ENERGY EFFICIENT SCOTLAND: The future of low carbon heat for off gas buildings

A call for evidence

March 2019

Scottish Government
Riaghaltas na h-Alba
gov.scot

MINISTERIAL FOREWORD

The choices we make about our energy system, and how we support the low carbon transition are among the most important decisions we face as a nation. Decarbonising Scotland's heat supply, whilst maintaining affordability for customers, is a critical part of delivering a successful transition.

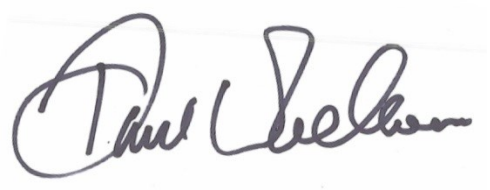
The Scottish Energy Strategy sets an ambitious but achievable target that, by 2030, the equivalent of 50% of Scotland's total energy requirements for heat, transport and electricity is to be supplied from renewable sources. We outlined in the Climate Change Plan our long-term ambition that by 2050 emissions from buildings in Scotland are near zero. We are already making good progress. An increasing proportion of buildings now have a good energy efficiency rating, with 42% of domestic properties now EPC band C or above. [1] The supply of renewable, low carbon heat also increased to provide 5.9% of non-electrical heat demand through renewable sources in 2017. However, there is more we need to do.

As we've set out previously, we're phasing our approach so that we are starting interventions with the things within our control. In practice this means driving up the energy efficiency, standards and performance across Scotland's building stock through our Energy Efficient Scotland programme, which it is estimated could have a whole economy cost of between £10 - £12 billion over its lifetime, and deploying low carbon heat in areas not currently using mains gas and developing district heating networks where it makes sense to do so.

Scotland's transformation into a low carbon society can only be achieved with public, private and third sectors working together and with the involvement of everyone. Our aim is, therefore, to work closely with businesses, the public sector, and individuals to achieve Scotland's ambitious goals. If we get this framework right and have sufficient advance sight of the pipeline of works, then investing in energy efficiency will boost economic growth, support jobs across the Scottish economy, bring Scotland's buildings up to standard, and help households and businesses save money.

[1] In 2017, Scottish House Condition Survey data reported 42% of homes achieved band C rating under SAP 2012, up from 35% in 2014. Using SAP 2009, 46% of dwellings were rated C or better, up 22 percentage points since 2010. In the same period, properties in the lowest EPC bands (E, F or G) have reduced from 27% in 2010 to 13% in 2017

This consultation seeks your views on our future strategic approach to decarbonising heat for off gas buildings. Your views will help us understand the roles that various low carbon heat technologies can play, as well as what kind of policies and legislation may be needed to support their uptake. I encourage you to respond to this consultation and my Ministerial colleagues and I very much look forward to hearing your views.



PAUL WHEELHOUSE MSP

Minister for Energy, Connectivity and the Islands

EXECUTIVE SUMMARY

With this call for evidence, the Scottish Government seeks evidence on the technologies and the actions necessary to support the decarbonisation of the heat supply of buildings that currently do not use mains gas as their primary heating fuel.

The call for evidence is divided in three parts. The first part considers the existing market for low carbon heat, including barriers to uptake. The second explores the various technologies that may have a role to play. The third part seeks views on the role of government in supporting the decarbonisation of the heat supply.

The responses we receive, alongside other evidence, will inform our ongoing work to strengthen Scotland's low carbon heat policy framework.

Scotland's transition to a more prosperous, low carbon economy is already well underway. Decarbonising the way we heat our buildings is a fundamental part of this transition and important if we are to achieve our climate change targets and ambition for all Scotland's buildings to be near zero carbon by 2050. The Climate Change Plan outlines an ambitious trajectory to supply 35% of domestic heat and 70% of heat used by non-domestic properties, from low carbon sources by 2032. Scotland's Energy Strategy also sets an ambitious target for the equivalent of 50% of Scotland's heat, transport and electricity consumption to be supplied from renewable sources by 2030.

Currently, natural gas, supplied via the mains gas network, is used to supply the majority of heat in Scotland and this is similar to other European energy systems, such as the Netherlands and Italy. Electricity and heating oil also account for significant shares and in recent years renewable sources have met an increasing proportion of heat demand.

Over the next few years we will support energy efficiency/ demand reduction in buildings; and promote the uptake of low carbon heat solutions in off gas buildings, as well as the development of heat networks in urban areas having learned from good practice in other jurisdictions across Europe.

Current Market for Low Carbon Heat

The market for renewable and low carbon heat has grown in recent years, through the Renewable Heat Incentive (RHI), among other factors. UK Government data shows that Scotland has received greater than its pro-rata share of installations under the RHI, with 20% of domestic and 19% of non-domestic projects located in Scotland[2].

However, whilst a growing share of Scotland's heat is met from low carbon and renewable sources there remains a number of barriers to uptake, which will need to be overcome if deployment is to be scaled up to achieve Scotland's climate change targets.

[2] BEIS (2018). Non-Domestic and Domestic Renewable Heat Incentive (RHI) monthly deployment data. https://www.gov.uk/government/collections/renewable-heat-incentive-statistics

Your answers to the questions, will help us identify which specific actions we can undertake to remove such obstacles in order to accelerate the uptake of low carbon and renewable sources of heat. We specifically ask you to reflect on building-specific restrictions, namely:

- poor building energy efficiency;
- building density;
- conservation areas and listed buildings; and
- high heat demand or need for high temperature heat.

We believe these different characteristics underline the need for future policy frameworks to be flexible enough to develop bespoke solutions to decarbonising heat supply in Scotland.

Low Carbon Heat Technologies

There are a wide range of technologies which could be deployed as replacements for existing high carbon heating systems, depending on the property's characteristics, its location and the features of the available technologies. This section of the Call for Evidence outlines the key low carbon heat technologies available, the scope for innovation and the potential constraints on the deployment of low carbon heat. We invite you to provide evidence on practical aspects of their large scale uptake, such as the current and prospective installation and operational costs. We are also interested in innovative new technologies that may have a role to play in the sector.

