuel poverty: householders' income, energy prices and the amount of energy needed to heat the home to a safe standard. Key actions to tackle fuel poverty are set out later in this section under "The cost of heat to consumers".

2.6 Energy and resource efficiency will continue to be a top priority for the Scottish Government. Our programmes that support demand reduction such as Home Energy Efficiency Programmes for Scotland and Resource Efficient Scotland are set out in Section 4.

2.7 It is not just the total amount of heat over the year and the emissions associated with this that need to be considered. It is important to be aware of when the demand for heat occurs and in particular the maximum or **peak demand**. Heat demand varies over the day, at weekends and holidays and, in the case of space heating, heat demand is significantly higher in winter months. The pattern of heat use is highlighted by analysis[12] showing annual heat and electricity consumption in the UK - demand for heat in the winter can be as much as five times the demand for electricity. A greater understanding of heat use across the system and how this is changing or may change in the future can help ensure that the system is designed and built to meet our needs and remain resilient. Simply moving to electric heating without addressing when demand is at its highest or the efficiency of the heat technology used could add further challenges for the electricity system.

2.8 Another consideration for heat is where it is needed. Heat can be transported in the right circumstances over a number of miles, but not over as great distances as electricity without significant losses. Opportunities in relation to efficient supply include district heating and thermal storage. Current estimates indicate that 10,000 homes are connected to district heating, with 0.2 TWh of heat being provided to domestic and non-domestic users through district heating.

2.9 Recovery of unused heat appears to have significant potential. The data available on the levels of unused excess heat available are however very limited and, as set out in Section 6, we are working with Scottish Environment Protection Agency (SEPA) to improve this.

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[11] The Scottish Fuel Poverty Statement (2002) defines fuel poverty: 'A household is in fuel poverty if, in order to maintain a satisfactory heating regime, it would be required to spend more than 10% of its income (including Housing Benefit or Income Support for Mortgage Interest) on all household fuel use'. The Scottish Government has commissioned research, on behalf of the Fuel Poverty Forum, to undertake a review of the evidence in relation to the assumptions underpinning the definition of fuel poverty in Scotland. This is expected to complete in spring 2014 and report its findings to the Fuel Poverty Forum.

[12] http://www.lolo.ac.uk/project/view/project/22

2.10 As set out in Section 3, modelling indicates a mix of heat sources will be required going forward with a growing proportion of low carbon and renewable generation. Switching from fossil fuel to lower carbon and renewable sources of heat has the potential to reduce greenhouse gas emissions, and in the case of renewables, make a significant contribution to Scotland's renewable heat target.

2.11 As set out in Energy in Scotland 2014[13], for a transitional period we will monitor the renewable heat target using **two methodologies**. The improved methodology, set out below, highlights the importance of demand reduction and efficient supply as well as renewable heat generation in meeting our target.

Improved methodology for renewable heat monitoring

The table below presents a time series demonstrating the impact of each monitoring method on progress towards the target of 11% of non-electrical heat demand delivered by renewable heat.

Renewable Heat Target - Renewable heat as a % of heat demand

	2009	2010	2011	2012
Total Renewable Heat Output (GWh)	845	1,696	2,263	2,481
Non-electrical Heat Demand - fixed 2020 forecast (GWh)	60,089	60,089	60,089	60,089
Non-electrical Heat Demand – annual estimate (GWh)	87,045	89,135	86,800	-
% of Renewable Heat Output (2020 demand)	1.4%	2.8%	3.8%	4.1%
% of Renewable Heat Output (annually)	1.0%	1.9%	2.6%	-

Using our original methodology, in 2012 Scotland produced enough heat from renewables to meet 4.1% of the **forecast** demand in 2020. The improved methodology developed with stakeholders "% of Renewable Heat Output (annually)" provides an estimate of progress based on the **current** level of heat demand as opposed to a projection for 2020.

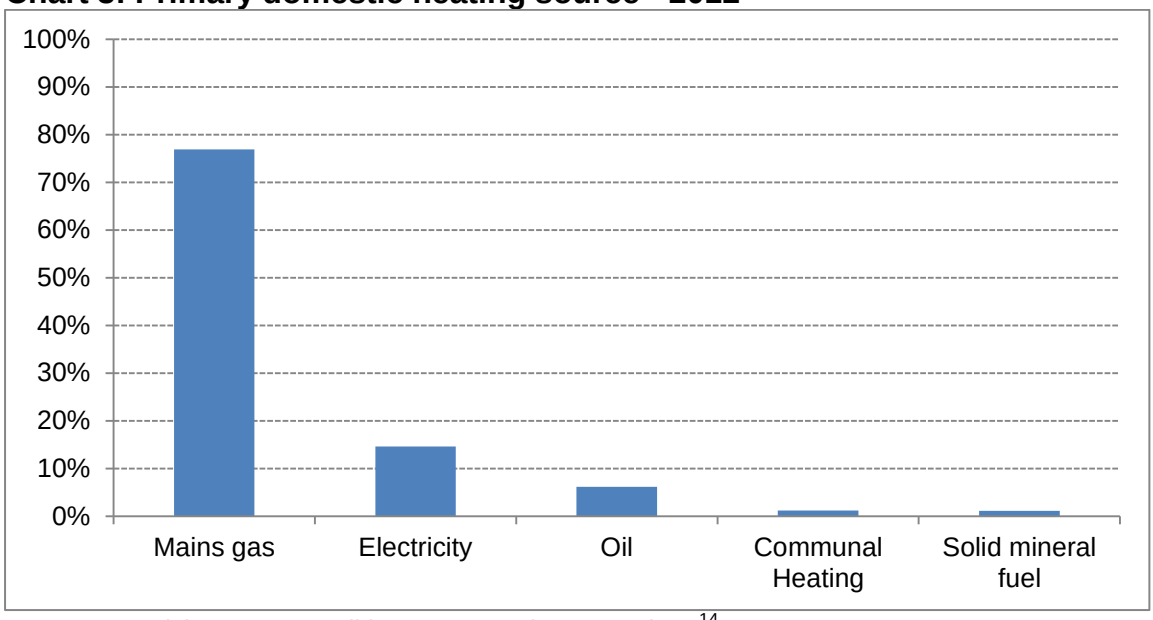
The Scottish Government estimates that renewable heat generation in 2011 equated to 2.6% of Scotland's non-electrical heat demand in 2011. As heat demand in 2011 was higher than the forecast heat demand in 2020, this results in a lower percentage of renewable heat generation. 2011 is now the latest available estimate due to a lag in the final energy consumption data for Scotland published by DECC.

[13] Energy in Scotland 2014, a statistical compendium available at: http://www.scotland.gov.uk/Topics/Statistics/Browse/Business/Energy/Compendium2014

The cost of heat to consumers

2.12 Our model identifies spend of approximately £2.6 billion annually in Scotland on heating by both householders and the non-domestic sector. The cost of heat to consumers varies depending on how the heat is supplied, the original source of the heat and the efficiency of the dwelling. Currently gas and electricity are the primary sources of heat for the majority of households. As shown in Chart 3, gas currently accounts for 76% of primary heating systems followed by electricity accounting for 15%. Oil accounted for 6% of household primary heating system, with solid fuel and communal heating covering the majority of the remainder.

Chart 3: Primary domestic heating source - 2012



Source: Scottish House Condition Survey using 2012 data,[14]

Domestic gas and electricity bills

2.13 Ofgem analysis demonstrates that the majority of a domestic gas bill is due to wholesale energy costs, accounting for 67% of the average bill, distribution costs account for 16%, environmental charges account for 6% of costs, VAT accounts for 5% and other costs account for 4% of an average bill. Finally the smallest segment of the bill is made up of transmission costs which account for 2%.

2.14 Electricity bills follow a similar pattern, with the highest proportion attributed to wholesale energy costs accounting for 58% of the average domestic electricity bill, distribution costs account for 16%, environmental charges account for 11%, VAT and other costs each account for 5%. The smallest segment of the bill is made up of transmission costs which account for 4%.

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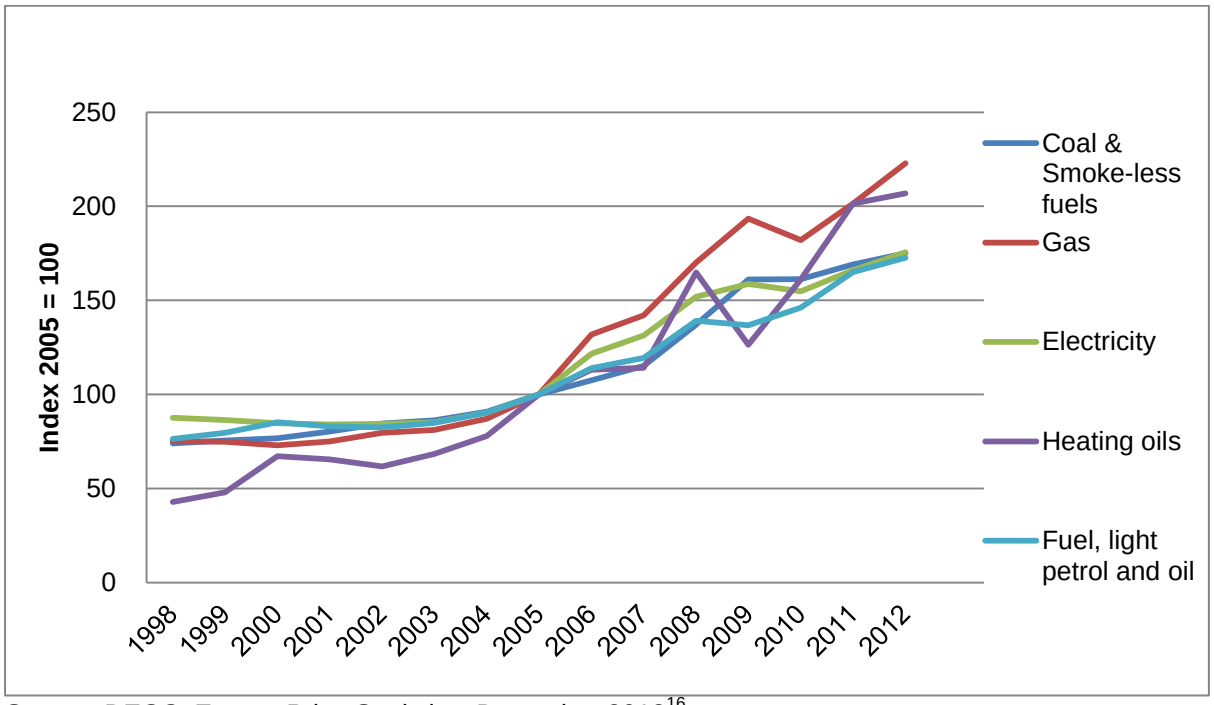
[14] See: http://www.scotland.gov.uk/Resource/0043/00439879.pdf. Communal heating (also known as group heating, district heating, and combined heat and power) provides heat to more than one dwelling from a centralized boiler plant. The average bills above are based on average annual consumption figures of 3,300 kWh for electricity and 16,500 kWh for gas, averages across all six suppliers and across Great Britain reflecting prices in 2012.

2.15 Between 1998 and 2012 retail prices have increased for every fuel type. Coal and smoke-less fuels increased by 137% , gas increased by 196%, electricity increased by 100%, heating oils increased by 382%, and fuel, light petrol and oil[15] increased by 126%.

Chart 4: UK Fuel price indices in the domestic sector (real terms 2005 = 100), 1998 - 2012



Source: DECC, Energy Price Statistics, December 2013[16]

2.16 Domestic energy prices increased substantially from 2004 to 2009 in real terms, before a slight dip in 2010. The price rises announced by suppliers from 2011 have led to further increases since then, and are now above the levels reached in 2009.

2.17 The average domestic gas bill in Scotland increased in real terms over the period 1998-2012 by 93% for standard credit, 102% for direct debit and 81% for pre-payment. The equivalent average domestic electricity bill over the same period increased by between 27% and 37% depending on the payment method.[17]

2.18 The independent Committee on Climate Change (CCC)[18] analysis demonstrates that 62% of the increases in energy bills are a result of increases in wholesale costs for gas and 16% is due to investment in energy networks. Less than 10% of this increase in household bills since 2004 is attributed to support for low-carbon technologies and support for energy efficiency improvement.

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[15] Data for the aggregate series fuel, light, petrol and oil have been recalculated using a chained index calculated by ONS. https://www.gov.uk/government/organisations/department-of-energy-climate-change/series/energy-price-statistics

[16] Series are annually weighted. Figures include VAT where applicable.

[17] https://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics

[18] http://www.theccc.org.uk/wp-content/uploads/2012/12/1672_CCC_Energy-Bills_bookmarked.pdf

Action to tackle fuel poverty and support householders with energy costs

2.19 Action on **tackling fuel poverty** is a priority for this Government. This is a vital social issue affecting families across Scotland and we are doing everything we can to achieve our statutory duty to eradicate it, as far as is reasonably practicable, by 2016.

2.20 Latest statistics show fuel poverty declined in Scotland between 2011 and 2012, yet 27.1% of households are still estimated to be 'fuel poor'. In mid- 2012, around 74,000 fewer households – a 3.4% drop – were in fuel poverty than in October 2011, with improved energy efficiency contributing two-thirds of the fall, and increases in household income contributing one third.

2.21 The Scottish Government has invested £220 million on fuel poverty and energy efficiency measures between 2009/10 and 2012/13 and has committed to providing nearly a quarter of a billion pounds over the period 2013/14 to 2015/16 on further initiatives.

2.22 We have allocated £74m in 2013/14 to our Home Energy Efficiency Programmes for Scotland, which will lever in additional investment from major energy companies to tackle fuel poverty, reduce carbon emissions and support jobs. In addition, for each of the next two years (2014/15 and 2015/16) the Scottish Government spending plans allocated funding of £79 million for fuel poverty and energy efficiency programmes.

2.23 Despite soaring energy prices, progress is being made. But proposed Westminster cuts to energy efficiency and fuel poverty programmes could jeopardise further improvements. We must seize the opportunity of additional powers in an independent Scotland to design a new means of funding and delivering energy efficiency improvements to Scottish homes that is fairer and better suited to our needs.

2.24 The current UK Government scheme to address fuel poverty and improve energy efficiency is designed in Westminster and operated through energy companies. The costs of programmes like the Energy Company Obligation (ECO) are met by householders through their energy bills irrespective of income.

2.25 In 'Scotland's Future' - our comprehensive guide to independence - we made our position clear about how ECO would be funded in an independent Scotland. These costs would be met by central resources. This is a fairer way of paying for energy efficiency measures than through people's energy bills. We would task the new Scottish combined economic regulator with ensuring an open and competitive energy market to protect the interests of Scottish consumers, including those most vulnerable to fuel poverty.

2.26 As well as the above fuel poverty focused programmes, there are a number of policies and programmes set out in Section 4 to help reduce energy consumption

helping ease the pressure on bills. A number of activities by Ofgem and others also aim to make the market more competitive for consumers[19].

2.27 Ofgem recently carried out an energy **Retail Market Review** (RMR)[20] for electricity and gas which highlighted the need for a more transparent and fair energy market. Following the RMR, Ofgem has introduced a number of reforms designed to provide customers with simpler and clearer information relating to current tariffs and personal energy usage. Ofgem is also introducing reforms aimed at making it easier for independent generators and suppliers to access and compete in the wholesale energy market. It is hoped increased consumer engagement and easier access to the wholesale market will lead to more competition, ultimately benefitting consumers.

2.28 The phased implementation of these reforms started in October 2013. The framework[21] which will be used to assess competition within the energy market was also recently published. The first annual assessment will be available in March 2014.

2.29 **Heating oil** unlike gas and electricity is an unregulated market, and therefore information on prices is not monitored as accurately.

2.30 In order to increase the buying power of householders and to increase competition between suppliers, some local communities are setting up oil clubs. The Citizens Advice Bureau has provided a range of guidance and advice to communities looking to establish an oil club[22]. According to the Oil Club website there are at least 132 oil buying clubs operating in Scotland[23]. However, there is no central source of information on the number of oil clubs in Scotland, nor a requirement for oil clubs to register their existence.

2.31 The modelling work for the HGPS recognises that the economics of heating for households vary depending on whether they are urban or rural and whether they are on or off gas grid.

Non-domestic gas and electricity bills

2.32 UK businesses (of all sizes) currently pay the lowest gas prices in the EU15. Small and medium-sized enterprises (SME) pay electricity prices around the median for the EU15 and larger intensive energy users pay electricity prices above the median. The market for gas in the US, however, has changed with the introduction

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[19] Examples of activity to reduce the need for heat such as the Home Energy Efficiency Programmes for Scotland and Resource Efficient Scotland can be found in Section 4.
[20] https://www.ofgem.gov.uk/gas/retail-market/market-review-and-reform/retail-market-review
[21] Published by Ofgem alongside the Office of Fair Trading and the Competition and Markets Authority: https://www.ofgem.gov.uk/ofgem-publications/85260/assessmentframework18decfinal.pdf
[22] http://www.citizensadvice.org.uk/index/campaigns/current_campaigns/oilclubs.htm
[23] An independent organisation created for the purpose to combine regional oil clubs together to obtain best value - www.oil-club.co.uk/. The Oil Club website holds details of UK based oil clubs.

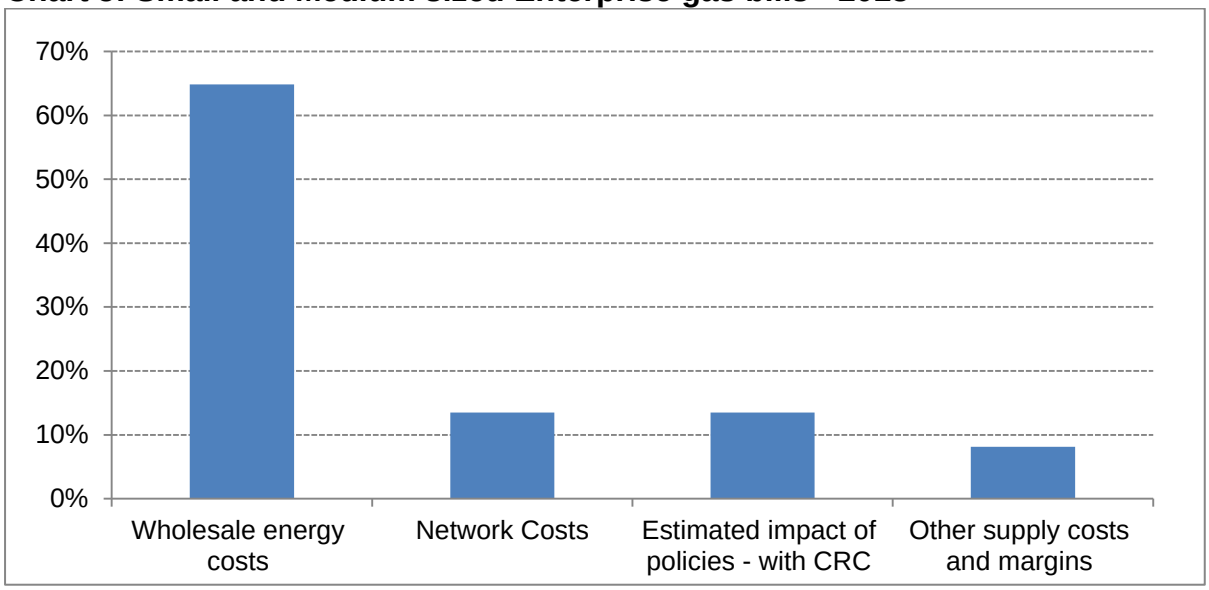
of shale gas. US gas prices are now moving independently (at a lower price) of prices in the UK and Europe[24].

2.33 Business energy costs differ for various reasons such as size of the business, fuel mix, whether the electricity is obtained from the grid or generated on site and whether they are covered by the CRC energy efficiency scheme or Climate Change Agreements.