This section also lists the main low carbon heat technologies, although it does not constitute a fully comprehensive list:

- Electric Heating Solutions, such as:
    - *Electric Heat Pumps*
    - *Hybrid Heat Pumps*
    - *Storage Heaters*
    - *Other electric heating sources and storage*
- Biomass and bio-liquid solutions
- Heat Networks

Enabling Uptake of Low Carbon Heat

With this section of the Call for Evidence, we seek to understand the elements that will be needed to create a future framework to support the uptake of low carbon heat in buildings not currently using mains gas, in particular the role of:

- Phasing and leadership
- Strategy in guiding investment and delivery
- Finance and incentives in supporting uptake
- Advice and information in enabling consumers to make informed choices
- Regulation in giving market certainty

We are also seeking your views on how we can support the growth of the supply chain to ensure local economies benefit from the new opportunities.

Next Steps

The call for evidence will run for 12 weeks. Responses received will be analysed and the resulting evidence will be used to inform further work to strengthen our policy framework for low carbon heat.

Contents

INTRODUCTION

Scotland's transition to a more prosperous, low carbon economy is already well underway. Decarbonising the way we heat our buildings is a critical next stage in this transition.

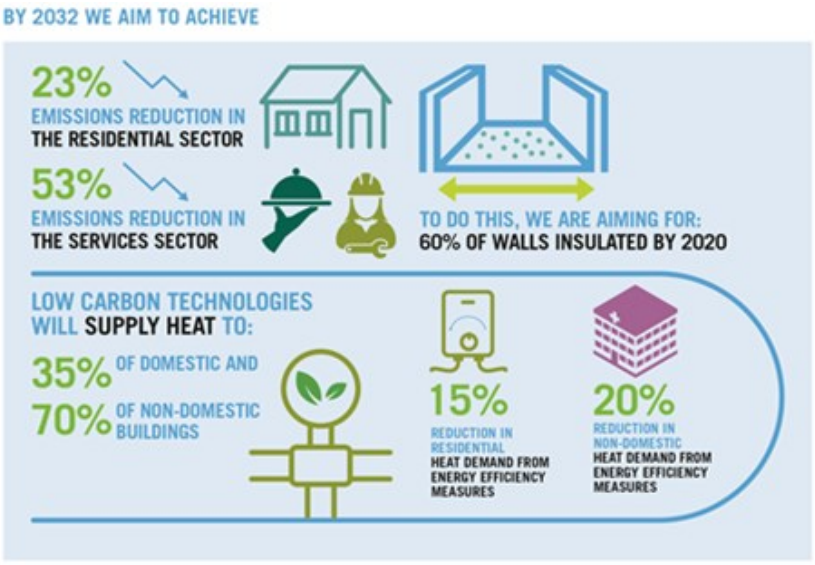
The Scottish Energy Strategy sets out a whole-system vision for the transition, placing energy efficiency alongside a low carbon heat supply. It sets two key targets for the Scottish energy system by 2030:

1. The equivalent of 50% of the energy for Scotland's heat, transport and electricity consumption to be supplied from renewable sources

2. An increase of 30% in the productivity of energy use across the Scottish economy

These targets are in line with our over-arching long-term target to reduce emissions by at least 80% by 2050[3] (as required by the Climate Change (Scotland) Act), and our stated ambition for Scotland's buildings to be near zero carbon by 2050. The Climate Change Plan[4] outlines an ambitious trajectory for the decarbonisation of Scotland's heat supply which will see around 35% of domestic and 70% of non-domestic buildings' heat supplied by low carbon sources by 2032[5] (*Figure 1)*.

Figure 1: Scotland's path towards heat decarbonisation



It is important that efforts to decarbonise our heat supply also support our objectives to eradicate fuel poverty and create sustainable and inclusive growth. We have established

[3] Our new Climate Change Bill strengthens our long term targets to reduce greenhouse gas emissions by at least 90% by 2050. This will mean a 100% reduction in net carbon dioxide emissions by that date, meaning Scotland will be carbon neutral.

[4] Scottish Climate Change Plan 2018: The Third Report on Proposals and Policies 2018-2032, see https://www.gov.scot/publications/scottish-governments-climate-change-plan-third-report-proposals-policies-2018/

[5] CCC (2018). Reducing emissions in Scotland. 2018 Progress Report to Parliament, see https://www.theccc.org.uk/wp-content/uploads/2018/09/Reducing-emissions-in-Scotland-2018-Progress-Report-to-Parliament.pdf

the independent Just Transition Commission to provide practical advice to Scottish Ministers on how we can move to a carbon-neutral economy that is fair for all. Our Energy Strategy is clear that we will maintain Scotland's leadership in developing local energy systems, building on a legacy of strong community engagement in local renewable generation[6]. We will publish a Local Energy Systems Policy Statement during 2019.

The Energy Strategy also sets out that bioenergy will have an important role in our future energy system. We will publish a draft Bioenergy Action Plan, providing clearer scope for the development of bioenergy in the Scottish energy system. This will be informed by research that aims to improve our understanding of the potential contribution that bioenergy can make to meeting Scottish energy demand across power, heat and transport fuels.

The Call for Evidence

This call builds on previous consultations and is focussed on an area within our control. It seeks evidence on the technologies and the government action necessary to support the decarbonisation of the heat supply of buildings that currently do not use mains gas as their primary heating fuel. In particular, we are seeking evidence and views on:

- The best low carbon heating technologies for deployment as alternatives to carbon intensive technologies, and where these technologies can most feasibly be deployed;
- Barriers to uptake and how these may be overcome;
- The relationship between energy efficiency levels and heat supply options;
- The challenges, risks and opportunities to Scotland's businesses, existing heating system and heating fuel supply chains and carbon intensive industries
- The potential impact that a transition to low carbon heat may have on fuel poverty.

The call for evidence will run for 12 weeks from 26 March 2019 – 18 June 2019. We will then analyse the responses received to inform further policy development. The responses, where relevant, will help us develop a Bioenergy Action Plan and Local Energy Systems Policy Statement.

[6] Scottish Energy Strategy: The future of energy in Scotland (2017), see https://www.gov.scot/publications/scottish-energy-strategy-future-energy-scotland-9781788515276/

BACKGROUND

The Scottish Government's approach to decarbonising heat

Under the Scotland Act, heat policy, energy efficiency and building standards are devolved, however regulation of energy markets, oil and gas, electricity and gas networks and consumer protection remain reserved to the UK Government. As such, the Scottish Government can set standards for energy efficiency, regulate technical aspects of district heating, and can introduce measures to decarbonise heat in buildings not using mains gas. It is not, however, within the Scottish Government's competence to require the decarbonisation of the heat supply of those currently using mains gas. In this area, we continue to work with the UK Government to identify and investigate the best way forward. The UK Government recently published an overview of current evidence on decarbonising heat[7]. We have also recently published our Vision for Scotland's electricity and gas networks between 2019 and 2030[8] which discusses the potential role of the gas network in providing low carbon heat in the future.

Our Climate Change Plan and Heat Policy Statement[9] outline our overarching approach to decarbonising heat, based on the hierarchy shown. (*Figure 2*).

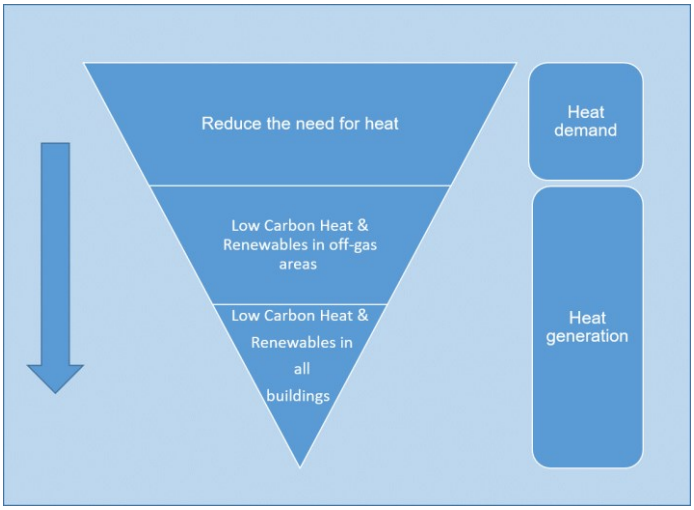
The Scottish Government has been consistent in its support for energy efficiency and low carbon heat, and continues to focus its efforts where it has control of the necessary levers. As such, over the short- to medium-term we are focussing on improving the energy efficiency of all buildings, deploying appropriate low carbon heat solutions in individual buildings that do not use mains gas and developing heat networks where appropriate.

[7]BEIS: Clean Growth: Transforming Heat. Overview of current evidence (2018), see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766109/decarbonising-heating.pdf

[8] Scotland's electricity and gas networks: vision to 2030 (2019) https://www.gov.scot/publications/vision-scotlands-electricity-gas-networks-2030/

[9]Heat Policy Statement: Towards decarbonising heat: Maximising the opportunities for Scotland, see https://www.gov.scot/publications/heat-policy-statement-towards-decarbonising-heat-maximising-opportunities-scotland/

FIGURE 2: The Scottish Government's hierarchical approach to heat decarbonisation



Reducing demand for heat, by making buildings and heating systems more efficient, is one of the most cost-effective ways to reduce emissions and bills, as well as to protect against future changes in energy prices. That is why we continue to invest heavily in improving the energy efficiency of Scotland's buildings and by 2021 we will have allocated over £1 billion since 2009 to improving energy efficiency and tackling fuel poverty. Last year we launched Energy Efficient Scotland[10] which, over the next 20 years, will transform our building stock so that it is warmer, greener and more efficient. Energy Efficient Scotland includes a framework of energy efficiency standards which will see all homes improved to meet EPC Band C by 2040, where technically feasible and cost effective, as well as all technically feasible and cost effective improvements applied to non-domestic buildings.

Our programmes and policies aim to create a favourable climate for investing in low carbon heat solutions. We currently make available a range of support including low cost loans and free impartial advice to householders and businesses, enabling them to switch to low carbon heat.

[10] Energy Efficient Scotland: route map (2018), see https://www.gov.scot/publications/energy-efficient-scotland-route-map/

In recent years, we have put in place a range of support programmes, including:

- The Low Carbon Infrastructure Transition Programme (LCITP) which offers financial support for low carbon projects covering a wide range of technologies, including of low carbon and renewable heat. Since March 2015, LCITP has offered over £40 million of funding to 13 low carbon demonstrator projects supporting low carbon energy generation, and supported the co-development of over 30 proof of concept and development proposals. The Low Carbon Innovative Funding Invitation was launched in January 2018; announcement of the successful projects is expected in early 2019.
- The District Heating Loan Fund which helps address the financial and technical barriers to district heating projects – Since 2011 over £15 million offered to 50 projects across Scotland.
- The Scottish Government actively promotes the GB-wide Renewable Heat Incentive (RHI) scheme – uptake in Scotland is higher pro-rata at 20% of the total accreditations for Great Britain.
- Our SME Loan Scheme offers low or no cost loans to business up to £100,000 for the installation of efficiency measures and renewable technologies via Resource Efficient Scotland (RES). Since 2008, the SME Loan Scheme has financed over 1000 projects resulting in estimated heat and electricity energy savings of 468 GWh, carbon savings of over 182 ktCO2 and financial savings of over £50 million.
- The Home Energy Scotland (HES) Loan Scheme provides interest-free loans up to the value of £38,500 for both energy efficiency measures and renewable technologies via the Energy Saving Trust (EST). There have been 1,325 loans offered from the Scottish Government under the HES Loan scheme since it was launched in May 2017 and the value paid out from the Scottish Government through the HES Loan Scheme to date totals £3.4 million.

Fuel Poverty & Low Carbon Heat

The Scottish Government is committed to eradicating fuel poverty and through the Fuel Poverty (Definition, Target & Strategy) (Scotland) Bill sets a new target that in 2040 no more than 5% of households in Scotland are in fuel poverty; and places a duty on Scottish Ministers to produce a long-term fuel poverty strategy**.**

In 2017, 24.9% of households were estimated to be living in fuel poverty, under the current definition[11]. The fuel poverty rate is affected by levels of household income, energy prices, the energy efficiency of housing, and energy behaviours at home.

Overall, all households that do not use mains gas are more likely to be in fuel poverty. In 2017, 52% of those using electric heating systems and 40% of those using oil were in fuel poverty, compared to 19% of households connected to the gas network. For properties using electricity for heat the high levels of fuel poverty are connected to the high unit cost of electricity, while for oil users it is likely connected to the nature of the rural housing stock with more detached dwellings with poor energy performance[12].

Decarbonising the heat supply to off gas buildings has the potential to affect the fuel poverty rate; attempts to address fuel poverty can also affect the drive to lower carbon emissions. When planning the implementation of heating systems that are fit for the future it is appropriate to consider all heating systems including those using high carbon fuels like oil and LPG but also those using electricity.