2.34 Estimating an average annual gas or electricity bill for non-domestic consumers is somewhat problematic as there is a much broader spectrum of non-domestic consumers than domestic consumers.

2.35 The UK Department of Energy and Climate Change (DECC) analysis provides a breakdown of SME gas and electricity bills in 2013. Chart 5 shows that wholesale energy costs account for 65% of SME gas bills, network costs account for 14%, estimated impact of policies – with CRC account for 14% and other supply costs and margins account for 8%.

Chart 5: Small and Medium sized Enterprise gas bills - 2013



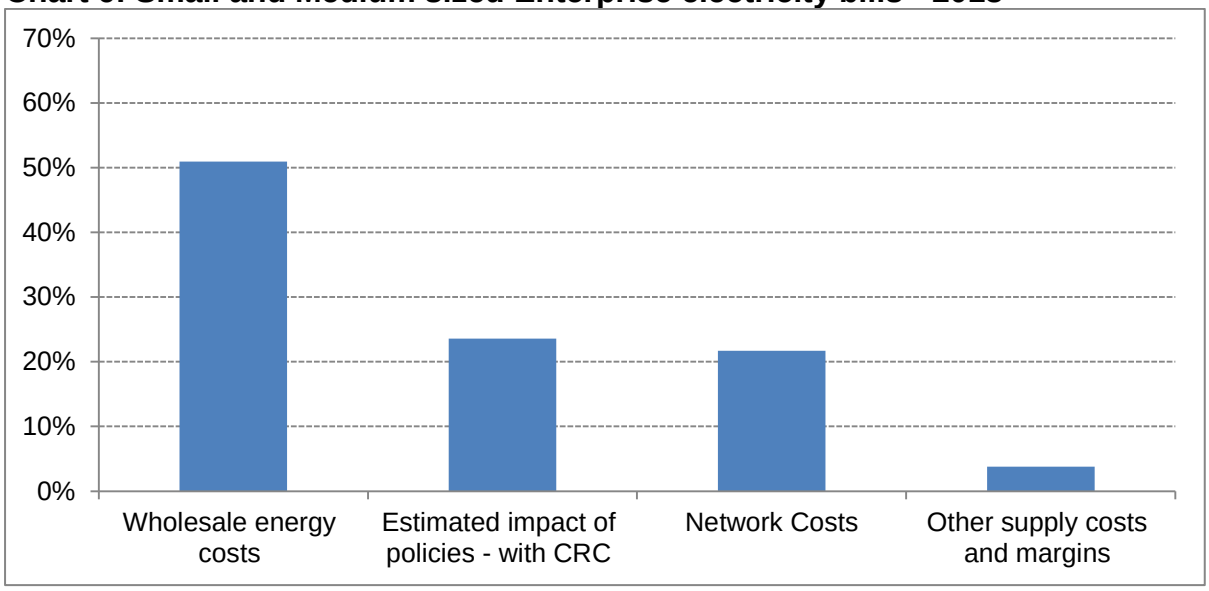
DECC: Estimated impacts of energy and climate change policies on energy prices and bills, March 2013 *(may not sum due to rounding)[25].

2.36 Chart 6 shows that wholesale energy costs account for 51% of SME electricity bills, policies – with CRC accounted for 24%, network costs accounted for 22% and other supply costs and margins accounted for 4%.

[24] Source: Thomson Reuters Datastream

[25] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/172923/130326_-_Price_and_Bill_Impacts_Report_Final.pdf

Chart 6: Small and Medium sized Enterprise electricity bills - 2013



DECC: Estimated impacts of energy and climate change policies on energy prices and bills, March 2013* May not sum due to rounding[26].

2.37 As part of its Retail Market Review, Ofgem has also set out proposals on how to make the market work better for business customers. These proposals include extending the existing rules for micro-businesses so that larger small businesses are also covered and implementing new rules to better protect businesses from unfair sales practices Standards of Conduct have been introduced which require energy companies to treat businesses fairly when billing, contracting and switching customers. These Standards of Conduct are backed by fines if necessary[27].

2.38 Scottish Ministers welcome these proposals and endorse Ofgem's plans to provide further support for businesses. We have also asked Ofgem to give due consideration to going further to support businesses on all aspects of their energy contracts. The Scottish Government will continue to engage with Ofgem, the UK Government, energy suppliers and business representatives as Ofgem's proposals are developed further and implemented.

Looking to the future

2.39 As electricity and heat generating assets approach the end of their operational life , they will need to be replaced or refurbished. This is likely to put upward pressure on energy bills in the coming years. For example some of the existing nuclear and fossil fuel plant in Scotland is scheduled to close over the coming decade[28]. The Scottish Government's policy is to replenish such assets with a

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[26] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/172923/130326_-_Price_and_Bill_Impacts_Report_Final.pdf. The figures in the graph are for medium-sized users of electricity based on the midpoints of Eurostat-bands for medium sized electricity consumers in industry.

[27] https://www.ofgem.gov.uk/publications-and-updates/retail-market-review-final-non-domestic-proposals

[28] http://www.scotland.gov.uk/Publications/2013/06/5757

combination of low carbon generating technologies, including renewables and thermal generation progressively fitted with Carbon Capture and Storage. The main goal is to guarantee that costs associated with delivering the policy are as low as possible and reasonably priced to consumers. Recent analysis suggests that policies which encourage low carbon and renewable energy generation options in addition to energy efficiency measures, will lead to lower increases in costs rather than taking no action.

2.40 Increases in energy costs over the past ten years have been greatly attributed to the ever-increasing price of gas. According to the Project Discovery report[29] produced by Ofgem, if energy supplies are more dependent on fossil fuels than low carbon sources, this will result in further uncertainty and price increases.

2.41 DECC has produced estimates of the impact of energy and climate change policies on average household energy bills in 2020[30]. This analysis shows that by 2020 the average household's energy bill would be 11% lower because of the net effect of the energy and climate change policies that have been established.

2.42 This reinforces the approach being taken for heat policy and the heat hierarchy – that demand reduction is at the top of the hierarchy and should be prioritised, followed by efficient supply, such as district heating which has been shown in appropriate circumstances to offer a viable alternative to individual solutions and can offer lower cost low carbon heat to consumers and then supply of renewable and low carbon heat. Policies to support this approach are set out in Sections 4 to 6.

[29] Project Discovery – Energy Markets Scenarios, Ofgem, see: https://www.ofgem.gov.uk/gas/wholesale-market/gas-security-supply
[30] https://www.gov.uk/policy-impacts-on-prices-and-bills

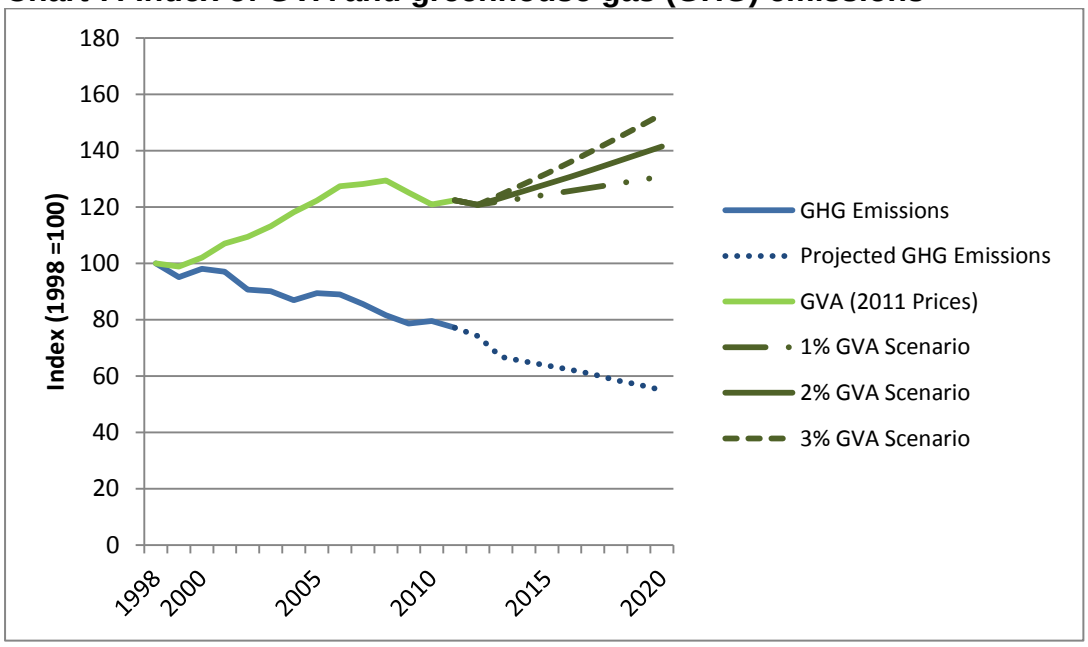
3. Looking to the future - economic impacts of low carbon heat and potential scenarios

3.1 In order to develop robust heat policy, evidence is needed to better understand the options and trade-offs of different illustrative routes to our use and generation of heat being largely decarbonised. In this section we set out work that has been carried out to improve the evidence base and some of the implications of the different illustrative routes.

Economic impacts of low carbon heat

3.2 The low carbon economy is at the heart of the Scottish Government's economic strategy and decarbonising heat is at the heart of the low carbon economy. Significant progress has already been made in breaking the link between emissions and economic growth. Chart 7 below shows how greenhouse gas emissions and Gross Value Added (GVA) have decoupled. However, the share of energy use (over 55%) accounted for by heat highlights the key role of decarbonising heat to continuing this progress in the future[31].

Chart 7: Index of GVA and greenhouse gas (GHG) emissions



Source: Chapter 7, Energy in Scotland 2014, Scottish Government
http://www.scotland.gov.uk/Topics/Statistics/Browse/Business/Energy/Compendium2014

3.3 By 2030 we will have largely decarbonised the electricity sector and by 2050 we will need to have largely decarbonised the heat sector in order to deliver our climate change emissions reduction targets. In the future, as the grid decarbonises, our modelling suggests that an increasing proportion of heat will be supplied by electricity.

[31] Energy in Scotland 2014, a statistical compendium available at:
http://www.scotland.gov.uk/Topics/Statistics/Browse/Business/Energy/Compendium2014

3.4 The fundamental changes in product and service markets, which will flow from tackling climate change and taking account of the carbon implications of our behaviour, represent significant strategic opportunities for Scottish business.

3.5 Modelling carried out for the Scottish Government by Arup indicates that over 40 years between 2010 and 2050, heat equipment worth over £100 billion in today's prices will be replaced. Going forward, if we are to meet our climate change targets, these installations will increasingly need to be low carbon installations, achieved through a mixture of increasing efficiency such as better controls, insulation, district heating and heat recovery, delivering renewables such as geothermal and biomass and, as we decarbonise the electricity grid, resistive heating, ground or air source heat pumps. Each of these technologies has different advantages and it is clear from the modelling that all will have a role in delivering low carbon heat. Demand for lower carbon technologies will increase as the economics of heat generation shifts in response to increasing fossil fuel and carbon costs and to regulation.

3.6 Change on this scale represents an opportunity for Scottish business. There will be opportunities for dynamic new businesses to challenge market incumbents in the design, manufacture, installation and maintenance of new technologies that deliver reduced need for heat, efficient heat supply and low carbon and renewable heat. The Scottish Government and its agencies support business in a number of ways including low carbon specific skills support (see Section 4).

Question 2: How can we ensure that Scottish businesses are best placed to take advantage of the new products and services which will be required to deliver low carbon heat?

3.7 Heat demand is ubiquitous. As a result the economic impacts are felt well beyond the sectors which supply energy and energy technology. It is important that we consider the economic impact on the users of heat, both domestic (households) and non-domestic (business, industry, public sector).

3.8 Too much of the heat generated in Scotland is wasted – it escapes from poorly insulated buildings, is used to heat unoccupied spaces or to achieve temperatures beyond what people consider comfortable.

3.9 Wasting heat costs money and resources. The cost of heating a "C" rated 3 bedroom semi-detached home is approximately £400 per year while heating a similar house rated "E" costs around £990[32].

3.10 We have used the Arup heat model to examine household fuel consumption and costs. The model highlights the importance of using heat efficiently if we are to ensure that Scottish consumers are protected and that the country's heat system decarbonises efficiently. If we can deliver the same heat and comfort with the use of less resources then we can deliver a system which tackles fuel poverty, reduces greenhouse gas emissions and provides a boost to business competitiveness.

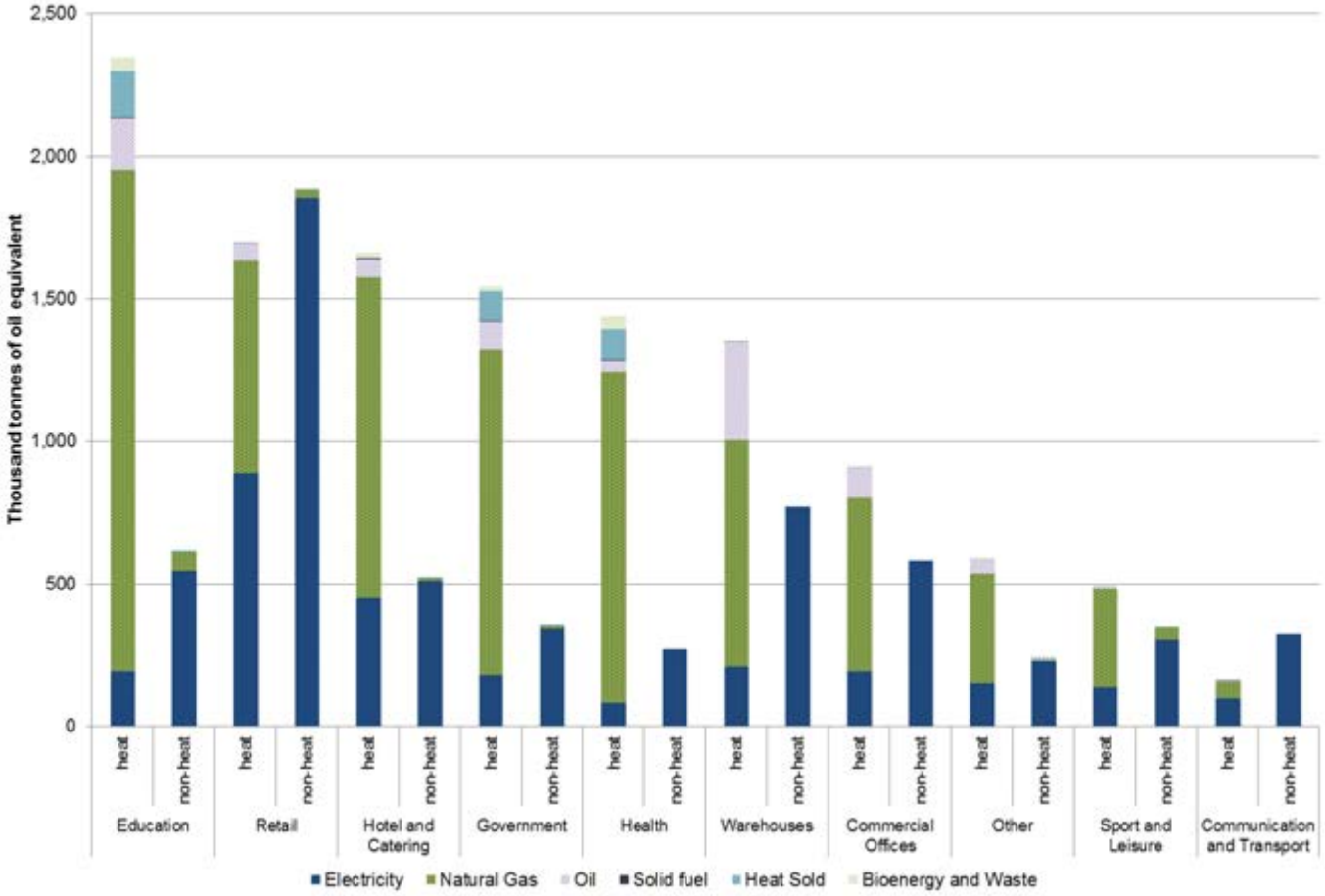
[32] These are median values based on a standard heating regime. Source: Scottish Government analysis using Scottish House Condition Survey 2012.

3.11 The key economic challenge is ensuring we provide affordable low carbon heat which all residents in this energy rich nation can benefit from. Whilst there will be costs associated with largely decarbonising the heat system, doing nothing would also involve costs and impact on household fuel bills. We are keen to ensure that heat decarbonisation benefits all users of heat in Scotland and that any costs are outweighed by reduced demand.

Question 3: Taking account of the cost of implementation, what policies should the Scottish Government pursue that will best ensure the impacts of heat decarbonisation benefit consumers? What evidence do you have to support this?

3.12 Heat is a critical input for business. Analysis by DECC shows the extent to which the energy demanded by various sectors in the economy splits between heat and non-heat uses. Communications and transport and retail are the only sectors for which demand for non-heat uses exceeds heat uses.

Chart 8: UK Service sector energy consumption by fuel and end use, 2012



Source: Estimates of Heat Use in the UK 2012, Department of Energy and Climate Change https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244735/4_estimates_of_heat_use_in_the_uk_2012.pdf

Potential scenarios and economic impacts

3.13 To enhance the evidence base informing the Heat Generation Policy Statement (HGPS), the Scottish Government commissioned Arup to develop a forward projection model to explore scenarios and pathways for largely decarbonising the heat system in Scotland up to 2050. The model brings together all heat use and generation within Scotland associated with the use and occupation of buildings, including space heating and cooling, hot water supply, cooking, and industrial processes. From this basis, the model examines how different measures change the thermal performance of the building stock and impact on the demand for and supply of heat and subsequent greenhouse gas emissions.

3.14 The model explores different pathways of heat decarbonisation by altering two key drivers – the level and nature of **'Government Intervention' (GI)** and the 'Uptake' of new measures. GI represents action by the Scottish, UK and local governments either to mandate or incentivise uptake of measures to reduce energy demand and to increase switching to lower carbon supply technologies. **Examples of GI** included in the model are:

- building regulations requiring certain energy efficiency standards of new buildings or existing buildings that are modified;
- subsidies/grants to incentivise uptake of demand reduction measures such as insulation;
- ensuring that consumers perceive and react to the true costs and benefits of their heating choices (including the carbon cost).

3.15 **Uptake** represents a change in the attitude of individuals and businesses which results in a greater willingness to overcome barriers and adopt lower carbon demand and supply measures and behaviours. This increased willingness to adopt new technologies, uptake retrofit measures and adjust demand for heat may be influenced by peers, company business models and action by the public sector including the leadership role that it plays.

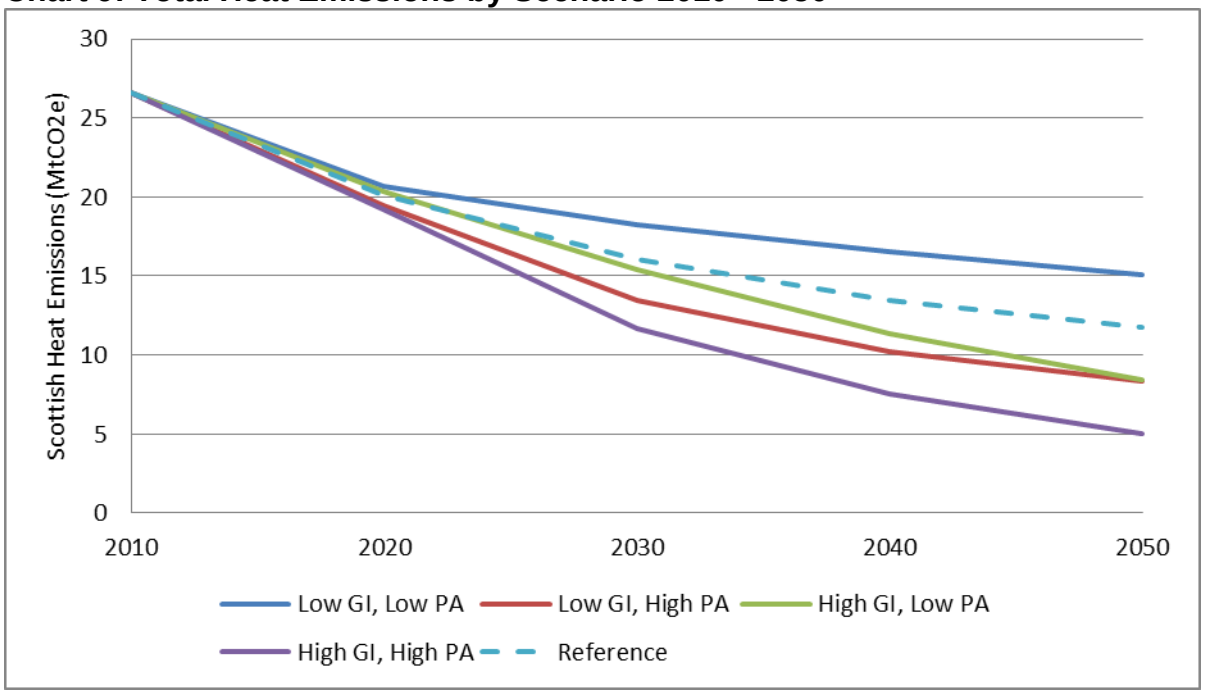
3.16 As with any model, the data used to develop it are very important. In order to ensure that the best available data were being used, stakeholders were invited to input in October 2013 during its development. This highlighted that in some cases the data available was very limited, for example on the amount of usable excess heat that could be recovered and reused. We are working with SEPA and through the development of the Scotland Heat Map to improve data. As data becomes available it will be possible to improve the accuracy of aspects of the model.

3.17 Through altering levels of GI and Uptake, the model allows for a wide range of forward projection heat emissions scenarios to be developed. Alongside the emissions profiles, the model also considers the capital and operation costs associated with a particular scenario to enable the cost effectiveness of scenarios to be calculated. Capital costs are those associated with replacing heating systems or retrofitting fabric improvements to the existing building stock and the additional costs of higher building standards on new build properties. Operational costs are those associated with fuel purchases, the maintenance of heat systems and the costs of industrial carbon capture and storage where it is implemented.

3.18 As part of its commission, Arup modelled four illustrative heat decarbonisation pathways based on low and high levels of GI and Uptake. These scenarios do not represent Scottish Government's view of what will happen nor are they proposals of what should happen. They are illustrative scenarios that provide valuable insight into some of the potential choices and trade-offs associated with a move to a largely decarbonised heat system.

3.19 The four scenarios were compared against a **reference case** scenario (see below) which reflected the continuation of existing heat related policies as set out in the Second Report on Proposals and Policies[33]. These scenarios are presented in Chart 9 below. In each scenario, it is assumed that decarbonisation of the electricity grid is being delivered, supporting emission reductions from heat, with varying amounts of electricity being used to provide heat in the different scenarios. Decarbonisation of heat is greatest when high Uptake is combined with high GI.

Chart 9: Total Heat Emissions by Scenario 2010 - 2050



Source: Arup; 2014

Reference Scenario

3.20 The reference scenario attempts to reflect the continuation of existing policies as set out in the Second Report on Proposals and Policies. In this scenario, the assumed level of GI is a mix of the low and high settings depicted in the other scenarios, given that there are energy efficiency and heat policies in place currently being delivered. The assumed level of Uptake in this reference scenario is relatively low compared to the other scenarios. The reference scenario is in place to provide an indication of the costs of a heat system in which no further action is taken to decarbonise. It represents a base case against which the other scenarios can be judged. Further detail on the scenarios can be found in Annex D.

[33] Low Carbon Scotland: Meeting our Emissions Reduction Targets 2013-2027. The Second Report on Proposals and Policies, see: http://www.scotland.gov.uk/Publications/2013/06/6387

Chart 10: Domestic Energy Demand by Scenario

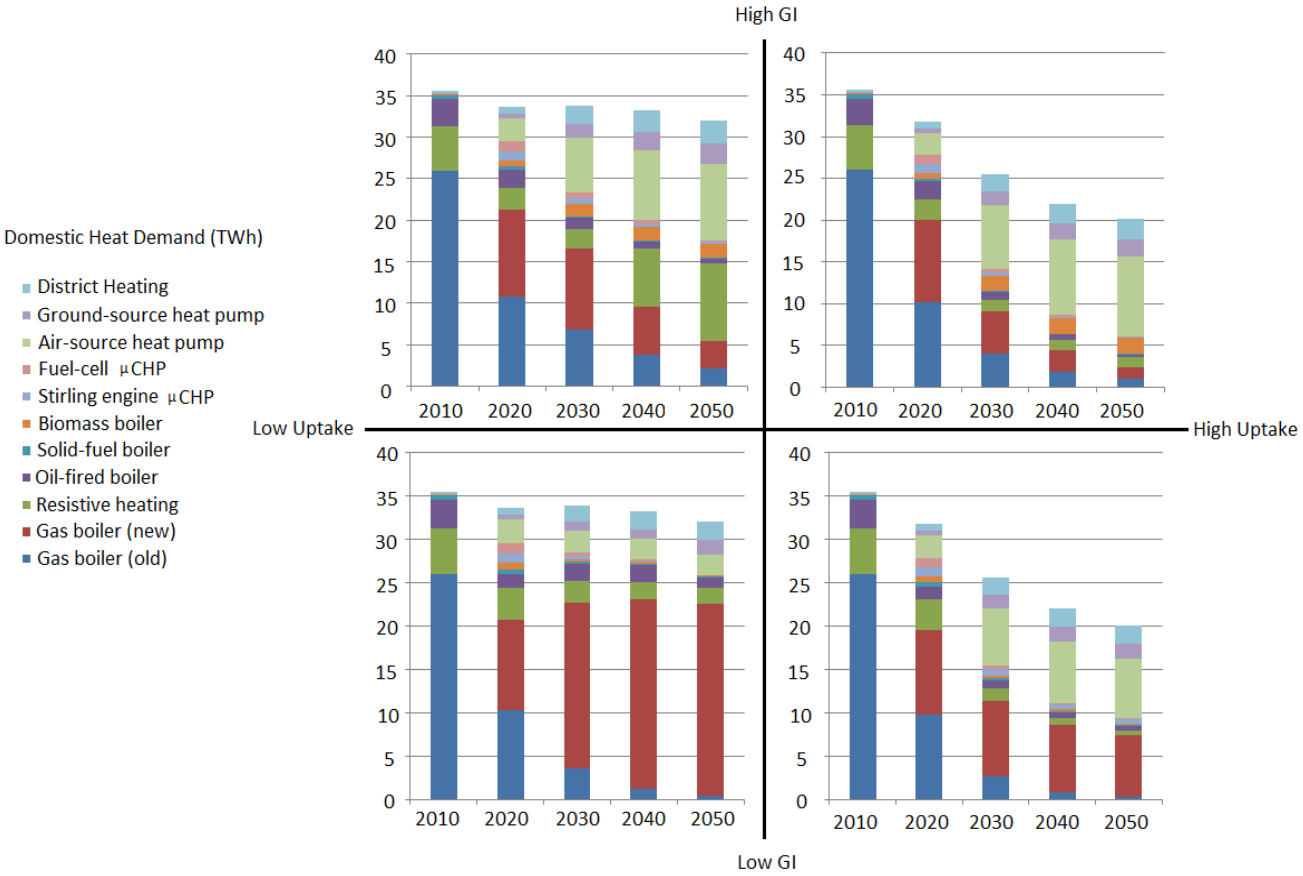
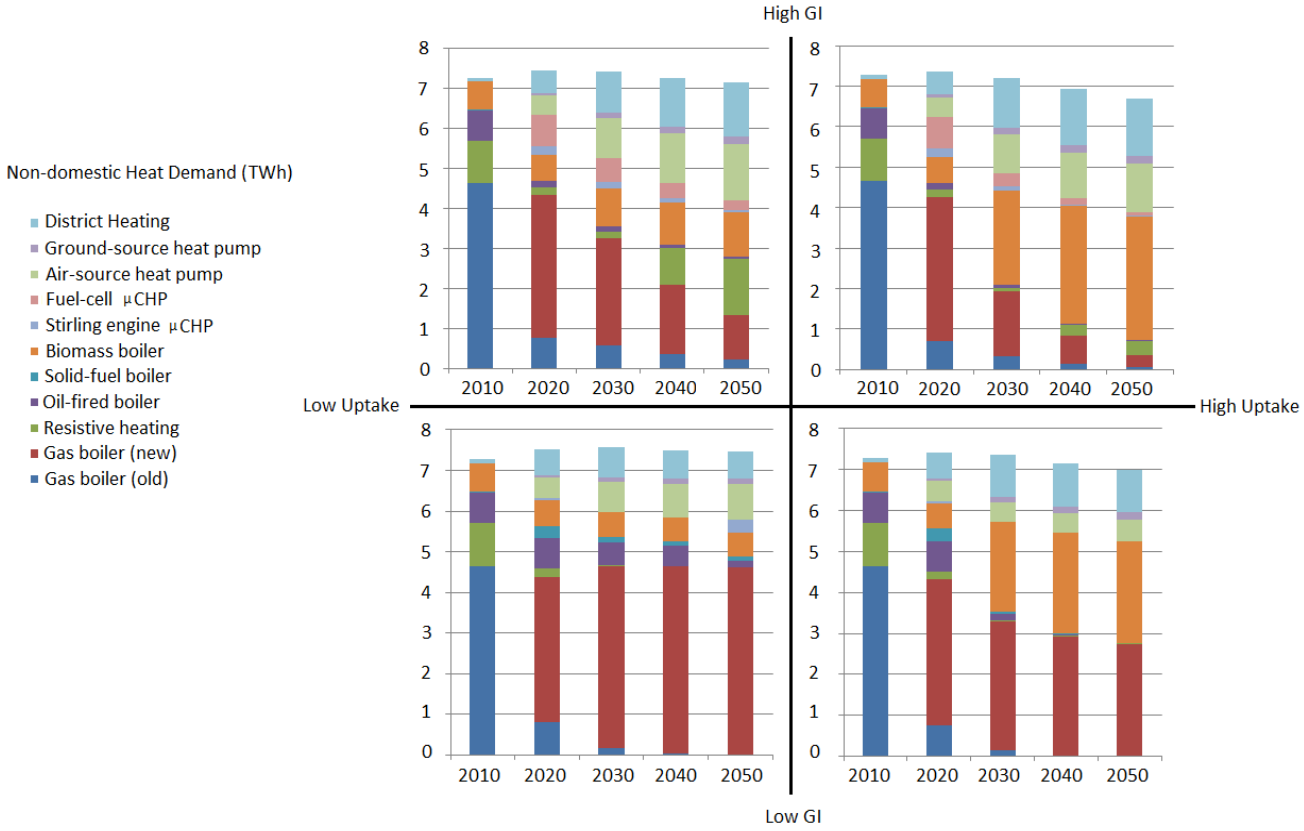


Chart 11: Non-Domestic Energy Demand by Scenario



3.21 Charts 10 and 11 above set out how the generation mix for domestic and non-domestic heat changes under each of the Arup model scenarios depending upon the mix of GI and Uptake. The important role that demand reduction and energy efficiency measures play in particular in the domestic sector can be seen from the charts.

3.22 The variation in the levels of heat demand as a result of energy efficiency technologies and behaviour change, and the technologies which are used to supply it drive changes in the cost. Table 1 below highlights total system costs and carbon emissions in 2050 for each of the 4 scenarios[34].

Table 1: Heat Emissions and Costs in 2050 by Scenario

Scenario	Emissions 2050 (MtCO2e)	2050 Emissions Reduction Compared to 2010	40 Year Costs Relative to Reference Case (£ million)
High Government Intervention / Low Uptake	8.45	68%	£14,148
Low Government Intervention / Low Uptake	15.05	43%	£6,303
Low Government Intervention / High Uptake	8.31	69%	-£1,838
High Government Intervention / High Uptake	5.05	81%	-£4,585

Source: Arup Heat Model, 2014

3.23 In two of the scenarios (High GI, High U and Low GI, High U) it is possible to both reduce the carbon intensity of heat beyond the reference case and deliver a heat system with lower costs to 2050 than the reference case. These results are driven by savings in operating costs resulting from increased adoption of new technologies, reductions in demand for increasingly expensive fossil fuels and widespread adoption of energy efficiency and demand management measures.

3.24 The modelling undertaken suggests that while the cost per KwH of heat is likely to increase in real terms between 2010 and 2050, there is significant potential to reduce the demand for fuels through the use of new technology, demand reduction and increased energy efficiency. By 2050 this action would mean that the total cost of energy for heating and hot water could be around 20% lower in real terms than in the 2010 base year.

3.25 As outlined in Section 2, the patterns of electricity demand, and peak demand in particular, are important factors to consider when assessing options and trade-offs in the use and generation of heat. Further modelling is required to understand the

[34] The costs and emissions presented are associated with the whole heat system and its capital and operating costs (fuel costs and maintenance). They exclude costs associated with electricity generating capacity beyond what is covered by the predicted electricity prices in the DECC central price scenario. As the scenarios cover whole heat system costs and both direct and indirect emissions they do not directly represent and are not comparable to scenarios developed using other models such as those presented in the RPP2.

impacts of peak electricity demand and the overall cost implications of providing sufficient generating capacity.

Question 4: What do you think should be the balance and focus of government intervention, business innovation and individual action and why?

4. Looking to the future - reducing the need for heat in homes, business and the public sector

4.1 Demand reduction is a significant contributor in terms of reducing greenhouse gas emissions from heat and sits at the top of both the Scottish Government Energy and Heat Hierarchies. It also helps to minimise energy bills and realise wider economic benefits. An improvement in the efficiency of housing helps to reduce fuel poverty and nationwide heat demand reduction reduces our reliance on fossil fuels.

4.2 Here we outline our existing policies and progress to help reduce the need for heat through encouraging and supporting individuals and business and industry to change behaviours, as well as investment in resource efficiency.

4.3 It will require a significant change in the approach by the whole of Scottish society to energy use, conservation and reduction, to achieve our climate change targets. We are making good progress towards our 2020 12% reduction target for energy efficiency. In 2011, final energy consumption, including energy used for heat, power and transport, was 9.2% lower than the baseline (2005-2007). Non-electric heat demand has reduced by 10.6% over the same period[35].

4.4 Moving forward:

- We have committed to providing nearly a quarter of a billion pounds of funding to tackle fuel poverty and improve domestic energy efficiency, including providing heating systems over a 3 year period.
- We are developing proposals with key stakeholders for draft regulations that would set minimum standards for energy efficiency in private sector housing, consulting in Spring 2015.
- We are working to ensure UK wide programmes such as ECO and Green Deal are being streamlined and improved to increase uptake an benefits in Scotland.
- We will continue to support business, industry and the public sector through our £7.3m Resource Efficient Scotland programme and SME loans scheme.
- With our partners, we will deliver a skills system that is responsive to the future skills challenges which new technologies and business growth opportunities present.
- We will apply energy performance regulations under development to large non-domestic buildings which are subject to sale or to a new lease.

Behaviour Change

4.5 Encouraging energy efficiency behaviours will continue to be informed by our Individual, Social and Material (ISM) tool[36]. To influence the way people behave we need to look at: the individual, the values and attitudes we hold, the habits we have learned; the social, the people around us; and the material, the tools and infrastructure available to us in our day-to-day lives.

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[35] Energy in Scotland 2014, a statistical compendium: http://www.scotland.gov.uk/Topics/Statistics/Browse/Business/Energy/Compendium2014

[36] http://www.scotland.gov.uk/Publications/2013/06/8511

4.6 We are encouraging households across Scotland to reduce their demand for energy, and use lower carbon options through:

- keeping the heat in (such as insulation, draught proofing, double glazing);
- better heating management (heating rooms to different temperature depending on whether they are occupied and what activity is being carried out); saving electricity (buying energy efficient appliances, washing clothes at lower temperatures); and
- installing more energy efficient heating system, or generating your own heat.

These household actions[37] are all supported through the **Greener Together** public campaign and website which supports behaviour change in homes and workplaces. The growing **Green Homes and Green Business Networks**[38] allow people to see low carbon technologies in use in others' homes and workplaces, and encourage their uptake.

4.7 The modelling work carried out to develop the HGPS demonstrates that reducing the average temperature of a home by a degree or two can make an important contribution to reducing carbon emission as well as, energy bills. This does not mean that a home should be cooler than recommended temperatures when in use but rather that by smart use of thermostats the heating can be tailored to come on when and where it is required within a building.

4.8 Zonal heating is already being used in some commercial buildings. Some large offices where hot desking is standard have introduced zones that are used at quiet periods, such as peak holiday periods avoiding the need to heat the rest of the building.

4.9 Energy informatics can make monitoring and controlling the performance of buildings much more accessible not only to energy professionals but to individual householders and small businesses. There are technologies already available, such as smart meters and Building Energy Management Systems, and more solutions under development.

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[37] For example, see pages on Top 10 tips to save energy in the home http://www.greenerscotland.org/saving-energy/how-save-energy-home/ten-top-tips-save-energy-home and How to insulate your home

[38] http://www.energysavingtrust.org.uk/scotland/exemplarhomes/search?membertype=businesses

Reducing the Need for Heat in Homes

4.10 According to the 2012 Scottish House Condition Survey[39], the level of loft insulation has improved. More than half of homes with lofts now have insulation 200mm or thicker, and two-thirds of cavity walls have been filled. The Survey also shows that the number of dwellings rated 'good' on the National Home Energy Rating[40] scale increased by 116,000 to reach 1,635,000 in 2012. And the most common Energy Performance Certificate[41] rating (from energy efficiency) in 2012 was 'C' for the first time since the system was introduced in December 2008. Large and small private sector organisations are taking action to save money and resource use with co-ordinated efforts such as the development of the public sector retrofit programmes.

4.11 Scotland's **Sustainable Housing Strategy** sets out a route-map to 2030 for warm, high quality, affordable, low carbon homes and aims to ensure that the refurbishment and house-building sectors contribute to, and benefit from, Scotland's low carbon economy. It identifies a number of actions that will help deliver this vision, the role of energy efficiency standards, and the need for a wider market transformation so that people recognise the benefits of energy efficiency and value it.

4.12 We have committed to providing around **a quarter of a billion pounds** of funding through our **Home Energy Efficiency Programmes for Scotland** (HEEPS) to improve energy efficiency and tackle fuel poverty, over a three year period. With £74m allocated in 2013/14, we have also announced a £79m fuel poverty budget in each of the next two years (2014/15 and 2015/16). In addition to this we will maximise the amount of ECO we can lever in as a result of our programmes.

4.13 Across the UK and elsewhere there is move to introduce an innovative sustainable finance mechanism funded by the private sector to offset the initial capital costs and encourage the uptake of spend to save energy efficiency measures. **Green Deal** is a UK Government long-term energy efficiency financing initiative which is still in its early days. It aims to address the barrier of up-front costs to the installation of energy efficiency measures and whole-property (domestic and non-domestic) approaches needed to meet climate change targets and promote green jobs. It enables both householders and occupants of non-domestic buildings to have energy efficiency improvements installed at little or no upfront capital cost paid through a charge on their electricity bill. As the energy service market develops, Green Deal will adapt further.

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[39] http://www.scotland.gov.uk/Publications/2013/12/3017

[40] The National Home Energy Rating (NHER) is a commonly used standard for calculating energy efficiency of dwellings. The assessment procedure is not based on actual running costs, but on the theoretical costs of maintaining a standard regime for a standard level of occupancy. The NHER model includes costs for space and water heating, lighting, and domestic appliances. It is also based on a standard occupancy level and takes account of climatic differences across the UK.