This call for evidence is concerned with all properties that do not use mains gas for heat, including those currently using electric heating systems. Homes using electricity for heat currently have extremely high levels of fuel poverty (52%)[13]. These homes are within the scope of this call as although they use electricity and thus are moving toward low carbon heat already, their levels of fuel poverty may mean that their existing heating system could need upgrading if fuel poverty targets are to be achieved. The decarbonisation of all heat and the achievement of fuel poverty targets will require wholesale changes in how buildings are heated across Scotland. If low carbon and fuel poverty targets are to be achieved it is appropriate to take a holistic view across the system and to plan for the affordable, low carbon system of the future. It is also appropriate to consider the network and generation infrastructure requirements of the future with planning for this inherently linked to the scale and type of electric heating.

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[11] The Scottish Fuel Poverty Statement sets out that 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 on all household fuel use.

[12] Citizens Advice Scotland (2018). Off- gas consumers: Updated information on households without mains gas heating, see https://www.cas.org.uk/publications/gas-consumers-updated-information-households-without-mains-gas-heating

[13] Ibid

Scotland's building stock & current heat supply

Scotland's building stock is extremely varied in terms of building type, construction method, age and energy efficiency rating. Natural gas is used to supply the majority of heat in Scotland, but electricity and heating oil also account for significant shares. In recent years, renewable sources have met an increasing proportion of heat demand and in 2017 accounted for an estimated 5.9% - 6.1% of non-electrical heat demand. The main renewable sources currently, in terms of capacity, are biomass (including CHP), heat pumps and energy from waste.[14]

Electricity is the primary heating fuel of 12% of Scottish households.[15] Electricity in Scotland is becoming increasingly low carbon, and by 2032 electricity generation is predicted to be largely decarbonised, therefore contributing to the supply of low carbon heat.

The remainder of this section provides a breakdown of heat supply across the domestic, non-domestic and industrial sectors and looks at the current market for low carbon heat in Scotland, giving a sense of the scale of the challenge ahead.

Domestic Buildings

In Scotland around 500,000 domestic properties or approximately 21% of total housing stock do not use mains gas as their primary source of heat.[16] Scotland has a higher proportion than the UK average of domestic properties that do not use mains gas as their primary heating source.

The majority of these properties use electrical heating systems, with the remainder, using heating oil, LPG or solid fuels as their primary heat source (excluding properties connected to district heating networks). Homes using high carbon fuels like oil, LPG and coal are much more common in remote and rural areas, with properties not connected to the gas grid in urban areas predominantly using electricity for heat.[17]

At present electric heating systems in the UK are predominantly electric storage heating systems that take advantage of lower electricity costs at certain times of the day[18] [19]. Direct electric heating systems without a storage functionality, such as panel heaters, are less common, with heat pump systems less common still.

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[14] Energy Saving Trust, Renewable Heat in Scotland, 2017, see http://www.energysavingtrust.org.uk/sites/default/files/Renewable%20Heat%20Report%20%202018.pdf

[15] Scottish House Condition Survey, 2017, Table 5, see https://www.gov.scot/publications/scottish-house-condition-survey-2017-key-findings/

[16] Scottish House Condition Survey, 2017, Table 5, see https://www.gov.scot/publications/scottish-house-condition-survey-2017-key-findings/

[17] ibid.

[18] Ofgem (2015). Insights paper on households with electric and other non-gas heating, see https://www.ofgem.gov.uk/publications-and-updates/insights-paper-households-electric-and-other-non-gas-heating

[19] No Scottish specific figures available

Homes that do not use mains gas as their primary heating fuel are recorded as having lower energy efficiency ratings than properties that do (see Table 1)[20]. These ratings are informed by both fuel costs and energy efficiency. Electric heating in particular is associated with high costs, while properties that use high carbon heating fuels like oil, LPG and solid fuels, are much more likely to have solid, stone walls, which have a lower level of energy efficiency and are often more difficult to retrofit [21].

Table 1: Energy efficiency SAP rating[22] and EPC band (Table 21 Scottish House Condition Survey (SHCS), 2017, SAP 2012.)

		SAP rating	**B/C**	**D/E**	***F/G***
Primary Heating Fuel	Gas	66.8	47%	52%	1%
	Oil	50.2	9%	70%	21%
	Electric	56.1	26%	59%	15%
	Other	55.5	42%	33%	25%
Location	Urban	66.1	46%	51%	2%
	Rural	54.9	22%	62%	17%
Scotland		64.3	42%	53%	5%

Non-Domestic Buildings

We estimate that there are approximately 200,000 non-domestic buildings in Scotland, which range from small shop and business units to large office buildings, industrial units and shopping centres. We currently know much less about our non-domestic buildings. We estimate that there are in excess of 100,000 (58%) non-domestic buildings (excluding military and agricultural buildings) which currently do not use mains gas for heat.[23] These buildings are predominantly electrically heated. Heating oil is the most popular alternative to electric heat for non-domestic buildings that do not use mains gas.

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[20] The Energy Efficiency Rating of a domestic property, as recorded within Energy Performance Certificates (EPC), takes account of both energy efficiency and fuel costs.

[21] Citizens Advice Scotland (2018). Off- gas consumers: Updated information on households without mains gas heating, see https://www.cas.org.uk/publications/gas-consumers-updated-information-households-without-mains-gas-heating

[22] A SAP calculation indicates a score from 1 to 100+ for the annual energy cost, where the higher the score the lower the running costs, with 100 representing zero energy cost. Dwellings with a rating in excess of 100 are net exporters of energy.

[23] Scotland's Non-Domestic Energy Efficiency Baseline, 2018, see https://www.gov.scot/publications/scotlands-non-domestic-energy-efficiency-baseline/

We do not currently have sufficient evidence to compare the relative energy efficiency of off gas and on gas non-domestic properties. However, recent Scottish Government analysis estimated that almost three in four of all non-domestic premises have a current EPC band of E or worse with 5 percent banded B or better[24].

Industrial Heat Users

A minority of non-domestic buildings will be used by industrial or manufacturing businesses to house their operations, processes or production lines. Heating these premises to create adequate conditions for the internal comfort of employees is part of heating Scotland's non-domestic building stock. There will be varied requirements on internal conditions that industrial premises have due to the specific nature of processes taking place within these buildings, however we do not have specific information on this.

Industrial heat consumption for process energy will often be the main reason for energy consumption at a site. These processes often include significant quantities of heat which, if captured and used, could help the competitiveness of industrial business by providing a revenue stream.

Fuel diversification is one method of reducing emissions from industry, in particular the energy intensive industrial sector (EII), and this could include using natural gas or LNG instead of solid fuels. Options to switch could be enabled by gas grid extension. There could be opportunities for buildings and industrial users to share the benefits from extended infrastructure. Significant EII demand could be a catalyst - creating connections between industrial sites and adjacent communities and helping to embed the energy transition.

Looking ahead, hydrogen as a fuel could meet some industrial demands albeit this would depend on a degree of repurposed infrastructure. A paper on how to decarbonise Scotland's industrial sectors and sites will be published for discussion in 2019. It will cover how to incentivise a wide range of methods to decarbonise including industrial heat recovery, energy efficiency measures and innovative technologies such as carbon capture and storage.

[24] Note that non-domestic EPC assessments follow a different methodology to domestic EPC assessments and therefore ratings are not directly comparable. See https://www.gov.scot/publications/scotlands-non-domestic-energy-efficiency-baseline/

CURRENT MARKET FOR LOW CARBON HEAT

This section covers:

- The distinctions of Scotland's renewable and low carbon heat market
- The existing barriers to their uptake, and the actions we can undertake to remove such obstacles in order to accelerate the uptake of low carbon and renewable sources of heat
- We specifically ask you to reflect on building-specific restrictions, namely:
    - poor building energy efficiency;
    - building density;
    - conservation areas and listed buildings; and
    - high heat demand or need for high temperature heat.
- We believe these factors underline the need for future policy frameworks to be flexible enough to develop bespoke solutions to decarbonising heat supply

The market for renewable and low carbon heat has grown in recent years. At present, the majority of low carbon heat installations in Scotland are likely driven by the Renewable Heat Incentive (RHI).

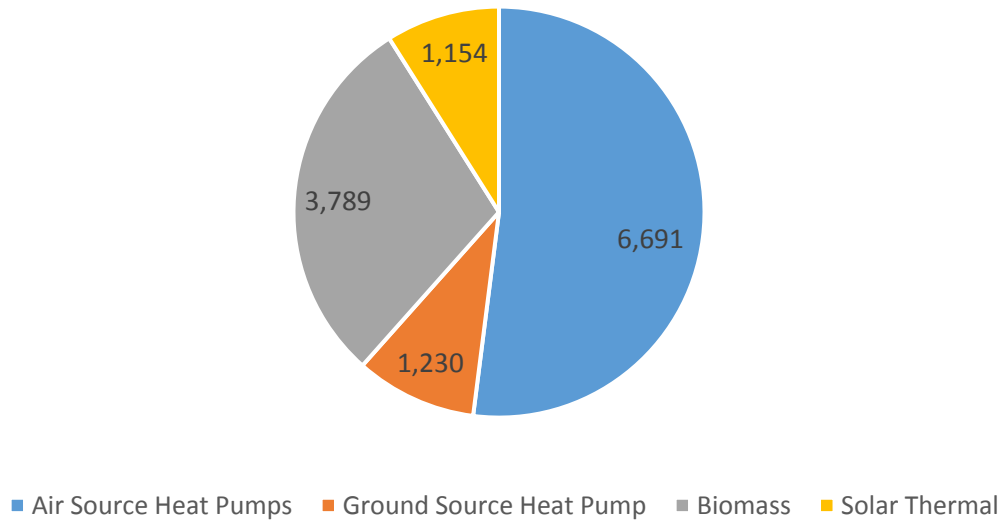
Over the period 2014-18 there have been in excess of 16,000 installations under the RHI in Scotland (combining domestic and non-domestic installations). Scotland has received greater than its pro-rata share of installations under the RHI, with 20% of domestic and 19% of non-domestic activity taking place in Scotland. The vast majority of domestic RHI installations in Scotland were in off gas grid properties (87%, compared to 72% in GB overall)[25].

The largest technology uptake on the non-domestic RHI has been biomass boilers with over 80% of accredited installations being some form of biomass boiler up to November 2018[26]. The domestic data shows a wider spread of technologies being supported under the RHI in Scotland, as shown in Figure 3.

[25] BEIS (2018). Non-Domestic and Domestic Renewable Heat Incentive (RHI) monthly deployment data. https://www.gov.uk/government/collections/renewable-heat-incentive-statistics

[26] BEIS (2018). Non-Domestic and Domestic Renewable Heat Incentive (RHI) monthly deployment data. Number of accreditations for low carbon technologies in the non-domestic sector are not available at a Scottish specific level.

Figure 3. Accredited Installations (Domestic RHI) Scotland



QUESTIONS

1. What evidence can you provide of low carbon heat technologies being taken up without government support?

Barriers to Uptake

Whilst a growing share of Scotland's heat is met from low carbon and renewable sources there remain a number of barriers to uptake, which will need to be overcome if deployment is to be scaled up to achieve Scotland's climate change targets. These barriers include:

- lack of consumer and supply-chain knowledge of low carbon heat technologies;
- the relatively high upfront costs of installing low carbon heating systems, relative to like-for-like replacement of incumbent systems;
- the disruption of upgrading and/or replacing the internal heat distribution systems so that they are compatible with low carbon technologies e.g. re-sizing radiators, installation of a wet central heating system;
- the need to dispose of heating systems components, in some cases prematurely, when switching to low carbon heat e.g. disposal of heating oil storage tanks.
- potentially higher operational and / or maintenance costs;

- limited capacity in some locations on the electricity grid to supply substantial increases in electrical heating;
- lack of any regulatory requirement to install low carbon heating systems;
- public finance limits to the level of support that can be provided by government to incentivise uptake; and
- low carbon heat technologies are not suitable for some energy intensive industrial processes.

We would like you to help us better understand the extent to which these factors, and others, act as barriers to the wider adoption of low carbon technologies, specifically with respect to properties that do not use mains gas, and what the Scottish Government can do to remove such obstacles.

QUESTIONS

2. What other barriers may impede the uptake of low carbon heat in buildings not currently using mains gas?

3. What could we do to remove these barriers and support the uptake of low carbon heat? Can you give examples of successful low carbon heat implementation?