[41] Energy Performance Certificates (EPCs) were introduced in December 2008 to promote improvements to the energy efficiency of buildings. Every building that is built, sold or re-let is required to have an EPC. Energy efficiency scores are banded into groups – A (most efficient) to G (least efficient). The methodology for calculating EPC rating takes into account energy for lighting, space heating and hot water.

Case Study: John Mooney, Fort William
Mr Mooney is a retiree who has lived in his detached home for 21 years. Prior to speaking with Home Energy Scotland he was spending upwards of £350/mth on oil and electricity (£200 oil and £150 on electricity). Wanting to lower his bills he called Home Energy Scotland and applied for a few schemes including the Renewable Heat Premium Payment, the Green Homes Cashback scheme and a cavity wall insulation scheme as well as looking into Green Deal. As a result of installing cavity wall insulation, under-floor insulation, double glazing, an air source heat pump, solar water heating and LED light bulbs, Mr Mooney has reduced his energy bills by £159 a month (over £1900 a year).

4.14 The Green Deal is being streamlined and improved to increase uptake in energy efficiency measures which will make it more straightforward and less time-consuming for families who want to improve their homes and benefit from lower bills. We will continue to sponsor **Home Energy Scotland**, which provides independent and impartial tailored energy advice and information on financial support and mechanisms available to householders.

Regulations and Standards

4.15 **Building regulations** have a key role to play in ensuring that the energy performance is optimised, both of new buildings and existing buildings being amended. These standards were reviewed and improved in 2002, 2007 and 2010. Most recently, it was announced that new standards from October 2015 will reduce emissions in new buildings from heating, cooling, lighting and ventilation by an average of 21% in new homes and 43% in new non-domestic buildings. More moderate improvements result from standards applicable to work on existing buildings. Recommendations to Government on further review of these standards can be found in the Sullivan Report 2013 update[42].

4.16 We will introduce the **Energy Efficiency Standard for Social Housing** (EESSH) early in 2014. The EESSH is designed to be straightforward and without prescription and sets a single minimum Energy Efficiency (EE) rating for social landlords to achieve by 2020. It is expected to potentially save tenants in the region of £130 million each year from reductions in energy use.

4.17 The Scottish Government has set up a working group of key stakeholders to develop proposals for draft regulations that would set minimum standards for energy efficiency in private sector housing. We will consult on draft regulations in Spring 2015.

4.18 Section 63 of the Climate Change (Scotland) Act 2009[43] places a duty on Ministers to regulate for energy performance assessments of existing non-domestic buildings and their emissions and for owners to improve the energy performance of

[42] http://www.scotland.gov.uk/Publications/2013/11/8593
[43] http://www.legislation.gov.uk/asp/2009/12/contents

their buildings and to reduce emissions. Regulations under development will apply to large buildings which are subject to sale or to a new lease. Following assessment, owners would then either have to implement building improvements or annually report their operational carbon and energy performance[44]. Section 63 has the scope to ultimately mandate physical energy performance improvements to all existing non-domestic buildings.

Reducing the Need for Heat in the Non-Domestic Sector

4.19 In supporting business, the Scottish Government approach is to focus on resource efficiency, looking at energy, materials, water and waste reduction. As well as ensuring energy use is efficient and capturing excess heat, businesses can also achieve significant energy and cost savings by reducing materials and water in production processes.

Case study: Glass industry
Resource Efficient Scotland is focusing part of its activity on increasing the quantity of glass recycled through remelt in Scotland, which also significantly reduces heat consumption and greenhouse gas emissions. Glass made from remelt is less energy intensive than glass made from raw materials (silica and other minerals). British Glass estimates that every tonne of new bottles and jars made using recycled glass rather than raw materials prevents the emission of 670 kg (0.67 tonnes) of CO_2. However, other opportunities also exist. As part of the Heat Network Partnership, a feasibility study has been commissioned looking at recovery of waste heat from the O-I furnaces in Alloa into a local district heating scheme.

4.20 In large, resource intensive processes and industries, smaller resource impacts are often overlooked. However, these impacts can deliver substantial resource efficiencies through projects with reasonable payback periods and initial costs more palatable than multi-million pound investments needed to tackle the major resource efficiency projects needed within the main process areas.

4.21 Working with energy intensive business and industry to date has focussed on ensuring that industry increases competitiveness by taking advantage of both, available compensation schemes for carbon costs at a time when UK carbon costs are higher than international comparisons[45], and UK and Scottish Government demand reduction and heat related support schemes. This will help to save costs, reduce emissions and to minimise the impact of rising energy prices. Specific

[44] http://www.scotland.gov.uk/Publications/2013/03/5662/3
[45] https://www.gov.uk/energy-intensive-industries-compensation-for-carbon-leakage
https://www.gov.uk/government/policies/reducing-demand-for-energy-from-industry-businesses-and-the-public-sector--2

schemes include UK Climate Change Agreements[46] and the EU Emissions Trading System (ETS)[47].

4.22 We are supporting resource efficiency across all organisations through investing annually into the Scottish Government's **Resource Efficient Scotland programme**. It supports organisations to realise potential annual savings of around £21-25m and energy efficiency savings of around 45GWh. The programme offers information, advice and support to businesses, third sector and public sector organisations to implement energy, material resource and water efficiency measures. Central to the programme is sector-focused activity which aims to identify common challenges and solutions and then work with sector bodies and key stakeholders to maximise opportunities for wider economic and environmental gain. We will continue to support business, industry and the public sector through Resource Efficient Scotland.

4.23 The **Resource Efficient Scotland SME loans scheme** provides loans of £1,000 to £100,000 to SMEs, private landlords and not-for-profit organisations for the installation of sustainable energy, material resource and water efficiency measures, and renewable energy technologies. Since its launch in 2008, the scheme has funded 569 projects, resulting in an estimated energy saving of 194,000MWh of heat and electricity and 64 $KtCO_2$ of carbon savings over the lifetime of the projects, as well as a financial saving of £19.9m.

Case study: MacDonald Hotels "Room 15" is the MacDonald Hotels' sustainability plan. The initiative is designed to make every aspect of the business and supply chain even more sustainable and is based on **15 commitments** for the Group to **achieve by 2015**. It includes the following features:

- The introduction of Room 15 energy policy and "Good Practice Guide";
- Appointment of "Energy Champion" at each hotel;
- Completed capital expenditure projects (to a value of over £900k) including on: LED lighting, combined heat and power installation, boiler optimisation devices, voltage optimisation, radiator control devices, monitoring equipment and shower head flow reduction devices,
- Approved on-going projects include over £125k on heat saving measures for swimming pools (combination of pool covers and pool chemicals);

(www.macdonaldhotels.co.uk/media/1000346/room15brochure__final_.pdf).

"The investment in energy saving infrastructure, combined with creating staff awareness through training, has given us one of the best returns on investment that we have achieved in recent years"- Gordon Fraser, Group Finance Director and Chairman of the Macdonald Hotels' Energy Committee.

4.24 To support the capacity of our businesses to maximise the opportunity for jobs and investment in resource efficiency and the wider heat sector, we need to deliver a

[46] https://www.gov.uk/government/policies/reducing-demand-for-energy-from-industry-businesses-and-the-public-sector--2/supporting-pages/climate-change-agreements-ccas
[47] https://www.gov.uk/government/policies/reducing-the-uk-s-greenhouse-gas-emissions-by-80-by-2050/supporting-pages/eu-emissions-trading-system-eu-ets

skills system that is responsive to the future skills challenges which new technologies and business growth opportunities present. Our training and education systems also need to be capable of developing the required skills and knowledge so that businesses are supported in their growth aspirations and we can maximise the employment opportunities they offer. The primary challenge here may be the adaptation of existing skills rather than developing new skills.

4.25 The **Low Carbon Skills Fund**, developed and managed by Skills Development Scotland (SDS), has enabled employers to upskill and reskill over 2,500 individuals in low carbon technologies (including renewables). This has entailed working with the Energy Skills Partnership (ESP) to develop and align college capacity to support low carbon priorities and environmental technology provision. The ESP has also established an Energy Efficiency Hub within the colleges. SDS will continue to develop and support skills uptake in low carbon technologies through initiatives like the Low Carbon Skills Fund.

Question 5: Given the existing financial incentives and policies in place, what other mechanisms do you think would result in significant behaviour change in both homes and non-domestic buildings and processes?

Key role of the Public Sector

4.26 The Scottish Government, its agencies, and local government have a key role to play leading by example through the actions they take on their own estates to minimise heat demand, as well as identifying opportunities for utilising unused excess heat. The public sector can also show leadership by taking action for the early adoption and project delivery of demand reduction, low carbon heat projects and providing a framework that makes it easy for business, industry and households to do likewise. Local authorities will be key to this in terms of their ability to enable changes through the planning process, encouraging developers to look at alternatives to fossil fuel heating, and considering how heat is delivered to social as well as private housing and businesses in future.

4.27 Developing energy efficiency programmes of scale across the public sector will facilitate efficiencies, such as in procurement, and provide a strong basis for developing the associated supply chain in Scotland. There are substantial energy and costs savings to be secured in improving energy efficiency across the public sector estate, and opportunity to use those savings as a means of financing the capital work required to retrofit buildings and infrastructure. We continue to support Scottish Futures Trust's low carbon workstream[48], to develop financial commercial models to support investment in programmes of energy efficiency projects across the public sector estate, and where feasible enable private sector investment. Initial focus has been on LED retrofit of streetlights, district heating and non-domestic energy efficiency retrofit of buildings.

[48] http://www.scottishfuturestrust.org.uk/our-work/low-carbon-and-energy-efficiency/

© Fife Council

4.28 Taking a nationwide approach to replicable heat projects with joint working across organisations has significant potential benefits in reducing costs and improving efficiency. An example in the electricity sector is the work already carried out on a **nationwide programme of street lighting** where various bodies[49] are working together to achieve robust technical specifications, economies of scale and reduced procurement times. It is estimated that an investment of £298 million could generate potential savings in the region of £1.3bn over a 20 year operational period before allowing for financing costs.

4.29 The Scottish Green Investment Portfolio Group (SGIP) and Scottish Futures Trust (SFT) have been collaborating with the UK Green Investment Bank (GIB) to develop financial 'products' that will be attractive to local authorities and the wider public sector. Subsequently, GIB has developed a Green Loan product specifically for local authorities to support spend-to-save energy efficiency projects.

4.30 The Scottish Government is providing financial support for local authorities, universities and colleges to help fund energy efficiency projects through our £9,5m Salix Finance revolving loans scheme.

4.31 **NHS Scotland** is taking a strategic approach to the implementation of measures to reducing heat demand, efficient distribution of heat and increasing renewable and low carbon supply across its estate. This work has been supported by SFT and Resource Efficient Scotland. A pilot energy audit conducted at a large acute hospital within the NHS Scotland estate identified potential cost and carbon savings at the site of around £1.5 m and about 9,000 tCO_2 respectively, a capital cost of approximately £10m. Following the outcome of a pan-NHS Scotland energy audit programme and detailed consideration of options for energy investment, NHS Scotland will publish in 2014 an Energy Strategy outlining plans.

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[49] A national Street Lighting Steering Group with representatives from SFT, Resource Efficient Scotland, Society of Chief Transport Officers in Scotland (SCOTS), COSLA, local authorities and Scotland Excel works to bring forward an accelerated nationwide programme of greener (LED) street lighting.

Case Study - Fife Energy Programme

Over 70% of Fife Council's carbon emissions come from heating and lighting council buildings, and cost £11.4 million per year (2011/12).

In 2012 the Fife Energy Strategy was developed in partnership by sustainability, asset management and finance officers. It was approved by Elected Members in January 2013. This is a strategic approach for the whole council estate that aims to significantly reduce carbon emissions and energy bills through: improving the energy efficiency of buildings; generating renewable energy to heat and light buildings; and reducing the number and size of buildings. The Fife Energy Programme is implementing the Strategy by investing to reduce annual energy costs. Measures that pay for themselves are prioritised, so that budgets for frontline services are under less pressure. Fife Council Management Team has approved a 10 year pay back of energy efficiency measures (with spending of £4m over 2013/14 and 14/15) to expand the range of works undertaken including boilers, insulation and heating controls.

Looking Forward

4.32 Both in our homes and offices, changing our habits and behaviours and installing energy efficiency measures can, for many, reduce our need for energy without impacting on comfort or productivity. The scenario modelling carried out to develop the evidence base underpinning the Heat Generation Policy Statement, indicates that it will require both high Government Intervention and high Uptake (i.e. high uptake of existing, new and different technologies) to achieve a largely decarbonised heat sector by 2050.

4.33 In the future we should see householders and business adopt technologies already available on the market which allow them to monitor and control the performance of homes, business and industrial processes to maximise demand reduction, ensure efficient use of heat and generation by identifying areas where efficiencies can be improved and where running costs can be minimised

4.34 That future relies on partnership to support the technology innovation and developments we require and to ensure that Scottish companies are at the heart of those developments. Partnerships with Scottish local authorities, and the wider public sector will be key in driving forward the development of our towns, cities and rural infrastructure[50], as well as with industry and Scottish academic institutions.

[50] http://open.glasgow.gov.uk/

5. Looking to the future – supplying heat efficiently and at least cost to consumers

5.1 Supplying heat efficiently, and therefore wasting less heat will help to reduce costs to consumers. It will also reduce emissions from heat and our reliance on fossil fuels. Efficiency supply options have been shown to reduce fuel poverty and there is a significant economic opportunity presented by efficient supply, particularly when coupled with other low carbon and renewable technologies. This is why after demand reduction supplying heat efficiently and at least cost to consumers sits in the middle of our heat hierarchy.

5.2 Here we outline our existing policies and progress to support efficient heat supply through district heating and thermal storage. Moving forward:

- We will publish the Scotland heat map in Spring 2014 and make heat map datasets available to Scottish local authorities from April 2014 to support local strategic heat planning.
- We will set a target for district heating: we propose an overall target of 1.5 TWh of heat to be delivered to households, business and industry and the public sector by district heating by 2020.
- We propose a target of 40,000 homes to be supplied with affordable low carbon heat through heat networks and communal heating by 2020.
- We are increasing funding for the District Heating Loans Fund by over £4 million, making a total of £8 million available over the two years 2014 to 2016. This is part of a £10.5 million package of support for heat policy of the next two years.
- We have initiated research to provide the basis for policy development in thermal storage.

Planning and Heat

5.3 Planning authorities have a key role to support the delivery of heat initiatives across Scotland. At national level, the National Planning Framework (NPF), Scottish Planning Policy (SPP) and online renewables planning advice, provide the national planning policy context and advice for heat.

5.4 The Proposed NPF3, which is the spatial interpretation of the Government Economic Strategy, was laid in the Scottish Parliament on January 14, 2014, and following a period of Parliamentary scrutiny is expected to be published in 2014, alongside updated SPP.

5.5 The Proposed NPF3 highlights that we are seeing an increasing number of district heating networks across the country, we can make much better use of the heat sources we have, including unused excess and renewable heat, and a Scotland heat map can help this to happen. There appear to be significant opportunities for the cities in particular to use renewable and low carbon heat energy. New development should be future-proofed to ensure that connections to existing or planned heat networks are taken forward as soon as they are viable.

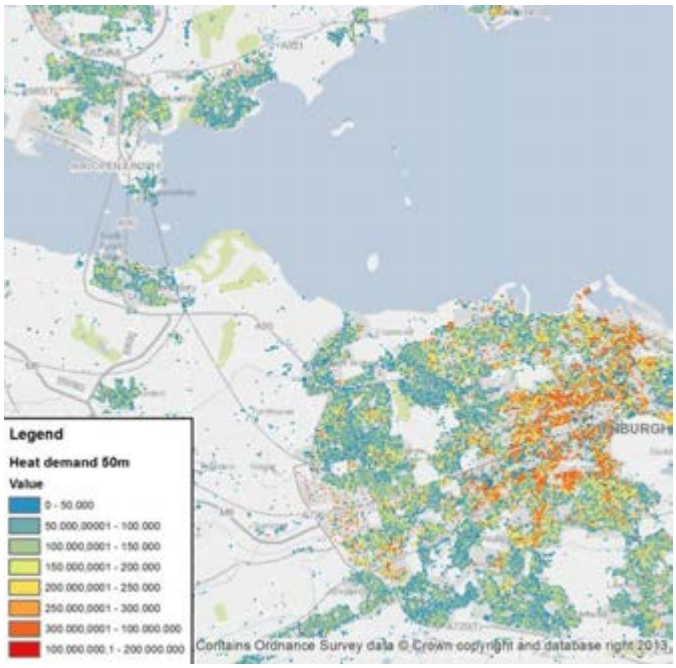
5.6 The Draft SPP published for consultation in April 2013, identified that local development plans should use heat mapping to assess the potential for co-locating developments with a high heat demand with sources of heat supply, and they should support the development of heat networks, even where they are reliant on carbon-based fuels if there is potential to convert them to run on renewable or low carbon sources of heat in future. Where heat networks are not viable, microgeneration and heat recovery technologies in or associated with individual properties should be encouraged. The updated SPP is expected to be published in June 2014,

5.7 Online renewables planning advice is also available identifying typical planning considerations and useful references for planning authorities, developers and other stakeholders in using heat maps, dealing with renewable heat and district heating proposals

Heat Mapping

5.8 Heat is not just about products and people. It is also important to consider places and infrastructure – the places where heat is required and where heat can be generated and distributed and the opportunity for infrastructure investment. The way heat is provided and used in different places already varies significantly, depending on the types and density of the buildings, the different temperatures of heat required and the types of fuel available in the area. This will affect the options going forward.

5.9 The **Scotland Heat Map**, currently being developed by the Scottish Government, will be an important resource to identify the opportunities for efficient heat supply projects and support their development. Developed with data provided by public and private sector organisations including all local authorities, it will help to identify opportunities for new and expanding heat projects including efficient supply projects. As well as being a national resource for strategic modelling and planning, the Scotland heat map dataset will be offered to every Scottish local authority to create a local heat map for their area.



Part of the Scotland Heat Map

5.10 Heat maps are a practical tool which can be used to:

- provide planning authorities with the knowledge base to highlight heat opportunities (such as heat recovery, district heating, renewable heat and low carbon heat) in development plans, in pre-application engagement with developers and in determining planning applications;
- identify projects at a local level and Scotland wide to provide a potential pipeline of projects and the development of local investment proposals;
- support heat plans for commercial and public sector energy management;
- identify heat resources and unused excess heat;
- identify heat opportunities in the domestic sector to benefit social housing and tackle fuel poverty.

5.11 The heat map datasets will be made **available to Scottish local authorities from April 2014** with a manual and training offered to local authorities on how to best use these shortly afterward. A less defined web version[51] of the Scotland heat map will be published in Spring 2014.

Question 6: **How do you think a national heat map could be used to support the development of a low carbon heat sector for Scotland?**

Perth & Kinross Council, contains Ordnance Survey data © Crown Copyright

District heating

5.12 District heating networks are a means of distributing heat to homes, businesses and public buildings, to allow us to make efficient use of a range of heat sources. Heat exchangers in individual buildings allow consumers to tap into the heat network for affordable controllable heat to meet their heat demand. In Scotland, individual boilers heating individual buildings are the main source of heat, but many other European countries have heat networks that supply towns or whole cities, resulting in lower carbon emissions, cheaper heating and long-term investment in infrastructure which can be adapted to meet changing energy markets.

5.13 In 2012, Fergus Ewing, the Minister for Energy, Enterprise & Tourism convened **the Expert Commission on District Heating** to make recommendations to Government on accelerating the uptake of district heating, including the potential scale of development. The Expert Commission reported in November 2012 and the Scottish Government responded to the recommendations in its District Heating Action Plan.

[51] Scotland heat map, see: http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-sources/19185/Heat/HeatMap

5.14 The Scottish Government's **District Heating Action Plan**, published in 2013, sets out how we intend to support the development of district heating in Scotland. It **identifies the main opportunity for large-scale heat networks is in our towns and cities** where there is concentrated high heat demand, such as high density housing estates and campus sites such as universities, large hospital sites and industrial complexes. Once buildings are properly insulated, further decarbonisation of heat in urban areas is challenging as there are limited practical and cost effective options for high density housing. **Distributing heat through heat networks allows consumers even in a city centre to access lower carbon and lower cost heat.** For example, Cube Housing Association's district heating network at Wyndford Estate in Glasgow, which replaced high cost electrical systems in multi-storey blocks, now gives individual tenants and private households the control to heat their homes properly, at an affordable cost.

5.15 In addition, the Action Plan recognises the **significant contribution smaller rural schemes, mainly renewable,** are making to reduce carbon emissions and fuel poverty. Housing associations such as West Highland Housing Association[52] and Albyn Homes have led the way in installing biomass district heating in new build properties. Developing a heat market has led to the creation of new businesses offering complete energy services packages, such as the 10 energy services companies on the Scottish Government's Biomass Procurement Framework. Other technologies such as heat pumps, geothermal and recovered heat also supply heat networks, for example the Water Source Heat Pumps (WSHPs) at Loch Ness Shores, supported by the District Heating Loan Fund.

Case study: Aberdeen Heat & Power (AH&P) was set up in 2002 by Aberdeen City Council as an independent, not-for-profit company, limited by guarantee. At that time the Council conducted an energy appraisal of its housing stock, which included 59 multi-storey blocks with 4500 flats, heated by electricity. The appraisal revealed that up to 70% of the residents were living in fuel poverty, could not afford to heat their homes properly with resulting damp, and in some cases, poor health conditions. An evaluation of the options showed that a combined heat & power (CHP) and district heating network would be the most cost effective option to improve the conditions for tenants in the long term.

The scheme has grown through three principal projects and now supplies almost 2000 homes in 22 multi story blocks, and 11 public buildings. Carbon emissions from these buildings have reduced by 45% and typical fuel costs to tenants have been reduced by up to 50% over the previous heating system. Customer satisfaction surveys have indicated that tenants are very satisfied with the heating system. Aberdeen Heat & Power recently set up a subsidiary, DEAL, to enable it to supply commercial customers in the city centre through the heat network extension funded by the Scottish Government. It recently received international recognition, winning the Award for Excellence from Global District Energy Climate Awards to add to previous awards from UK Housing and COSLA.

[52] See case study in Section 6.

5.16 Once the infrastructure for distributing heat is in place, it allows future upgrades or changes to the heat supply without disruption to individual consumers connected to the network. New technologies or currently untapped resources have potential to be captured and connected to district heating. Creating the infrastructure, however, requires significant up-front capital investment in infrastructure with very long lifespans. The scale of investment needed to achieve the change to our homes and non-domestic building and development of new infrastructure will require significant capital. This presents opportunities to consider ways of how these might be financed to ensure that both the heat users and those carrying out the work benefit.

Our Ambition for District Heating

5.17 The Expert Commission's report recommended that baseline data was gathered to enable the Scottish Government to set stretching yet realistic targets for district heating. The Commission recommended that the target be based on total heat load supplied through heat networks, irrespective of source. Additionally the Commission highlighted the importance of the public sector estate in supporting the development of district heating and the opportunity to address fuel poverty in multi-storey social housing, and recommended subsidiary targets be set for these sectors.

5.18 There have already been some significant heat network developments in Scotland. The Scottish Government commissioned the Energy Saving Trust to carry out a study which created a database of 112 operational district heating networks supplying around 10,000 homes and a range of public, commercial and industrial buildings. The total estimated capacity of district heating schemes in operation in Scotland is nearly 100 MWth, about half of which is renewable, mainly biomass.

5.19 A 2009 assessment of the technical potential and costs of district heating in the UK[53] showed that, in the right conditions, heat networks could supply up to 14% of the UK's heat demand. It also showed district heating to be a cost-effective and viable alternative to individual renewable technologies while reducing the cost of energy for consumers.

5.20 The Department of Energy and Climate Change (DECC) estimate of the current heat demand supplied by district heating in the UK is less than 2%. In Scotland, we estimate that it is less than 1%. The difference may be due to the higher proportion of high density built up areas in England. For example, many boroughs in London and a few other cities such as Sheffield and Nottingham have had well developed heat networks and communal heating for many years.

5.21 To support development of heat networks in Scotland, the Scottish Government committed to consider district heating targets in the development of the Heat Generation Policy Statement. We now propose **to set an overall target of 1.5**

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[53] Powry, The Potential and Costs of District Heating Networks, 2009, published by DECC http://webarchive.nationalarchives.gov.uk/20121205174605/http:/decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/distributed%20energy%20heat/1467-potential-costs-district-heating-network.pdf

TWh of heat to be delivered by district heating by 2020, from both renewable and traditional energy sources, to deliver affordable low carbon heat to households, business and the public sector. This represents 2% of total forecast non-electrical heat demand in Scotland in 2020. Subsidiary targets are discussed below.

Question 7: Do you support the proposed unit of measure for the overall district heating target of 1.5 TWh by 2020? And why?

Question 8: Do you support the level of ambition for the district heating target? What evidence do you have to support your views?

5.22 By 2050, our modelling indicates that Scotland could supply around 8 TWh of heat through district heating. A significant amount of the heat from district heating is currently provided from gas fired CHP. In future, the modelling indicates that to achieve the emission reductions required a much higher proportion of this heat will need to come from even more low carbon sources such as excess unused industrial heat and renewable sources such as geothermal, biomethane or biomass.

5.23 We also recognise the significant opportunity to tackle high heating bills for households, particularly in multi-storey blocks where there are limited alternatives for affordable low carbon heat. Scotland has a higher proportion of households in multi-storey blocks than the rest of the UK, mainly with electric heating. The Scottish Housing Condition Survey found that around a third of households in these blocks, a significant number of which are in Scotland's cities, are in fuel poverty. To tackle this problem, a number of large-scale social housing district heating schemes have been installed in our cities, notably Aberdeen, Glasgow, Edinburgh and Dundee.

5.24 In rural areas, renewable district heating can also significantly reduce carbon emissions and costs. Over half of the current operational heat networks are small to medium scale renewable systems, mainly biomass. This type of scheme, located where there is available local woodfuel resource or heat from biogas CHP, provides affordable low carbon heat as well as supporting jobs and income in the supply chain.

5.25 We therefore, **propose to set a target of 40,000 homes to be supplied with low cost, low carbon heat through heat networks and communal heating by 2020**. The majority of these homes will be in high density heat areas, particularly electrically heated multi-storey blocks along with a significant increase in renewable heat networks in off-gas grid areas. This will help deliver our targets on reducing fuel poverty.

© Aberdeen Heat & Power

5.26 This proposed target is based on there currently being 10,000 homes on district heating. There are very limited data regarding the number of homes on existing communal heating systems.[54]. Should evidence be provided of significant numbers of such homes we would expect to revise the target for homes connected accordingly.

Question 9: Do you support the level of ambition for the number of homes to be connected to district heating by 2020? What evidence do you have to support your views?

Question 10: Do you have evidence of existing communal heating systems installed before 2000? If so please provide details.

Role of the Public Sector

5.27 We recognise the important role the public sector, particularly local authorities, has to play in the development of district heating. This is both at a strategic level through the use of heat maps in **local development plans** as well as at a practical level through the **substantial heating demand** from public sector buildings such as offices, hospitals, leisure centres, and social housing. The public sector provides a **valuable customer base** to support investment in district heating infrastructure.

5.28 The public sector also has an important role in **directly developing heat networks** and heat supply. Local authorities have led the way: Fife Council has implemented the heat network in Dunfermline; Aberdeen City Council created an independent, not for profit organisation, Aberdeen Heat & Power, which now supplies over 2,000 homes; and a similar organisation, Shetland Heat & Power, set up by Shetland Council, has now been operating successfully for over 10 years.

5.29 There are examples of other public sector organisations considering district heating as part of a strategic approach to reducing greenhouse gas emissions and costs. NHS Scotland recognises the potential for district heating across the healthcare estate, which already has a number of large heating systems supplying several buildings. NHS Scotland considers district heating to be an important and viable technology. It will consider district heating alongside a range of energy efficiency and renewable energy technologies on a site by site basis. NHS Scotland will support its implementation where technical and financial parameters are met.

5.30 Building on the data gathering for the Heat Mapping Programme for Scotland, the Heat Network Partnership for Scotland (see below for further details) is **reviewing the extent** to which **the public sector estate is suitable for connecting to district heating**. Once that work is completed the Scottish Government will work with public sector organisations to consider setting targets for delivery and how the opportunity can be realised.

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[54] Communal heating systems are defined here as being a single heat source providing heat to more than one home, all within a single block

Case study: District Heating at the University of Edinburgh
As part of its long-term energy strategy, the University of Edinburgh invested around £12 million in three gas-fired combined heat and power (CHP) plants and district heating networks at Pollock Halls, King's Buildings and George Square. The George Square plant and network replaced a 50 year old steam system in 2005, connecting 14 buildings. It now provides heat to over 20 buildings. This includes the Informatics Forum built in 2008, saving the cost of constructing a separate boiler plant. This network cost £7 million to install and is saving around £0.5 million a year in energy costs at current prices, with annual savings of £1.5m and 8,500 tCO_2e achieved from all three projects.

The University has continued to extend its heat networks, and has commissioned a fourth energy centre with a new underground network supplying heat to the University's buildings at Holyrood, the Pleasance and High School Yards. This £8m project has been funded from savings achieved on first three Energy Centres.

© University of Edinburgh

Regulation of district heating

5.31 Unlike gas and electricity, heat supply is currently unregulated. Heat is generally supplied locally and, historically, the scale of the market has not been sufficient to require regulatory intervention. However, as more consumers are connected it is important to ensure that they have confidence in the reliability of supply and transparency on their heat bills.

5.32 As the market grows, the Scottish Government will need to develop appropriate regulation, commensurate with the scale of the heat market. The Expert Commission on District Heating recommended that the Scottish Government set up a licensing body for district heating with defined design and operating standards for district heating guaranteeing supply and customers' rights for all tenancies and providing full transparency on price.

5.33 Regulation would support other recommendations such as the ability to grant licences to heat network operators to assign wayleave access rights, similar to other utilities, with rights of access to install, maintain and/or repair heat network infrastructure. Consumer regulations would also provide greater customer confidence and protection in relation to any requirement to connect to district heating, as proposed by the Expert Commission.

5.34 Regulation and standards for district heating can underpin long-term strategic development plans for heat. This enables district heating projects to be designed and built today, with the potential for future expansion, connecting up more customers and linking stand-alone schemes together, to create large-scale integrated heat networks. For example, the Scottish Government funded Glasgow City Council to ensure the district heating for the Commonwealth Games Athletes' Village and Emirates arena has the capacity for expansion. This means that surrounding areas will have the opportunity to benefit from the heat supply in the future.

5.35 We wish to work with industry to develop regulations in such a way that they support development and do not act as a barrier at this early stage in the growth of the heat supply market, nor place excessive costs on the sector which could be passed on to consumers.

5.36 Industry is already taking a lead to develop greater consumer protection through the **Independent Heat Customer Protection Scheme**[55], and the principles of the scheme were consulted on at the end of 2013. The Scottish Government is engaging with the Scheme's development to ensure that it meets the needs of Scottish consumers and district heating providers.

5.37 In addition, the UK Government, working with the Scottish Government, recently consulted on the requirements under the European Energy Efficiency Directive Articles, 9, 10, 11 and 13 on the metering and billing of district heating, district cooling, communal heating and/or hot water. The guiding principles were set out in the consultation, including the main aim to give heating, cooling and hot water customers greater control over their consumption, and consequently costs and billing. The consultation set out a number of options for running a scheme to monitor heating and billing for heat networks. The Scottish Government is working with the UK Government to review the responses, and will consider the most appropriate options for administering such a scheme in Scotland[56].

Question 11: Do you believe further regulation of heat supply is required? What level of regulation would be appropriate?

Question 12: Do proposed consumer protection schemes meet the needs of heat users and supply organisations? And if not, what changes are needed or what more is needed?

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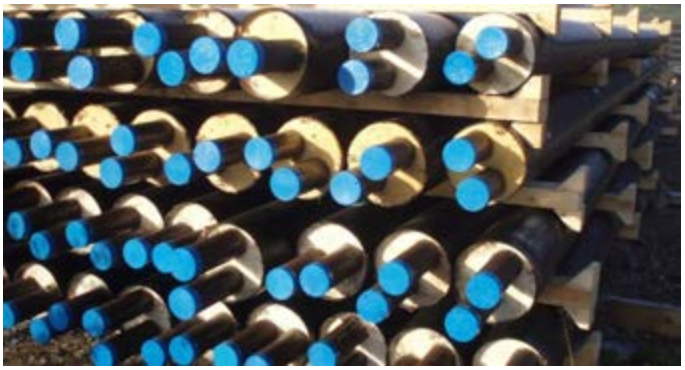
[55] http://www.heatcustomerprotection.co.uk/
[56] www.gov.uk/government/consultations/implementing-the-energy-efficiency-directive-metering-and-billing-of-heating-and-cooling


District heating pipes

5.38 Regulations to encourage more efficient use of all our heat resources are also being developed. Article 14 of the Energy Efficiency Directive aims to encourage organisations who produce excess heat to identify the cost-effective potential for cogeneration, efficient district heating and cooling and the recovery of industrial waste heat or, when these are not cost-effective, through other efficient heating and cooling supply options.

5.39 From 5 June 2014, operators of new or substantially refurbished combustion installations, under certain conditions, will be required to look at the costs and benefits of supplying heat to heat networks. The Scottish Government is proposing to implement these requirement through amendments to the Pollution Prevention and Control (PPC regulations), published for consultation on 22 January 2014[57].

Case study: Biomass district heating in Wick
In June 2012, Ignis Wick Ltd (the operating subsidiary of Ignis Biomass Ltd) purchased the assets of the Wick District Heating scheme, and took over its operation from the Highland Council. Ignis Wick invested £2.5 m in a new biomass steam boiler and associated modifications, to replace the existing oil fuelled boiler installation. This investment in woodfuel supply reduced fuel costs and secured the heat supply to 165 homes and the adjacent Old Pulteney whisky distillery. The woodfuel is supplied from local woodlands, creating significant investment in the economy of Caithness. Skilled jobs will be secured in the forest and in support services as a result.

Since 2012, Ignis has continued to invest in the network, with assistance from the Scottish Government's District Heating Loan Fund. The heat network supplies over 200 domestic customers (of which over 90% is social housing) with low cost heat, as well as Highland Council's Assembly Room and the distillery. A further extension will connect a local hotel, hospital, care home and up to 12 flats, replacing the fossil fuel currently used to provide heating and hot water in all of these buildings with affordable renewable heat.

Future plans include continued expansion of the heat network and investment in a biomass combined heat and power plant to meet the planned increase in heat customers.

[57] Consultation open until 16 April 2014: www.scotland.gov.uk/Publications/2014/01/4430

Support for District Heating

5.40 The Expert Commission identified initial development support and funding as one of the priorities for district heating growth. As set out in the District Heating Action Plan, the **Scottish Government has established the Heat Network Partnership for Scotland** to co-ordinate support for district heating development across a number of agencies and programmes: Scottish Enterprise, Scottish Futures Trust, the Energy Saving Trust, Scottish European Green Energy Centre and Resource Efficient Scotland[58]. The Heat Network Partnership website[59] gives details of where projects can get support and, as it is developed, will form a hub of information on district heating in Scotland.

5.41 The Scotland Heat Map will also be a key resource to underpin identification of potential projects and opportunities for replication and scale that could reduce costs. Fife Council used the heat map to identify potential new housing connections to the proposed extension of a district heating network, which led to an extended feasibility plan funded through the Warm Homes Fund.

Question 13: Is there sufficient non-financial support for the development of heat networks? If not, please comment on priorities and timescales for support? Please provide evidence, where possible, based on practical examples of district heating development.

5.42 Financial support for district heating is available from a number of sources including loans and investment through the District Heating Loan Fund, Warm Homes, Renewable Energy Investment Fund and the Green Investment Bank.

5.43 Launched in 2011/12, the Scottish Government's **District Heating Loan Fund** has committed loans totalling £4.4 million to 23 projects, 11 of which are now fully commissioned. **We are now increasing funding for the District Heating Loans Fund by over £4 million**, making a total of £8 million available over the two years 2014 to 2016. From 2011 to 2015, this takes our total commitment to District Heating Loans Fund to over £11 million.

5.44 This is part of a £10.5 million package of support for heat policy over the next two years. In addition, we have dedicated significant resources through our Heat Network Partners for development support for district heating.

[58] More information the role of HNP partners is in Annex E.
[59] www.districtheatingscotland.com

Funding for district heating

In addition to our District Heating Loans Fund, to date, our **Warm Homes Fund** has offered loan funding of £6.9 million for three housing association district heating projects in Oban, Fife and West Whitlawburn, Cambuslang, as well as a numbers of grants for feasibility studies looking at new schemes and/or the extension of existing schemes.

The **Renewable Energy Investment Fund** (REIF) is a £103m fund running till March 2016 which is delivered on behalf of the Scottish Government by the Scottish Investment Bank to provide capital support for renewables in the forms of loans and equity. Renewable district heating is one of the priority areas for investment.

In addition, in 2012 and 2013 we provided specific demonstration support to build up experience of projects on the ground. The Scottish Government gave grants of £1 million to private households to connect to Cube Housing Association's heat network at Wyndford Estate, to Glasgow City Council to future proof the Commonwealth Games Athletes' Village heat network for future expansion to the surrounding area, and for Fife Council to develop the specification for an extension to their Dunfermline heat network.

5.45 The Heat Network Partnership is working with the Scottish Green Investment Portfolio (SGIP) team, to move projects from planning to implementation and bring forward a project investment pipeline for district heating. Through our SGIP team, we are working closely with the Green Investment Bank (GIB) and other private sector finance companies, to attract private sector investment into low carbon and district heating projects. The GIB is working through around £500 million of Scottish opportunities including Energy Efficiency funds targeted at public and health estates.

5.46 Potential projects include the Glasgow City Centre and North District Heating scheme, currently making good progress in conjunction with GIB, Strathclyde University, Glasgow City Council and other project partners. The GIB is also working with SGIP and the Scottish Funding Council on a number of larger scale campus district heating schemes at St Andrews and Stirling. Opportunities also exist on large-scale industrial complexes such as Grangemouth to explore the potential for heat networks and distributed heat to improve energy efficiency and reduce costs.

5.47 A number of other schemes aimed at delivering energy efficiency and renewable energy include district heating as an eligible technology. District heating will now be included as a primary measure in the Energy Company Obligation (ECO). The Renewable Heat Incentive can support renewable energy generation to supply district heating.

5.48 It is clear, however, that barriers remain in securing investment in the high up front capital costs of district heating. Particular challenges are the creation of new heat supply businesses, securing long-term heat contracts and the long life cycle of district heating infrastructure which may need a longer-term view on returns on

investment. To put in place the necessary support we are seeking further evidence from developers on the need for investment and support for district heating.

Question 14: Are the many existing financial support mechanisms sufficient to support delivery of district heating systems?
Question 14a: If no, can you provide information and evidence to demonstrate the need for additional funding or alternative finance mechanisms, indicating the type of funding or finance required, over what timescale and setting out why existing mechanisms do not meet your needs. We would be particularly interested in evidence based on practical experience of development of district heating projects.

Question 15: If the mechanism that you propose was in place, what additional specific district heating outputs would result from your work and on what timescale?