4. How can complementary systems, such as solar PV and heat pump systems be deployed to overcome such barriers?

Building-Specific Restrictions on Low Carbon Heat

Whilst there are a variety of low carbon technologies that could be deployed their suitability may be constrained by a number of building-specific factors, including:

- **poor building energy efficiency**, which may prevent some low carbon technologies from operating effectively particularly where they use low temperature heat;
- **hard-to-treat properties**, which typically have, solid walls, narrower cavities, are of non-traditional construction or are more than three storeys high. This can add to the complexity and cost of improving their energy performance and decarbonising their heat supply[27]
- **building density** which may make it technically challenging to install certain types of low carbon heat either due to physical constraints or low demand levels. Over 30% of Scottish homes are flats which in many cases may prevent the installation of some low carbon technologies in individual units and a communal supply solution may be

[27] Home Energy Efficiency Programmes for Scotland Delivery Report 2016/17 – published June 2018

more appropriate. Conversely, in remote and rural communities it may not be commercially-viable to develop communal solutions due to the dispersed nature of buildings and so individual heating systems may be more suitable.

- **conservation areas and listed buildings** which protect buildings and communities of historical significance. In these areas additional controls are in place, which may prevent the installation of some low carbon heat solutions, with permission required to be sought on a case by case basis.

- **high heat demand or need for high temperature heat**, such as in larger building complexes such as hospitals, hotels, prisons, etc. where it may be more appropriate to consider district, communal or CHP-based solutions.

These different characteristics underline the need for future policy frameworks to be flexible enough to develop bespoke solutions to decarbonising the heat supply.

QUESTIONS

5. **What do you consider to be the principal building-specific constraints on low carbon heat?**
6. **What can be done to overcome these constraints?**
7. **What evidence can you provide on the limitations of low carbon heat technologies (e.g. heat pumps) in buildings with poor energy efficiency?**
8. **What low carbon heat solutions are appropriate for hard-to-treat properties where there are limited opportunities to improve energy efficiency of the building fabric?**

This section covers:

- The wide range of technologies which could be deployed as replacements for existing high carbon heating systems and how the feasibility of these technologies is dictated by the property's characteristics, its location and the features of available technologies
- The key low carbon heat technologies available, the scope for innovation and the potential constraints on the deployment of low carbon heat
- We invite you to provide evidence on practical aspects of their large scale uptake, such as the current and prospective installation and operation costs. We are also interested in innovative new technologies that may have a role to play in the sector

LOW CARBON HEAT TECHNOLOGIES

There are a range of different heat technologies which could be deployed as replacements for high carbon heating systems. The right technology will depend on the property's characteristics, its location and the features of the available technologies. We want to build the evidence base around these technologies and the extent to which innovation and cost reduction are possible. We are also interested in innovative new technologies that may have a role to play in the sector. The following section outlines the key low carbon heat technologies available, the scope for innovation and the potential constraints on the deployment of low carbon heat. We are interested in evidence on the cost of installation and operation for the variety of low carbon heat technologies.

We are also keen to receive evidence on the life cycle of different devices, the relative cost of replacing existing systems and components within existing systems, and running costs. Table 2 outlines average self-reported costs of domestic installations made under the RHI, while Table 3 covers non-domestic installations[28].

The remainder of this section outlines each of the main low carbon heat technologies, (although is not a comprehensive list), their applicability and the scope for innovation to drive down overall costs.

[28] These statistics are based on cost data reported to Ofgem as part of the RHI application process. RHI statisticians have removed outliers in order produce a best estimate of average costs. Users should be aware that the data is self-reported and not validated as part of the application process.

Table 2: Average self-reported costs of domestic RHI installations (Apr/14 – Dec/17) reported by BEIS

Technology	Installation capacity	Median cost	Median cost per KW
Air Source Heat Pump	8 KW	£7,500	£970
	12-13 KW	£10,850	£865
	16 KW	£12,430	£780
Ground Source Heat Pumps	8 KW	£14,860	£1,860
	12-13 KW	£18,330	£1,475
	16 KW	£24,060	£1,500
Biomass boilers	10-20 KW	£9,713	£694
	20-30 KW	£14,121	£583
	30-45 KW	£19,759	£534
Solar Thermal	3-5 KW	£4,983	£1,277

Table 3: Self-reported costs of non-domestic RHI installations (Nov/11 – Mar/17) reported by BEIS

Technology	Installation capacity	Median cost of installation	Median cost per kW
Air Source Heat Pumps	All sizes	£9,300	£790
Water or Ground Source Heat Pumps	<100 kW	£31,510	£1,880
Solid Biomass Boiler	< 200 kW	£60,000	£580
Solid Biomass Boiler	200 - 1000 kW	£187,000	£380
Solar Thermal	< 200 kW	£14,000	£1,420

Source: BEIS 'Non-Domestic and Domestic Renewable Heat Incentive (RHI) monthly deployment data: August 2018'

Electric Heating Solutions

The falling carbon intensity of electricity generated in Scotland means that the electrification of heat has the potential to play a key role in the decarbonisation of heat in buildings.

Electric Heat Pumps

Analysis by the CCC suggests that heat pumps are a key technology for decarbonising off gas properties[29]. Other independent commentators support this view but, like the CCC, note the limitations presented by the level of energy efficiency required to match heat demand, and the pressure that the electrification of heat would put on electricity generation and distribution infrastructure[30] [31].

[29] Committee on Climate Change (2016). Next steps for UK heat policy, see https://www.theccc.org.uk/publication/next-steps-for-uk-heat-policy/

[30] Imperial College Centre for Energy Policy and Technology (2016). Managing Heat System Decarbonisation, see https://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/icept/Heat-infrastructure-paper.pdf

[31] Delta – EE (2018). Technical Feasibility of Electric Heating in Rural Off-Gas Grid Dwellings, see https://www.gov.uk/government/publications/electric-heating-in-rural-off-gas-grid-dwellings-technical-feasibility

Heat pumps tend to provide heat at lower temperatures than conventional fossil fuel boiler systems. As such, they operate optimally in buildings that are energy efficient and that have been adapted to provide low temperature heat e.g. larger radiators or underfloor heating. They also require a change in heating patterns, needing to be on for longer in order to achieve comfortable indoor temperatures. Heat pumps are often used alongside an additional electric heat source in order to provide hot water.

Higher temperature heat pump systems may be more suited to being used with less energy efficient properties or with existing heat distribution systems. However, higher temperature systems can be more expensive to operate and have a higher upfront cost compared to low temperature equivalents.[32] [33] Heat pumps can be used as the sole heat provision system to a property, alongside thermal storage, or as part of the heat source for a district heating system.