Thermal Storage

5.49 Thermal storage provides a way of managing the peaks and troughs of heat demand over a period of time. Heat stores (or heat accumulators) store heat normally in the form of hot water, for example in large insulated tanks, above or below ground. However technologies can range significantly. Hot water tanks in individual properties and electric storage heaters are small scale thermal storage systems.

5.50 Used in conjunction with other technologies, greater thermal storage capacity has the potential to reduce the cost of delivering our heat needs. The Low Carbon Innovation Coordination Group[60] estimated that innovation in heat pumps, heat networks and heat storage could reduce UK energy system costs significantly to 2050. Storage as part of a wider system can extend the period of time that heat can be provided from a few days to a whole season (also called inter-seasonally) depending on the technology used. Thermal storage can be used alongside heat recovery, solar thermal panels, heat pumps, biomass boilers, and combined heat and power. It can be part of a wider approach to managing our energy system, including the electricity network.

Case study: Sunamp Heat Batteries
Sunamp (East Lothian), produces heat batteries using phase change materials. These can store energy more efficiently than hot water, taking up less than a quarter of the space. They can be used in conjunction with heat pumps, solar, combined heat and power, and waste heat recovery from cooling to store energy until it is needed. Sunamp's products have been trialled by Berwickshire Housing Association. Initial results suggest reduced heating costs for these households.

[60] http://www.lowcarboninnovation.co.uk/

Case study: Bunhill

Bunhill heat store (115m^3 or 115,000 litres) and **energy centre** (with a 1.9MWe gas CHP engine) in Islington, London is part of Bunhill heat network, supplying affordable low carbon heat to over 850 homes and two leisure centres. Islington Council is working with Greater London Authority and UK Power Networks on an proposed extension of the network that aims to capture excess heat from a large electricity substation and an underground train ventilation shaft.
http://www.islingtonclimatechangepartnership.org.uk/wp-content/uploads/BUNHILL-case-study-2013.pdf

Bunhill energy centre and heat store © Islington Council

5.51 Thermal storage can utilise intermittent energy sources such as wind and wave generation, and potentially bringing down the cost of decarbonisation through greater efficiency. Thermal storage can enable combined heat and power (CHP) plant to run at maximum capacity, reducing the number of hours run at part load which enhances overall efficiency. It can provide 'grid balancing services' by enabling electricity generation equipment such as CHP to be switched on and off at short notice without negatively affecting the heat supply that users need.

Case study: South Jutland, Denmark

Four district heating plants are planned in the cities of Løgumkloster, Toftlund, Gram and Vojens, South Jutland, Denmark. Solar energy will be deposited in huge seasonal thermal stores. Each store will be placed 10 meters underground and will hold between 100,000 and 200,000 m^3 of water, supplied by 40,000 to 80,000m^2 of solar thermal panels. The districting heating plant will get half of all its heat from solar heating.

Case study: Drake Landing Solar Community
The thermal store is part of the Drake Landing Solar Community. This community is a master-planned neighbourhood in the Town of Okotoks. It is heated by a district system designed to store abundant solar energy underground during the summer months and distribute the energy to each home for space heating needs during winter months. The borehole thermal energy storage system uses 144 bore holes each stretching to a depth of 37 meters and planned in a grid with 2.25 meters between them for storing large quantities of solar heat collected in summer for use later in winter.

5.52 We have commissioned ClimateXChange to carry out **a literature review and summary of the many recent papers on energy storage** to provide a basis for further stakeholder engagement and policy development. This research will cover both thermal storage and other energy storage systems such as liquid air and hydrogen storage.

Question 16: Do you have any further evidence on thermal storage and consideration of how it might interact with other technologies and policy priorities?

6. Looking to the future - low carbon heat and renewable heat

6.1 Having explored opportunities for demand reduction and efficient supply of heat, we now consider the opportunities for using low carbon technologies and renewables to provide our **heat source**, an important aspect of the heat hierarchy.

6.2 Low carbon and renewable heat technologies can support emissions reductions in the short, medium and in some cases long term. They can also offer significant economic opportunities to reduce industry and householder costs and enable new or emerging sectors to develop products and services for use around the world. Some of these technologies can also help us to diversify our sources of heat, to build up security of supply for the future.

6.3 Currently, renewables are generally more expensive than traditional heating technologies that rely on gas from the national gas grid. In future, their relative costs will depend on the relative price and availability of fuels, such as gas and oil, additional carbon costs such as the EU ETS and Carbon Price Floor, and the relative reduction in technology costs of renewables. Off the gas grid, existing renewable technologies are currently more cost competitive with alternatives available. We would anticipate the focus of moving from traditional heating to low carbon renewable heating would focus on Scotland's homes and businesses that are off the gas grid.

6.4 Here we outline existing policies and progress to support low carbon and renewable heat technologies through financial incentives such as the renewable heat incentive and the Warm Homes Fund, the Resource Efficient Scotland SME Loans Scheme and in depth advice programmes for householders. Moving forward we will:

- Support Scottish based industries to develop individual sector 'roadmaps' for decarbonisation.
- Through the Scottish Environment Protection Agency (SEPA), encourage industry to identify sources of unused excess heat.
- Offer local authorities heat map datasets and publish the heat map to support identification of low carbon and renewable energy projects.
- Support the uptake of the Renewable Heat Incentive by continuation and, where necessary, adjustment of existing activities supporting the uptake of renewable energy such as the SME loans scheme and in-depth renewable energy advice.
- Work with industry, academia and Scottish Enterprise, Scottish Development International and other public sector partners to develop a call for geothermal demonstration projects.

Decarbonising heat used by industry

6.5 A number of heat intensive industries such as food and drink, cement and chemicals are based in Scotland. Industry has already taken significant steps to become more energy and resource efficient through significant investment in

processes and building efficiencies, reflected in many Climate Change Agreements. This activity is supported by Resource Efficient Scotland (see Section 4 above).

6.6 However, a study on the opportunities for decarbonisation of heat intensive industries[61] found that **there is potential for further decarbonisation**. There were also gaps in the evidence base in relation to the extent to which certain short term measures are truly applicable and the remaining potential for technology improvements and increased uptake of technologies. The potential for energy efficient boilers, burners, insulation, CHP, heat pumps, fuel cells, and absorption refrigeration were unclear for certain sectors based purely on published papers.

6.7 Resource Efficient Scotland will lead on behalf of the Scottish Government to provide support to Scottish based industry to develop **individual sector 'roadmaps' for decarbonisation**. This work will be carried out in conjunction with SEPA and will engage directly with a process to develop UK wide industry sector pathways and action plans[62].

Case study*:* Iron and Steel industry
Zero Waste Scotland (ZWS) has commissioned a study on steel recycling to consider the technical and economic feasibility of using an Electric Arc Furnace in Scotland for steel reprocessing, powered by off-peak renewable energy. This will report by end December 2014.

Recovery of unused excess heat

6.8 Many industrial processes and commercial buildings generate heat as a by-product. The **unused excess heat** is often rejected as waste and can be **costly to cool** where this is required before expulsion into the environment. Unused excess heat may have an **economic value when recovered** for re-use or exported for secondary use by others. This heat can be used for many purposes, depending on its temperature and the wider circumstances. The TINA report[63] identified recovery of excess unused heat integrated with heat networks and large scale storage as a priority.

6.9 Scottish Enterprise's recently published report 'Heat Recovery: Sector Opportunities from Sustainable Growth in Scotland'[64] states that installing and maintaining heat recovery will improve the efficiency of companies recovering the

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[61] DECC, Decarbonisation of Heat in Industry, A review of the research evidence, by Ricardo AEA: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/230949/D13_951813__Ricardo_AEA_Industrial_Decarbonisation_Literature_Review_201___.pdf
[62] The UK Government have committed to work with 8 heat intensive industry sectors (cement, ceramics, chemicals, food and drink, glass, iron and steel, oil refining, and pulp and paper) over the next 18 months to develop individual sector 'roadmaps' for decarbonisation. The Project will roll out in three cohorts, each lasting for approximately 6-8 months.
[63] UK Technology Innovation Needs Assessment http://www.scottishrenewables.com/media/uploads/hidden_links/web_employment_in_renewable_energy_in_scotland_2013.pdf
[64] http://www.scottish-enterprise.com/knowledge-hub/articles/insight/heat-recovery-low-carbon

heat, create local economic activity, provide opportunities throughout the supply chain and provide more stable energy bills for organisations who adopt the technology.

6.10 The report identifies eight economic development opportunities related to heat recovery[65]. These include:

- co-location opportunities from use of waste heat from power stations, CHP plants and waste incineration plants;
- capture and use of unused excess heat or to generate electricity;
- use of waste heat from process cooling and refrigeration; and
- capture of warm air from ventilation units, heat from wastewater drains or use ground and air soured heat pumps on individual sites.

Information on unused excess heat

6.11 Key steps in being able to take advantage of unused excess heat are to **identify where it is available**, identify **potential users** and to **link users to suppliers** both physically and contractually, though this may be through a third party such as a district heating network and the organisation that operates it.

6.12 Article 14(5) of the Energy Efficiency Directive aims to deal with some of these steps by including a requirement that Member States shall ensure that after 5 June 2014 a cost benefit analysis is carried out on using the waste heat from nearby industrial installations. This must be carried out for district heating networks planned, extended or refurbished over a certain size.[66]

6.13 To undertake such a cost benefit analysis, organisations will need to know the location and volume of waste heat from nearby industrial installations. As discussed above (Section 5), the Scottish Government is developing a Scotland heat map which could support such cost benefit processes. However, the heat map will only be as useful as the data available for inclusion. In the case of industrial installations, proxies have been used in the most part for potential heat sources as there is limited actual temperature and volume/flow data.

6.14 In order to improve the accuracy of the heat map data for users, SEPA will, over the next year, review the potential for additional data to be requested through the PPC Regulations and submitted via the Scottish Pollutant Release Inventory.

6.15 The benefits of this data could be much broader than simply the ability to comply with these regulations. For example, organisations with excess heat could identify potential customers for this heat and, as a result, reduce the costs of cooling effluent before emission into watercourses. They may also be able to benefit

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[65] The other opportunities are covered elsewhere in this document. They are: using heat maps, identify and support area based district heating and cooling networks; use heat storage and innovative techniques to improve the use of renewable heat or to provide flexibility between the electricity and heat markets; extract heat from deep geothermal and warm underground water, including minewater, to use on site or feed into a district heating network and extract heat from surface water – rivers and canals

[66] See consultation (closes 16 April 2014) for details: www.scotland.gov.uk/Publications/2014/01/4430

through selling excess heat to district heating networks. Additionally, these data could support the development of the co-location of heat users, and be integrated into local development plans.

6.16 There will be a number of options for collecting such data and SEPA is considering these. It may, for example, be an option to voluntarily submit temperature and volume/flow data for each installation to SEPA. A separate consultation is planned and your views on how organisations could be encouraged to provide such data, with as little burden as possible, will be sought. Any proposals by SEPA will be set out in that consultation.

6.17 Heat recovery has been covered under low carbon heat in this document as the majority of excess heat will originate from fossil fuel sources. However, where a heat source is renewable the recovered heat would also be assumed to be renewable. As this technology develops and heat sources change, it may be more appropriate to class this as efficient supply rather than low carbon.

6.18 In many cases, recovered heat must be distributed through a district heating network to get to the heat consumer. However there are examples of heat recovery being used on the same site such as the sales area of a supermarket being heated by the recovered heat from storage fridges and freezers.

Question 17: Do you see heat recovery and information about excess heat available as a useful tool for industry to maximise the benefits of the heat it consumes? Do you have any comments?

Renewable heat

6.19 The Scottish Government estimates that renewable heat generation in 2011 equated to 2.6% of Scotland's non-electrical heat demand in 2011. This grew from 1% in 2009.

6.20 The 2009 Renewable Heat Action Plan set a target of delivering 11% of Scotland's projected 2020 heat demand from renewable sources. The target was defined in terms of estimated non-electrical heat demand in 2020. As shown in Section 2 above, this does not lend itself to annual monitoring of both renewable heat capacity and heat demand reduction which are both key aspects of the target in the intervening years. The **improved methodology** for measuring the heat target allows progress to be assessed based on the current level of heat demand as opposed to a static projection for 2020.

6.21 While we are making good progress, the 11% heat target is challenging and a number of barriers will need to be overcome in achieving this goal. Audit Scotland[67] recommended in September 2013 that the Scottish Government should use its

[67] Renewable Energy, http://www.audit-scotland.gov.uk/docs/central/2013/nr_130912_renewable_energy.pdf

revised methodology for measuring progress towards the renewable heat target to set a realistic interim milestone for 2017.

6.22 A simple linear projection suggests that to stay on course to meet the 2020 target, renewable heat generation should be approximately 8% of non-electric heat demand in 2017. However, based on recent deployment and the current potential capacity in the pipeline, the **potential variability** of when renewable heat projects would come online make it difficult to set interim renewable heat milestones which would provide any meaningful assessment of progress towards the 11% 2020 target.

6.23 The Scottish Government has put in place a number of supporting measures, including significant finance resource through the Renewable Energy Investment Fund and Warm Homes Fund, to maximise investment in renewable heat in Scotland.

6.24 Financial incentives are an important tool to drive uptake of renewable technologies. We must, however, recognise that budgets are constrained, with limits set on the Renewable Heat Incentive (RHI) at a UK level. Costs can be reduced through market growth and innovation, and building consumer confidence. Scottish Government programmes are supporting uptake of the RHI through advice and support and, under certain circumstances, finance.

6.25 The UK **non-domestic Renewable Heat Incentive** (RHI) presents a significant opportunity for businesses, the public sector and third sector to get a reasonable return on investment through installing renewable heat technologies. £4.3 million has been paid to the growing number of accredited Scottish based organisations since November 2011, 20% of the eligible heat generated. Over 20% of the eligible capacity is currently in Scotland, with around 15% of total non-domestic RHI payments going to installations in Scotland. The majority of these installations are biomass projects, with large scale biomass accounting for almost half the RHI eligible heat generated.

6.26 The UK Government published its response to several consultations on the non-domestic RHI in December 2013[68]. This set out an increase in support for renewable CHP, large biomass boilers (over 1MW), deep geothermal, ground source heat pumps, solar thermal and biogas combustion. New support was introduced for air-water heat pumps and commercial and industrial energy from waste. Support for small scale biomass continues but at a slightly lower rate than previously. Taking these changes into account, it is estimated that non-domestic RHI could support across the UK 5,000 non-domestic installations and an additional 6.4TWh of renewable heat by the end of 2015/16. It is expected that these changes will come into force in Spring 2014.

6.27 A number of issues are expected to be included in the 2014 Review of the non-domestic RHI, including expanding the types of eligible technologies, energy

[68] https://www.gov.uk/government/consultations/renewable-heat-incentive-expanding-the-non-domestic-scheme

efficiency, sizing of biomass boilers and increasing certainty[69]. To continue successful delivery of the RHI in Scotland, we are keen to hear from stakeholders whether there are issues specific to Scotland that should be taken into consideration in the Scottish Government's engagement on the 2014 Review.

Question 18: Are there any Scottish specific issues that should be dealt with in the review of the non-domestic RHI? What are they, and what evidence do you have to support your views?

6.28 We will continue to engage with and support **installers** and the wider supply chain to build capacity within Scottish SMEs to take advantage of market opportunities. Our **Resource Efficient Scotland SME loans scheme** provides loans of £1,000 to £100,000 to SMEs, private landlords and not-for-profit organisations for the installation of sustainable energy, material resource and water efficiency measures, and renewable energy technologies.

6.29 Skills Development Scotland (SDS) will continue to develop and support skills uptake in low carbon technologies including renewables through initiatives like the Low Carbon Skills Fund (see paragraph 4.25).

6.30 The CARES loan fund[70] provides loans of up to £150,000 supporting the development of locally-owned renewable energy projects which provide community benefits. It offers loans towards the high risk, pre-planning consent stages of renewable energy projects. As well as supporting our renewable energy targets it supports the aim to reach 500 MW of community and locally owned renewable energy by 2020.

6.31 DECC has announced that the **domestic RHI will be launched in Spring 2014**. Tariffs have been set for eligible technologies (air and ground source heat pumps, biomass and solar thermal). Financial support will be paid to the owner of the system at a set rate per unit of heat produced for seven years. We want to maximise potential uptake of the domestic RHI for Scotland. To that end, we will review the current provision of advice and support to ensure that Scottish householders, private landlords and others eligible to apply are encouraged to make use of the scheme.

6.32 As the primary focus of the domestic RHI will be to support homes off the gas grid, Scotland has an excellent opportunity to benefit, with 24% of Scottish households not using gas as their primary heating fuel and a significant proportion of these could be in fuel poverty[71].

6.33 Until the introduction for the domestic RHI in 2014, Renewable Heat Payment Premium (RHPP) vouchers provide a one off grant towards the cost of installing

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[69] https://www.gov.uk/government/consultations/renewable-heat-incentive-expanding-the-non-domestic-scheme
[70] http://www.localenergyscotland.org/communities/
[71] The Scottish House Condition Survey using 2012 data indicates that 24% of homes do not use gas as their primary heating fuel. 15% of homes use electricity as their primary fuel, 6% use oil, the remainder using solid fuel of communal heating.

eligible renewable technologies (e.g. £2,000 for a biomass boiler). At present, take up of RHPP vouchers in Scotland is 12.5% of GB total this year – above pro-rata. Once the RHI is available, the value of any RHPP voucher received by householders will be deducted from the total RHI tariff payments due over time for RHI eligible installations.

Question 19: Without interim milestones and taking into account the existing mechanisms to support uptake of renewable heat technologies, what non-financial mechanisms do you think are most effective in driving this uptake?

6.34 There are a number of renewable energy and low carbon technologies which are developing and growing in significance. The degree of development to date varies, however all are likely to play an important role in the short, medium and potentially long term to support our decarbonisation aims. These include:

- heat pumps both as renewable energy and heat recovery technology;
- biomass;
- anaerobic digestion, biogas and biomethane;
- solar thermal; and
- combined heat and power

In addition, significant potential for geothermal in Scotland has been identified.

6.35 Below we provide some examples of these technologies to seek feedback on key issues. We provide further detail on technologies in Annex E.

Heat pumps both as renewable energy and heat recovery technology

6.36 Scottish Enterprise has identified a range of research and development opportunities including for new heat pump technologies. Despite strong regional competition in the heat pump market from Sweden, Germany, and Denmark as well as global competition identified by the Technology Innovation Needs Assessment report[72], there are Scottish and wider UK based companies active in the market such as Star refrigeration and Colt International. **Scotland has companies with an international competitive edge** in heat pumps and other heat recovery technologies[73]. There is also investment interest from international players, such as Mitsubishi, in basing their regional manufacturing in the UK. There are some companies within the supply chain for key parts and controls (e.g. Sunvic).

6.37 To date, most **heat pump installations** have been for **individual households** as demonstrated by the heat pump field trials carried out by the Energy Saving Trust[74]. However there is **potential for large scale applications** either in

[72] http://www.scottishrenewables.com/media/uploads/hidden_links/web_employment_in_renewable_energy_in_scotland_2013.pdf

[73] Scottish Enterprise, Heat Recovery: Sector Opportunities from Sustainable Growth in Scotland http://www.scottish-enterprise.com/knowledge-hub/articles/insight/heat-recovery-low-carbon

[74] The Heat is On identified that heat pumps can provide an efficient, effective solution for heating in many homes, significantly reducing carbon emissions, where the homes have first been made energy efficient. http://www.energysavingtrust.org.uk/Organisations/Working-with-Energy-Saving-Trust/The-Foundation/Our-pioneering-research/The-heat-is-on-heat-pump-field-trials

conjunction with district heating and heat recovery, geothermal heat or using ambient heat. The city of Drammen is using the latter (see case study below).

Case study: Star Refrigeration is a Glasgow-based cooling solutions specialist which focuses on the design, manufacture, installation, commissioning and aftercare of industrial refrigeration and HVAC (heating, ventilation and air conditioning). It supplied a "Neatpump" to the city of Drammen in Norway in 2011. Drammen utilises this as the heat source of first choice on its 22km thermal network as it is the lowest cost heat available. Star's Neatpump provides over 60,000 MWh per year in Drammen. It extracts heat from seawater but any industrial waste stream, such as air conditioning, rivers or sewage treatment plants and large scale cooling processes could be harnessed. It operates using ammonia, avoiding use of greenhouse gases such as hydrofluorocarbons or ozone depleting gases, and delivers heat at up to 90°C.

Geothermal

6.38 The knowledge and capability of Scotland's industry base gives us a good foundation to develop the **geothermal industry**. We recently published a study[75] highlighting that there may be significant potential for deep geothermal energy in Scotland to provide a renewable source of heat. This shows that Scotland's **renewables potential** could be even greater than imagined. Further work needs to be done to fully understand our geothermal resource, as well to clarify the legislative framework (currently designed for purposes other than deep geothermal heat) – learning from experience in Europe and further afield. The report provided over 30 recommendations, which we are currently considering.

6.39 We would like to see geothermal energy play a significant role in our energy future. We will work with academics, engineers and industry to understand more about our geothermal resource, and use this learning to help understand the development pathway of a geothermal industry in Scotland. We will work with industry to ensure it is aligned with our aims on decarbonising heat and electricity supply at an affordable cost to consumers while achieving the greatest possible economic benefit and competitive advantage for Scotland, including opportunities for community ownership and community benefits.

6.40 Our initial focus is on three **report recommendations** to: support the development of demonstration projects; tackle legal and ownership issues; and to develop our vision and an appropriate strategy or routemap for geothermal energy.

6.41 A number of potential schemes which are at early concept or feasibility stage have been highlighted to us and we will work with industry, academia and Scottish Enterprise, Scottish Development International and other public sector partners to **develop a call for demonstration projects**. Successful applicants would be funded to carry out a **detailed feasibility study and develop a business case**.

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[75] Study into the Potential for Deep Geothermal Energy in Scotland http://www.scotland.gov.uk/Publications/2013/11/2800

Any demonstration scheme with a compelling business case will then be supported in accessing available finance or funding, for example through the £103 million Renewable Energy Investment Fund.

Question 20: Do you support the approach to focus on three areas to support geothermal: demonstration projects; ownership issues; and development of our geothermal vision and a routemap?
Question 20a: If not, which recommendations should be prioritised and deprioritised?

Biomass

6.42 As reflected in the Electricity Generation Policy Statement, our policy on biomass is set out in the National Planning Framework II, Section 36 Thermal Guidance, and in Section 36 Biomass Scoping Opinion guidance. Essentially, because of the multiple energy uses to which biomass can be put, the limits to supply, and the competition for that supply from other non-energy sectors, we need to encourage the most efficient and beneficial use of what is a finite resource. We would **prefer to see biomass used in heat-only or good quality combined heat and power schemes, off gas-grid wherever possible, and at a scale appropriate to make best use of both the available heat, and of local supply**.

Case study: West Highland Housing Association
West Highland Housing Association (WHHA) is investing £400,000 of Warm Homes Fund money in a scheme to heat 75 new-build properties in Dunbeg, near Oban. Much of Argyll, where WHHA's properties are based, has no access to mains gas. WHHA fitted its first biomass boiler in 2005, so the benefits were understood.

The Association is fitting a 199kW biomass boiler on-site, which is then connected to all the homes. The boiler uses Scottish wood pellets to heat a 5,000 litre water tank known as a thermal store. This water travels through pipes to the homes where heat from it is exchanged with water in a separate, sealed system which runs through radiators in the houses. The first phase of 50 homes will be completed by April 2014, with a second phase of a further 25 completed a month later. The houses are currently being built by around 40 workmen, providing employment opportunities for local contractors. WHHA will be the heat provider for the scheme. Tenants will pay a charge which is lower than that levied by gas and electricity companies to heat their homes. WHHA will receive Renewable Heat Premium Payments, which will go towards paying off the capital cost of the system.

6.43 Ofgem figures show that there are 461 biomass plants in Scotland receiving the RHI which represents a significant increase in the number of plants since 2011. These will be mostly small (less than 200kW thermal output) commercial plants.

According to the FTT Futures report[76], the woodfuel sector has potential to support approximately 250 jobs by 2016 and contribute £11M to gross value added.

6.44 The Forestry Commission Scotland (FCS) has supported the development of the woodfuel sector including: developing the Usewoodfuel website; facilitating regional woodfuel forums across Scotland; providing knowledge transfer and networking opportunities; promoting the RHI to non-domestic end users; and encouraging farms and estates to manage their woods for woodfuel. In 2014/15, the FCS support will focus on increasing professionalism in the supply chain by supporting the development of an industry-led body for biomass installers and woodfuel suppliers.

6.45 It has been suggested that a study could be undertaken building on the FTT Futures work, exploring the potential for growth in the sector, looking at the complete economic system, the key players, market drivers, challenges and constraints. This work would help inform future support and investment and allow the design and delivery of appropriate projects and support interventions to help realise the identified growth potential. A small scoping study is currently being funded by FCS which looks at some of these issues and could provide a useful starting point for the wider study proposed above.

Energy from Waste

6.46 Currently the non-domestic RHI pays a tariff for the **proportion of heat generated from biomass in municipal solid waste** (MSW) incinerated in energy from waste plant. This applies when there is a biogenic content of 50% or higher. As the biodegradable content of commercial and industrial wastes provides another renewable fuel source, DECC intends to introduce, by Spring 2014, support for **commercial and industrial energy from waste** provided there is a minimum of 10% biogenic content in the waste. Support will be available at the tariff rates offered for biomass.

6.47 The **Waste (Scotland) Regulations 2012** were introduced to transform the availability of recycling services to households and businesses, help save money and release valuable materials into the Scottish economy. The Regulations include requirements for businesses to recycle food waste, glass, paper and card and on councils to provide food waste services to households. They also banned certain materials including paper, card and food collected separately for recycling from going to incineration or landfill from January 2014.

6.48 Through Zero Waste Scotland, the Scottish Government has invested around £20 million **to help councils** meet the cost of rolling out household **food waste collections** as part of their waste reduction targets. Over **one million households** across Scotland now have a food waste recycling service, with much of this now being used to create biogas and energy through anaerobic digestion. Since 2008

[76] In 2011 Scottish Enterprise commissioned a baseline study into the Forest and Timber Technology sector (the FTT Futures study). The figures provided were potential 5 year growth. For further details please contact Scottish Enterprise – Steve Harrison, Project Manager, Steve.Harrison@scotent.co.uk

there has been a three-fold increase in food waste processing infrastructure (including anaerobic digestion).

Anaerobic Digestion, Biogas and Biomethane

6.49 **Biogas**, produced in an anaerobic digester, can fuel combined heat and power or be treated to remove some of the other gases in the mixture leaving biomethane. **Biomethane** can be injected into the gas grid, reducing the greenhouse gas emissions associated with burning gas from the network.

6.50 In December 2013 there were only three biogas and biomethane installations receiving RHI payments. None of these were in Scotland. However, we understand that a significant sized biomethane injection project is being developed in Scotland.

6.51 Currently most of the anaerobic digestion facilities in Scotland are accompanied by CHP. There are 14 Scottish anaerobic digestion plants using their biogas to produce electricity receiving Feed in Tariff or Renewable Obligation Certificates with a combined capacity of 16MW and estimated electrical production of 9.2 GWh.

Garden waste for anaerobic digestion © Fife Council

6.52 While 30 to 40% of the heat produced is used to maintain the required temperature of the digester, it is estimated that up to 3.5 GWh of heat could be available for use in **local district heating systems** if there were demand for that heat. Under the RHI (at £71/MWh) this would be worth £2.5 million. However, as anaerobic digestion facilities are often in rural areas it is not clear if there is a significant heat demand local to these plants. We believe some of the potential heat may already be used in pasteurisation processes on dairy farms.

6.53 The Scottish Government is keen to see useful heat provision maximised as well as electricity provision through the production of biogas.

Question 21: How can the anaerobic digestion industry be best encouraged to avoid useful heat being wasted? We are interested in any evidence or practical experience to support your views.

Solar Thermal

6.54 Solar heating is mainly known as a source for heating domestic water[77], but can also be used for space heating, district heating and process heat for some industrial applications. Solar thermal capacity in Scotland increased by approximately 25% between 2011 and 2012 and estimated output increased by 40% over the same period[78].

6.55 The majority of solar energy is between late spring and early autumn. However, even during a Scottish winter, although cold, the clear skies can provide solar energy to be harvested. When outside temperatures are –5°C, the sun still produces enough energy for some solar systems to heat a thermal store to 50 to 60°C.

6.56 There has been relatively low delivery of solar thermal through the non-domestic RHI. As a result DECC intends, by Spring 2014, to increase the tariff for solar thermal to 10p/kWh. Additionally, as with other technologies which have a relatively low deployment forecast, a fixed percentage of the budget (2.5%) has been assigned to solar thermal to give sufficient room for growth in the market.

6.57 As part of the 2014 review of the RHI, DECC intends to examine the case for other renewable fuels such as active air solar heating.

Combined Heat and Power

6.58 Combined heat and power systems generate electricity and useful heat (water /steam). Combined cooling, heat and power (CCHP) or trigeneration adds useful cooling, such as through absorption refrigeration, in addition to generation of heat and power. Combining generation is a thermodynamically efficient use of fuel, as it uses the heat that would otherwise be discarded in separate production of electricity. Heat and power can be generated by engines, generally using gas, though other fuels can be used such as biomass (see paragraphs 6.42 – 6.45). More recently

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[77] 83% of homeowners surveyed (sample from England, Wales and Scotland) had heard of solar thermal; 47% had heard of ground source heat pumps and biomass boilers; and 32% had heard of air source heat pumps in homeowners' willingness to take up more efficient heating systems. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191541/More_efficient_heating_report_2204.pdf, published by DECC.

[78] Total capacity in 2012 estimated at 28MW, an increase of 6MW on 2011 and total annual output in 2012 estimated to be 15,544MWh, an increase of 4,544MWh on 2011. Source: Renewable Heat in Scotland 2012, http://www.energysavingtrust.org.uk/scotland/Take-action/Get-business-funding/Renewable-Heat-in-Scotland-2012

hydrogen fuel cells have been developed which produce a greater proportion of power compared to heat.

6.59 CHP can range in scale from very large as used in industry to micro-CHP, usually running on gas for individual buildings. CHP is also commonly used as the first technology applied in developing district heating. Combined with a heat store, CHP can switch electricity generation on or off at short notice. This can provide ancillary services, which have a commercial value, to the electricity system operator by providing electricity or stopping the supply back into a local or national grid at short notice. This helps the system operator to balance the electricity system as required[79].

6.60 Gas CHP is common and is likely to continue to have a role in both the short and medium term. In the longer term decarbonisation of fuels would be required to meet ambitious climate change targets.

6.61 Aberdeen uses a gas-powered CHP district heating system to supply heat to multi-storey blocks across the city. The University of Edinburgh has both gas CHP and trigeneration plants to heat and cool its campus.

CHP plant installation © University of Edinburgh

Carbon Capture and Storage (CCS)

6.62 Carbon capture and storage (CCS), is the process of capturing waste carbon dioxide (CO_2) from large point sources such as fossil fuel power plants (coal and gas), transporting it to a storage site and depositing it where it will not enter the atmosphere, normally in underground geological formations. The North Sea is the largest CO_2 storage resource in Europe and this, coupled with our existing oil and

[79] Such services are not restricted to CHP.

gas capabilities, ready supply chain and existing infrastructure, means that Scotland is in a strong position to be at the centre of CCS development in Europe.

6.63 Large scale deployment of CCS is an important component in the decarbonisation of electricity generation and in turn may support the decarbonisation of large industrial CO_2 emitting sectors such as steel, aluminum and cement production.

6.64 CCS fitted to industrial and power generation plants will use some of the unused excess heat and any remaining usable excess heat will be a source of decarbonised heat which the plant could sell, for example to a district heating network operator.

6.65 Two potential projects in Scotland have made significant development progress. Peterhead CCS project (Gas), which has been awarded FEED (Front End Engineering and Design) study funding, and Summit Power's Coal-Gasification project (Captain Clean Energy) proposed to be built in Grangemouth.

Existing infrastructure – the gas network

6.66 Changing the way we heat our homes, businesses and industry will over time mean significant change for Scotland's existing energy infrastructure. It will have impacts on the existing gas and electricity networks and see the development of new infrastructure like heat networks, heat storage and carbon capture and storage and potentially also new infrastructure to support the use of hydrogen.

6.67 Economic and technical trade-offs and constraints will impact on the respective scale and pace of development of different technologies. The development of a broader energy generation policy statement and modelling to support this, could help to identify these trade-offs and constraints. These will also be impacted by decisions taken at a UK-wide level and potentially by neighbouring nations.

6.68 Many heat technologies are currently reliant on the gas network, for example 76% of Scottish homes use mains gas as their primary heating fuel. In future-proofing our heat system we need to consider to what extent the gas network can be "decarbonised".

6.69 The modelling carried out by Arup indicates that the scenario with the most extensive emission reductions to 2050, saw a significant shift away from the use of gas appliances such as boilers in later decades. This of course is only a scenario, but provides one theoretical route to achieving our challenging statutory emissions reduction targets by 2050.

6.70 By increasing the proportion of biomethane in the gas grid, the greenhouse gas emissions associated with its use would decrease. Arup did not include the potential of biomethane to decarbonise the gas grid in their modelling because of limited available information. A number of **biomethane** projects in Britain are

supported by the RHI, but these only represent a tiny fraction of the gas currently used.

6.71 We have had feedback from representatives of manufacturers of gas-using technologies that by decarbonising the gas grid by injecting biomethane, decarbonisation of heat could be supported by continued use of gas. There are, however, many factors to consider, such as:

- whether there are limits to the amount of biomethane that might be available,
- whether heat users' gas appliances would need to be replaced,
- the energy and cost implications of improving biomethane to the quality required, and
- the energy and cost implication of injecting gas into the network under pressure.

More evidence is required on what extent biogas could support decarbonisation of the gas network.

6.72 DECC modelling[80] for the UK looked at possible scenarios for the mix of technologies required to achieve UK climate change objectives at least cost. It identified large scale deployment of both air and ground source heat pumps, a greater role for heat networks by 2050 and gas playing a major role into the 2030s but diminishing thereafter. Additional DECC modelling suggests that hybrid systems which combine an air source heat pump with a gas boiler might be a cost effective option. The model shows these systems being taken up from the 2020s. As further emissions reductions are needed to achieve the 2050 target, the model predicts the majority of heat will then be delivered by heat pumps, with gas only used to provide heating in winter.

6.73 The DECC modelling results suggest that full decarbonisation of heat through electrification might be more costly, as this would require additional generation capacity and further reinforcement of the electricity grid to meet peak heat demands. However, the model only included a simplified representation of the gas and electricity grids and their costs. The model, therefore, does not necessarily factor in all the implications of keeping a system of gas boilers and associated infrastructure that are used only occasionally.

6.74 DECC identifies that further work is required to understand the practical implications of a partially-used gas grid, including the technical feasibility and the implications for network costs. It follows that whether gas or electricity is used to meet occasional peaks in heat demand, some expensive redundancy in the systems would be involved.

[80] The Future of Heating: Meeting the challenge, DECC, 2013
https://www.gov.uk/government/publications/the-future-of-heating-meeting-the-challenge

ANNEXES

Annex A - Abbreviations and Glossary

Abbreviation

CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CCC	Committee on Climate Change
CCS	Carbon Capture and Storage
CHP	Combined heat and power
CO_2	Carbon Dioxide
COSLA	Convention of Scottish Local Authorities
CRC	Carbon Reduction Commitment
DECC	UK Government Department of Energy and Climate Change
ECO	Energy Companies Obligation
EESSH	Energy Efficiency Standard for Social Housing
EfW	Electricity from Waste
ESP	Energy Skills Partnership
EU	European Union
EU 15	The 15 member states in the European Union prior to the accession of ten candidate countries on 1 May 2004.
GW	Gigawatt = 1 billion Watts or 1000 Megawatts.
GWh	Unit of energy equivalent to 1 billion Watt hours
HEEPS	Home Energy Efficiency Programmes
ISM	Individual Social and Material tool
kW	Kilowatt - a unit of power equivalent to 1 thousand Watts
LED	Light emitting diode, a semi-conductor light source
mCHP	Micro combined heat and power
m^3	Cubic metres
MT	Megatons = 1 million tonnes
$MtCO_2e$	Million Metric Tonnes of Carbon Dioxide equivalent
MW	Megawatt = 1 million Watts
NHS	National Health Service
Ofgem	Office of Gas and Electricity Markets
OPEX	Operating expenses
PWLB	Public Works Loan Board
REIF	Renewable Energy Investment Trust
RHI	Renewable Heat Incentive
RMR	Retail Market Review
ROCs	Renewable Obligation Certificates
ROS	Renewables Obligation (Scotland)
RPP2	The Second Report on Proposals and Policies. Title: Low Carbon Scotland: Meeting our Emissions Reduction Targets 2013-2027.
SDS	Skills Development Scotland

SFT	Scottish Futures Trust
SG	Scottish Government
SGIP	Scottish Green Portfolio Group
SME	Small to Medium (Sized) Enterprises
TINA	UK Technology Innovation Needs Assessment
TWh	Terrawatt hours, 1 terrawatt hour per year = 114 megawatts
UK	United Kingdom
GIB	Green Investment Bank
US	United States (of America)
VAT	Value Added Tax
ZWS	Zero Waste Scotland

Glossary

Affordable Warmth The provision of warm living conditions for people for whom fuel costs represent a large proportion of their disposable income.

Biogas Energy produced from the anaerobic digestion of sewerage and industrial waste.

Biomass Dry organic material derived from plants or animals. As a fuel it includes energy crops as well as forestry and agricultural residues.

Carbon dioxide (CO_2) A naturally occurring gas comprising 0.04% of the atmosphere. The burning of fossil fuels releases carbon dioxide fixed by plants many millions of years ago, and this has increased its concentration by some 12% in the past century. It contributes about 60% of the potential global warming effect of man-made emissions of greenhouse gases.

Combined Heat and Power Also sometimes referred to as co-generation, CHP integrates the production of usable heat and power (electricity), in one single process. Steam or hot water, which would otherwise have been rejected when electricity alone is produced, is used for space or process heating.

Fuel Cell It acts like a constantly recharging battery, electromagnetically combining hydrogen and oxygen to generate power. For hydrogen fuel cells, water and heat are the only by-products and there is no air pollution.

Fuel poverty A household is in fuel poverty if, in order to maintain a satisfactory heating regime, it would be required to spend more than 10% of its income (including Housing Benefit or Income Support for Mortgage Interest) on all household fuel use.

Greenhouse gas A greenhouse gas is any gaseous compound in the atmosphere which absorbs infrared radiation, thereby trapping and holding heat in the atmosphere. The basket of Kyoto Protocol greenhouse gases comprises carbon dioxide, methane, nitrous oxide, and the three F-gases (hydrofluorocarbons- HFCs, perfluorocarbons – PFCs and sulphur hexafluoride- SF6).

Kilowatt (kW) A unit of power which equals 1,000 or 10^3 Watts. Domestic electrical appliances have power ratings up to a few kilowatts. Also see Watt

Kilowatt-hour (kWh) The unit of measurement of electricity consumption in the UK. This is the “unit” used by electricity suppliers for their customer accounts.

Megawatt (MW) The normal unit of measurement of electrical generation capacity of power stations which equals 10^6 Watts. Also see Watt.

Ofgem The Office of Gas and Electricity Markets, established under the Utilities Act 2000 to regulate the gas and electricity supply industries. This combines the regulatory functions previously carried out separately by OFGAS and OFFER.