Air Source Heat Pumps are approximately equivalent in size to other domestic appliances such as a fridge or washing machine and are attached to an external wall. As such they are often the most deployable type of heat pumps. The installation of Ground Source and Water Source Heat Pumps is restricted by the need to install underground pipes or have access to a nearby body of water, respectively.

Heat pump systems have a higher upfront installation cost compared to existing high carbon heating systems, but over their lifetime may have lower maintenance costs. [34] [35] [36] Running costs for heat pumps, can be competitive with existing high carbon systems, where appropriately installed. They are also less likely to be subject to price fluctuations than heating systems that use feed stocks like oil or biomass.

Whilst not commonly used at present in Scotland, heat pumps are established technologies with developed supply chains in other countries, potentially enabling their more immediate deployment to decarbonise off gas heating systems.

[32] ClimateXChange (2017). Heat Generation Technology Landscaping Study, Scotland's Energy Efficiency Programme (SEEP), see https://www.climatexchange.org.uk/media/1337/technology_landscaping_report-heat_technology.pdf

[33] BEIS (2016). Evidence gathering – Low Carbon Heating Technologies Domestic High Temperature Heat Pumps, see https://www.gov.uk/government/publications/evidence-gathering-high-temperature-heat-pumps-hybrid-heat-pumps-and-gas-driven-heat-pumps

[34] BEIS (2018). Non-Domestic and Domestic Renewable Heat Incentive (RHI) monthly deployment data, see https://www.gov.uk/government/collections/renewable-heat-incentive-statistics

[35] Committee on Climate Change (2015). Sectoral scenarios for the Fifth Carbon Budget Technical report, see https://www.theccc.org.uk/publication/sectoral-scenarios-for-the-fifth-carbon-budget-technical-report/

[36] Imperial College London (2018). Analysis of Alternative UK Heat Decarbonisation Pathways, see https://www.theccc.org.uk/publication/analysis-of-alternative-uk-heat-decarbonisation-pathways/

QUESTIONS

Please specify whether your evidence relates to domestic or non-domestic systems.

9. Regarding ground source, air source and water source heat pumps, what evidence can you provide on:

a) the cost of the technology, including installation, maintenance and running costs and alignment with costs related in the RHI data in tables 2 and 3

b) customer satisfaction with the system

c) lifecycle and overall efficiency of the technology

10. What factors might inhibit uptake of heat pumps?

11. What do you propose as solutions to overcome any barriers to uptake?

12. What innovations could reduce the operational cost of heat pumps, i.e. higher performing heat pumps, new refrigerants, 'time-of-use' tariffs coupled with thermal storage, and 'heat-as-a-service' business models?

Hybrid Heat Pumps

A recent analysis from the CCC suggests that hybrid heat pump (HHP) systems may have an important role to play for properties currently on and off the gas grid.[37] Hybrid systems combine a heat pump alongside an existing fossil fuel boiler, with the heat pump covering the baseload demand and the boiler used during peak demand.

Hybrid systems allow for a lower capacity of heat pump, relative to a full heat pump solution, helping to potentially keep upfront costs down. They can also help improve security of supply, by providing backup heat during cold periods, thus helping shift the extra demand out of peak hours to balance electricity networks, as well as allowing consumers to retain a more familiar system alongside a less familiar technology.[38] Hybrid heat pumps could be used in off gas buildings with oil or LPG boilers, and potentially combined with bio-fuel solutions. They may also have a role to play in less thermally efficient buildings where a full electric heating solution is infeasible.

[37] Committee on Climate Change (2018). Hydrogen in a low carbon economy, see https://www.theccc.org.uk/publication/hydrogen-in-a-low-carbon-economy/

[38] Element Energy (2017). Hybrid Heat Pumps, see https://www.gov.uk/government/publications/hybrid-heat-pumps-study

QUESTIONS

Please specify whether your evidence relates to domestic or non-domestic systems.

13. Regarding hybrid heat pumps, what evidence can you provide on:

a) the cost of the technology, including installation, maintenance and running costs

b) customer satisfaction with the system

c) lifecycle and overall efficiency of the technology

d) the ability of hybrid heat pumps to reduce peak demand for electricity whilst also reducing carbon emissions

14. What factors might inhibit uptake of hybrid heat pumps?

15. What do you propose as solutions to overcome any barriers to uptake?

16. Can you share any evidence on the types of buildings where hybrid heat pumps may best be deployed?

Storage Heaters

Electric storage heaters conventionally involve the use of internal ceramic bricks within a casing, that are used to store (typically at night when overall electricity demand is lower) and then release heat (typically during the day). They are associated with Economy 10, Economy 7 and dynamically tele-switched (DTS), meters and tariffs and are currently thought to be the most commonly used electric heating technology in the UK[39] [40].

Storage heaters act to partly decouple energy demand from energy supply and provide an opportunity to manage utilisation of energy as part of a 'smart' electricity system. They can act as a means of lessening demand at peak times. For example, on Shetland[41] and Mull[42] innovation projects have sought to demonstrate the use of modern smart electrical storage heaters. These systems can be operated to release constraints on the electricity networks, increase the level of renewable generation, and link local heat demand to local electricity generation.

[39] Ofgem (2015). Insights paper on households with electric and other non-gas heating, see https://www.ofgem.gov.uk/publications-and-updates/insights-paper-households-electric-and-other-non-gas-heating

[40] No Scottish specific figures available

[41] http://www.ninessmartgrid.co.uk/our-trials/demand-side-management/components-of-domestic-demand-side-management/

[42] http://sse.com/newsandviews/allarticles/2015/03/isle-of-mull-to-trial-innovative-grid-connection-model/

More efficient and controllable storage heaters are now available, which can be operated manually, or automatically with a thermostat, and can utilise a fan for heat propagation or a direct heat convection unit to provide additional heat when required.

Conventional electric storage heaters are less expensive to purchase and install than heat pumps and comparable in price to high carbon systems such as oil and LPG[43]. Like other forms of electric heat, the widespread adoption of storage heaters could put a substantial strain on the electricity grid if their implementation is not managed appropriately[44]. As they are less efficient at converting electricity to heat than heat pumps they can be more expensive to operate. As such, they may be more suited to smaller properties with lower energy demands.

QUESTIONS

Please specify whether your evidence relates to domestic or non-domestic systems.