Renewable energy Energy derived from a source which is continually replenished, such as wind, wave, sun, water and energy from plant material. Although not strictly renewable, geothermal energy is generally included. The organic component of municipal waste is also included as a renewable energy source.

Solid fuels Fuels supplied as solids including coal, coke, and solid fuels manufactured from coal such as furnacite.

Tariff a scale of charges for the supply of heat, gas or electricity (or other services or commodities). It may include a fixed charge for the provision of the supply and a variable charge dependant on the energy supplied.

Watt An international standard unit of power, defined as one joule per second. Power is the rate at which energy is generated or used. Being a small unit, it is usually used as a multiple such as kilowatts or megawatts.

Annex B: Responding to this Consultation

We are inviting written responses to this consultation paper by **9 June 2014**. **Please send your response with the completed Respondent Information Form (see "Handling your Response" below) to:**

eem@scotland.gsi.gov.uk
Please put "**Heat – HGPS – Response**" as the subject of your email.

or by post to

Consultation on the Draft Heat Generation Policy Statement
The Scottish Government
Energy Efficiency, Heat and Low Carbon Economy Unit
Area 1D South
Victoria Quay
Edinburgh
EH6 6QQ

If you have any queries, please contact Joyce Whytock on Tel. 0131 244 0265 or using the email address above.

We would be grateful if you would use the consultation questionnaire provided or could clearly indicate in your response which questions or parts of the consultation paper you are responding to as this will aid our analysis of the responses.

This consultation, and all other Scottish Government consultation exercises, can be viewed online on the consultation web pages of the Scottish Government website at http://www.scotland.gov.uk/consultations.

The Scottish Government has an email alert system for consultations, http://register.scotland.gov.uk. This system allows individuals and organisations to register and receive a weekly email containing details of all new consultations (including web links). It complements, but in no way replaces Scottish Government distribution lists, and is designed to allow stakeholders to keep up to date with all Scottish Government consultation activity, and therefore be alerted at the earliest opportunity to those of most interest. We would encourage you to register.

Handling your response

We need to know how you wish your response to be handled and, in particular, whether you are happy for your response to be made public. Please complete and return the **Respondent Information Form** which forms part of the consultation questionnaire for this consultation paper as this will ensure that we treat your response appropriately. If you ask for your response not to be published we will regard it as confidential, and we will treat it accordingly.

All respondents should be aware that the Scottish Government is subject to the provisions of the Freedom of Information (Scotland) Act 2002 and would therefore

have to consider any request made to it under the Act for information relating to responses made to this consultation exercise.

Next steps in the process

Where respondents have given permission for their response to be made public and after we have checked that they contain no potentially defamatory material, responses will be made available to the public in the Scottish Government Library. You can make arrangements to view responses by contacting the Scottish Government Library on 0131 244 4552. Responses can be copied and sent to you, but a charge may be made for this service.

What happens next?

Following the closing date, all responses will be analysed and considered along with any other available evidence to help us to revise the Heat Generation Policy Statement. We aim to issue a report on this consultation process later this year.

Comments and complaints

If you have any comments about how this consultation exercise has been conducted, please send them to the address given above.

Strategic Environmental Assessment and Equalities Impact Assessment

In addition to the consultation questions in the Draft Heat Generation Policy Statement, views are also invited on the Interim Equality Impact Assessment (EQIA) and Strategic Environmental Assessment (SEA) which accompany this draft Policy Statement. All documents are available on the Scottish Government website at: http://www.scotland.gov.uk/Consultations/Current

Details of the questions included in the SEA, and how to respond are set out at page vi of the document. Comments on these documents should also be made by **9 June** 2014 to: EEM@scotland.gsi.gov.uk

The subject of the email should read as follows:
Heat – HGPS – EQIA response for comments on the EQIA; and
Heat – HGPS – SEA response for responses to the questions in the SEA.

TOWARDS DECARBONISING HEAT: MAXIMISING THE OPPORTUNITIES FOR SCOTLAND DRAFT HEAT GENERATION POLICY STATEMENT FOR CONSULTATION

RESPONDENT INFORMATION FORM

Please Note this form **must** be returned with your response to ensure that we handle your response appropriately

1. Name/Organisation

Organisation Name

Title **Mr** ☐ **Ms** ☐ **Mrs** ☐ **Miss** ☐ **Dr** ☐ **Please tick as appropriate**

Surname

Forename

2. Postal Address

Postcode	**Phone**	**Email**

3. Permissions - I am responding as…

Individual / **Group/Organisation**

☐ **Please tick as appropriate** ☐

(a) Do you agree to your response being made available to the public (in Scottish Government library and/or on the Scottish Government web site)?

Please tick as appropriate
☐ **Yes** ☐ **No**

(b) Where confidentiality is not requested, we will make your responses available to the public on the following basis

Please tick ONE of the following boxes

(c) The name and address of your organisation **will be** made available to the public (in the Scottish Government library and/or on the Scottish Government web site).

Are you content for your **response** to be made available?

Please tick as appropriate
☐ **Yes** ☐ **No**

Yes, make my response, name and address all available ☐

or

Yes, make my response available, but not my name and address ☐

or

Yes, make my response and name available, but not my address ☐

(d) We will share your response internally with other Scottish Government policy teams who may be addressing the issues you discuss. They may wish to contact you again in the future, but we require your permission to do so. Are you content for Scottish Government to contact you again in relation to this consultation exercise?

Please tick as appropriate ☐ **Yes** ☐ **No**

Annex C: Summary of Consultation Questions

Q1: Do you agree with the heat vision and heat hierarchy?
Yes ☐ No ☐ Don't know ☐

Q1a: And why?

Q2: How can we ensure that Scottish businesses are best placed to take advantage of the new products and services which will be required to deliver low carbon heat?

Q3: Taking account of the cost of implementation, what policies should the Scottish Government pursue that will best ensure the impacts of heat decarbonisation to benefit consumers?

Q3a: What evidence do you have to support this?

Q4: What do you think should be the balance and focus of government intervention, business innovation and individual action and why?

Q5: Given the existing financial incentives and policies in place, what other mechanisms do you think would result in significant behaviour change in both homes and non-domestic buildings and processes?

Q6: How do you think a national heat map could be used to support the development of a low carbon heat sector for Scotland?

Q7: Do you support the proposed unit of measure for the overall district heating target of 1.5 TWh by 2020?
Yes ☐ No ☐ Don't know ☐

Q7a: And why?

Q8: Do you support the level of ambition for the district heating target?
Yes ☐ No ☐ Don't know ☐

Q8a: What evidence do you have to support your views?

Q9: Do you support the level of ambition for the number of homes to be connected to district heating by 2020?
Yes ☐ No ☐ Don't know ☐

Q9a: What evidence do you have to support your views?

Q10: Do you have evidence of existing communal heating systems installed before 2000?

Yes ☐ No ☐ Don't know ☐

Q10a: If so please provide details.

Q11: Do you believe further regulation of heat supply is required?

Yes ☐ No ☐ Don't know ☐

Q11 a: What level of regulation would be appropriate?

Q12: Do proposed consumer protection schemes meet the needs of heat users and supply organisations?

Yes ☐ No ☐ Don't know ☐

Q12a: And if not, what changes are needed or what more is needed?

Q13: Is there sufficient non-financial support for the development of heat networks?

Yes ☐ No ☐ Don't know ☐

Q13a: If not, please comment on priorities and timescales for support? Please provide evidence, where possible, based on practical examples of district heating development.

Q14: Are the many existing financial support mechanisms sufficient to support delivery of district heating systems?

Yes ☐ No ☐ Don't know ☐

Q14a: If no, can you provide information and evidence to demonstrate the need for additional funding or finance mechanisms, indicating the type of funding or finance required, over what timescale and setting out why existing mechanisms do not meet your needs. We would be particularly interested in evidence based on practical experience of development of district heating projects.

Q15: If the mechanism that you propose was in place, what additional specific outputs and outcomes for district heating would result from your own work and on what timescale?

Q16: Do you have any further evidence on thermal storage and consideration of how it might interact with other technologies and policy priorities?

Q17: Do you see heat recovery and information about excess heat available as a useful tool for industry to maximise the benefits of the heat it consumes?
Yes ☐ No ☐ Don't know ☐

Q17a: Do you have any comments?

Q18: Are there any Scottish specific issues that should be dealt with in the review of the non-domestic RHI?
Yes ☐ No ☐ Don't know ☐
What are they, and what evidence do you have to support your views?

Q19: Without interim milestones and taking into account the existing mechanisms to support uptake of renewable heat technologies, what non-financial mechanisms do you think are most effective in driving this uptake?

Q20: Do you support the approach to focus on three areas to support geothermal: demonstration projects; ownership issues; and development of our geothermal vision and a routemap?
Yes ☐ No ☐ Don't know ☐

Q20a: If not, which recommendations should be prioritised and deprioritised?

Q21: How can the anaerobic digestion industry be best encouraged to avoid useful heat being wasted? We are interested in any evidence or practical experience to support your views.

Questions in the Strategic Environmental Assessment (SEA)
Details of the questions included in the SEA and how to respond are set out at page vi of the SEA document which can be found on the Scottish Government website at: http://www.scotland.gov.uk/Consultations/Current

Annex D: Heat Model Scenarios

Scenario 1: Low Government Intervention (GI) and Low Uptake (U)

Scenario 1 presents the smallest reduction in emissions of all the scenarios, with emissions in 2050 43% lower than in 2010. In this scenario there are low levels of Government Intervention (Scottish, UK, local) to either mandate or incentivise uptake of measures to reduce energy demand and to increase switching to lower carbon supply technologies. This is coupled with a low Uptake of new technologies where consumers demand existing familiar means of heat supply and demand reduction technologies. They assess new supply technologies based only on their cost and not on their emissions abatement potential.

Due to the Low GI – Low Uptake combination, in the domestic sector, heat demand only falls slightly out to 2050 due to low uptake rates of fabric retrofit measures. Emissions reduction is primarily driven by the installation of more efficient gas boilers and low level use of heat pumps and district heating. In the non-domestic sector, the demand for heat rises marginally, however biomass energy and heat pumps progressively generate a greater share of the heat supplied.

Scenario 2: Low Government Intervention (GI) and High Uptake (U)

Scenario 2 demonstrates a 69% reduction in heat emissions from 2010 to 2050. In this scenario there are low levels of Government Intervention (Scottish, UK, local) to either mandate or incentivise uptake of measures to reduce energy demand and to increase switching to lower carbon supply technologies. This is coupled with a high Uptake of new technologies where consumers have high uptake rates of energy demand reduction measures and low carbon heating solutions.

Due to the Low GI – High Uptake combination, demand for heat declines in both the domestic and non-domestic sectors, driven by consumer uptake of retro-fitting, improving the energy efficiency of the existing domestic and commercial building stock. On the heat supply side, the domestic sector experiences a fall in the contribution of gas boilers from around 73% in 2010 to 37% in 2050. This is replaced by higher usage of heat pump solutions and a growing role of district heating. In the non-domestic sector, by 2050, around 60% of heat is supplied by low carbon solutions, mainly from biomass heating, heat pumps and district heating networks.

Scenario 3: High Government Intervention (GI) and Low Uptake (U)

Scenario 3 demonstrates a 68% reduction in heat emissions from 2010 to 2050. In this scenario there are high levels of Government Intervention (Scottish, UK, local) to either mandate or incentivise uptake of measures to reduce energy demand and to increase switching to lower carbon supply technologies. This is coupled with a low Uptake of new technologies where consumers demand existing familiar means of heat supply and demand reduction technologies. They assess new supply technologies based only on their cost and not on their emissions abatement potential.

This High GI – Low Uptake scenario achieves a similar outcome to the reverse scenario above (Low GI - High Uptake), however emissions reductions are driven by Government Intervention ensuring consumers choose heat supply technologies based on emissions abatement despite low natural Uptake rates.

In the existing domestic and non-domestic building stock, this combination leads to a significant rise in the uptake of electric storage heating due to its relatively low installation cost and low carbon nature due to electrical grid decarbonisation. It is also driven in this scenario by consumer resistance to new heating technologies such as heat pumps. This scenario and its suggested rise in electric heating uptake could have implications for the electrical grid infrastructure and its ability to meet an increased demand for electricity.

In the new-build stock, due to high GI, ongoing building standard improvements ensure that new additions to the stock are highly energy efficient.

Scenario 4: High Government Intervention (GI) and High Uptake (U)

Scenario 4 presents the highest emissions reduction scenario in which emissions in 2050 are 81% lower than in 2010. In this scenario there are high levels of Government Intervention (Scottish, UK, local) to either mandate or incentivise uptake of measures to reduce energy demand and to increase switching to lower carbon supply technologies. This is coupled with a high Uptake of new technologies where consumers have high uptake rates of energy demand reduction measures and low carbon heating solutions.

On the heat demand side, the High GI – High Uptake combination drives a significant reduction in heat demand by 2050 as a result of improving building regulations for new buildings and the adoption of energy efficiency measures to refurbish the existing building stock. On the heat supply side, there is almost a complete move away from on-site combustion from gas boilers. In the domestic sector modern electric heating technologies such as heat pumps play a very significant role, providing 58% of all heat. This may have some implication for capacity on the current electricity grid, however, to a much lesser degree than the High GI - Low Uptake scenario.

In non-domestic buildings, biomass gains a substantial share of the heat supply market, supplying around 46% of all heat by 2050. Micro-CHP technologies, in particular fuel cells, supply a material share of the supply system in the 2020s and 2030s, though faces stronger competition from electric heating technologies in the 2040s due to grid decarbonisation. This makes it an attractive low cost and high emissions abatement option for consumers. District heating plays a notable role in supplying low carbon heat to both domestic and non-domestic sectors.

Annex E: The Heat Network Partnership

The Heat Network Partnership for Scotland co-ordinates support to district heating development across a number of agencies and programmes: Scottish Enterprise, Scottish Futures Trust (SFT), the Energy Saving Trust, Scottish European Green Energy Centre and Resource Efficient Scotland. The Heat Network Partnership website (www.districtheatingscotland.com) gives details of where projects can get support and, as it is developed, will form a hub of information on district heating in Scotland. Background on the establishment of the Heat Network Partnership can be found in Section 5 of the main report under “Support for District heating”.

The Resource Efficient Scotland programme offers support and advice to organisations wishing to investigate and progress district heating opportunities at every stage from the initial feasibility study to determine whether a project is viable, through to stakeholder engagement and implementation. Resource Efficient Scotland also provides the secretariat for the Heat Network Partnership.

The Energy Saving Trust works with governments, local authorities, third sector organisations and businesses to reduce carbon emissions, use water more sustainably and save money on energy bills. The Energy Saving Trust currently manages the District Heating Loans Fund and the Warm Homes Fund on behalf of the Scottish Government.

The Scottish Government’s low carbon work stream led by SFT aims to develop financial commercial models to support investment in programmes of energy efficiency projects across the public sector estate, and enable private sector investment in those projects. The SFT is leading the Heat Network Partnership’s work with local authorities, and other public sector bodies, on potential business models for district heating.

Scottish Enterprise offers a range of support tools to help companies take advantage of heat network opportunities, working with partners to increase the number of heat projects that are ready for investment and to encourage innovation by supporting projects in funding applications. For example Scottish Enterprise provided support to Luddon Construction to work with Glasgow City Council to carry out the study on district heating in Glasgow City Centre and Glasgow North.

Annex F: Renewable and low carbon heat technologies – descriptions and examples

Heat pumps and other heat recovery technologies

A key technology in the use of excess heat at lower temperatures is the heat pump. **Heat pumps** use compression (the same principle as a refrigerator) to extract tepid low grade heat to produce heat for space and/ or water heating. They can also be reversed to provide cooling. Heat pumps vary significantly in scale. Currently the majority of electrically driven heat pumps in Scotland provide heat for individual buildings. There are opportunities for use of large scale heat pumps as demonstrated in Drammen (see case study). Heat can be extracted from air, ground, surface water bodies or flooded mine shafts. Using these sources when the system meets the required efficiency is classed as a renewable energy supply. Heat pumps can also use excess heat recovered from, for example, factories, refrigeration and data centres, and where the source of this heat is originally a fossil fuel, it would be classed as low carbon heat.

Examples of heat pump use in domestic properties can be accessed via the Green Homes Network[81] and a report by Consumer Focus[82] which considered social landlords' and tenants' experience of renewable heat in off-gas grid housing.

There are also a number of companies such as Baxi, Calor, and Scottish Gas who supply **gas absorption heat pumps** (GAHPs) manufactured by Robur. These systems use the same operating principles as the electric heat pumps described above, with the compressor replaced by a separate device powered by a gas burner. Domestic GAHPs, potentially a more efficient alternative to gas boilers, are expected to come to market in the near future. There are a small number of commercial applications of GAHP in the UK already. **Hybrid systems integrating a boiler and an electric heat pump** are also under development.

Biomass

Biomass is dry organic material derived from plant or animal matter. Sources of biomass include trees (eg woodfuel), energy crops (eg aquatic plant), agricultural residues (eg straw or husks from arable crop residues, animal manures and slurries, animal bedding such as poultry litter, any excess production such as grass silage). Biomass can be used in stoves and boilers or anaerobic digestion.

There has been continued growth of local **woodfuel** markets. The Forestry Commission Scotland (FCS) has indicated that woodfuel demand has increased fourfold since 2004-05. Scotland has done well from the RHI with the vast majority of the accredited RHI capacity being biomass. The greatest activity has been in Highlands, Aberdeenshire and Dumfries and Galloway and demand is anticipated to continue to be strong across Scotland.

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[81] See http://www.energysavingtrust.org.uk/scotland/Generating-energy/Green-Homes-Network
[82] Consumer focus, 2012, 21st century heating in rural homes: http://www.consumerfocus.org.uk/scotland/publications/21st-century-heating-in-rural-homes

Anaerobic Digestion, Biogas and biomethane

Biogas is a mixture of gases produced by the breakdown of organic matter in the absence of oxygen. This currently occurs in landfill sites where the waste contains organic matter. However the amount or organic waste going to landfill is diminishing (see above). Biogas can also be produced under more controlled processes in an **anaerobic digester**. This uses anaerobic bacteria or fermentation of biodegradable materials such as manure, sewage, food waste, green waste, plant material, and crops. Biogas can either act as the fuel such as for a combined heat and power (CHP) engine or be treated to remove some of the other gases in the mixture leaving **biomethane**, which can then be injected into the gas grid.

Solar Thermal

Solar thermal, or solar water heating, commonly uses panels to transform the sun's energy into heat or thermal energy by heating up water. Angle, pitch of the solar panels, with no overshadowing, and water storage are important to maximise the energy collected.

When coupled with increased water storage capacity solar thermal can deliver a substantial proportion of a household's heat demand. Solar collectors can be installed over the roof covering, or inset within the roof structure. Electricity is used to run the pump that circulates the heat transfer fluid between the collector and the hot water store. A boiler or immersion heater is used to make the water hotter or provide hot water when solar energy is unavailable. South-facing roofs are most effective.

Case Study: Solar Thermal
Jonathan Rosie built a three bedroom home north of Inverness and his current energy bills are around £500 annually. An integral part of the build was the installation of underfloor heating and associated hot water system supplied by Begetube Ltd in Inverness. A 1 cubic meter hot water tank and wood burning stove were installed along with the solar thermal system. In winter the stove has only been used two or three hours in the evening for 3 or 4 days a week –the house has been maintained at 24°C all year round. Woodfuel for 15 months has been around £195 for 3 bags of wood pellets. . Electricity consumption for 12 months from March 2012 was 2500 kWh –about £375.

Additional case studies of individual solar thermal systems, and many other renewable energy and low carbon technologies can be seen via **Green Homes and Green Business Networks**[83].

[83] http://www.energysavingtrust.org.uk/scotland/Generating-energy/Green-Homes-Network

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