17. Regarding electric storage heating, what evidence can you provide on:

a) the cost of the technology, including installation, maintenance and running costs

b) customer satisfaction with the system?

c) lifecycle and overall efficiency of the technology

18. What factors might inhibit uptake of electric storage heating?

19. What do you propose as solutions to overcome any barriers to uptake?

Other electric heating sources and storage (battery and thermal storage)

There are multiple other means of using electricity to provide both space and water heating. Direct or resistive heaters, electric panel heaters and infrared heaters can all be used to provide space heating but ordinarily use relatively high cost on-peak electricity and thus can be expensive to run if they are the sole heat source. These units are often used as secondary, supplementary heat sources or in areas of a property where heat is only occasionally required. For water heating, electric immersion water heaters using a hot water tank, and electric showering units are both common.

There are a variety of energy storage technologies, beyond storage heaters, that are relevant to future low carbon heat systems. Heat pumps systems also normally involve some form of energy storage, the most fundamental of which is a hot water storage tank. A buffer tank, which essentially increases the volume of the heat distribution system and is capable of improving overall efficiency, is also a useful add-on to a heat pump system.

[43] Delta – EE (2016): Electrification of heat and the impact on the Scottish electricity system, see https://www.climatexchange.org.uk/media/1897/electrification_of_heat_and_impact_on_scottish_electricity_system_-_final_report1.pdf

[44] National Energy Action (2017). Heat Decarbonisation Potential impacts on social equity and fuel poverty, see http://www.nea.org.uk/wp-content/uploads/2017/09/Heat-Decarbonisation-Report-September-2017.pdf

All electric heating systems can operate alongside electric battery storage. Battery storage on a household scale can be used to store the excess electricity generated by intermittent renewable energy devices such as solar PV and wind energy. Phase-change devices are also capable of storing the excess electricity from renewable devices and returning it as heat when required.

Storage used alongside electric heating is useful as a means of reducing the peak demand and as a result lessening the requirement for electricity generation and electricity network investment.

QUESTIONS

20. Can you provide any evidence of electric heating technologies not already described that should be considered as potential future heating solution?

21. Can you comment on the comparative installation, operating and maintenance costs of these technologies in relation to other electric heating sources? As well as their lifetime and efficiency?

22. Can you provide evidence on the performance of integrated systems such as heat pumps used in conjunction with battery storage and solar PV?

23. How could locally integrated systems, such as those mentioned above, help to overcome electrical grid constraints and what market mechanisms could be used to promote on site generation and use for low carbon heat?

Biomass and bio-liquid solutions

Solid biomass currently accounts for more than 80% of renewable heat capacity in Scotland. It has been widely supported under the RHI. [45] Like incumbent heating systems biomass can be used to provide high temperature heat via conventional internal heat distribution systems. There are concerns, however, around the long term sustainability of domestic biomass feed stocks, and certain geographic restrictions on where they should be deployed. For example[46] [47] individual standalone biomass boilers should only be installed in remote and rural areas where air quality issues are less of a concern, however biomass CHP can be used in urban areas where suitable controls are in place.

[45] BEIS, Non-Domestic and Domestic Renewable Heat Incentive (RHI) monthly deployment data: November 2018, see https://www.gov.uk/government/collections/renewable-heat-incentive-statistics

[46] Committee on Climate Change (2018). Biomass in a low carbon economy, see https://www.theccc.org.uk/publication/biomass-in-a-low-carbon-economy/

[47] Policy Exchange (2016). Too hot to handle? How to decarbonise domestic heating, see https://policyexchange.org.uk/publication/too-hot-to-handle/

Unlike solid biomass, the market and supply chains for bio-liquid heating fuels are much less developed. However, they potentially offer an additional energy source that can support emission reduction in off gas buildings, particularly in hard-to-treat properties that have a poor energy performance.

Like biomass systems, bio-liquid systems can provide high temperature heat and when used as a 'drop-in' fuel or like-for-like replacement, are compatible with incumbent internal heat distribution systems to some extent. They could potentially be used as a transitionary fuel as they can be blended with high-carbon heating oil or LPG, especially for properties which have limited choices for heat. In order to meet our long term decarbonisation targets, however, it is likely that systems would be required to run on 100% bio-liquids.

There is currently limited domestic production of bio-liquids, which could constrain a rapid expansion in the scale of deployment. They are currently used in transport and have the potential to aid the decarbonisation of the aviation and shipping sectors. Like solid biomass, the use of bio-liquids would need a sustainable long-term, domestic supply infrastructure and to be consistent with air quality objectives. Likewise, running costs would be a key consideration so as not to push people into fuel poverty.

QUESTIONS

Please specify whether your evidence relates to domestic or non-domestic systems.

24. Regarding Bioenergy technologies, what evidence can you provide on:

a) the cost of the technology, including installation, maintenance, fuel and other running costs, and the extent to which costs of biomass boilers are in line with those in tables 2 and 3 above

b) customer satisfaction with the system

c) lifecycle and overall efficiency of the technology

d) type of feedstock used, and whether this is grown in Scotland or imported?

25. What factors might inhibit uptake of bioenergy technology?

26. What do you propose as solutions to overcome any barriers to uptake?

27. What evidence can you provide to show whether there is a strong potential for growth of the biogas supply?

28. Can you provide evidence on the relative cost of using Scottish produced bioenergy feedstocks compared with conventional fossil fuels?

29. Can you provide any evidence on the potential to supply bioliquid fuels sustainably at reasonable cost? With reference to specific fuels such as bio-LPG and different types of bio-diesel.

Heat Networks

A heat network is a distribution system of insulated pipes that takes heat from a central source to multiple properties.[48] Heat networks can use a wide range of heat sources, including those recovered from industry and urban infrastructure, sewers, canals and rivers, or waste plants as well as biofuels, or CHP. Many of the heat networks currently operating in Scotland use mains-gas, although it is understood that over time heat networks can be retrofitted to use lower carbon sources of heat.

Heat networks are ordinarily located in dense urban areas. Viable heat networks have, however, been developed at smaller scales, including in remote and rural areas, and remain a viable option where alternative solutions are technically or financially prohibitive, or where there are co-benefits from implementation, such as providing high-temperature heat for industry. In fact heat networks in Scotland tend to be smaller in scale and serve groups of buildings that are under single ownership, such as campuses or blocks of flats owned by a university, a local authority or a housing association.

Some building types are more easily retrofitted to district heating than others and we are interested in evidence on the most appropriate circumstances and building typologies to facilitate the development of heat networks – both retrofit and new build.

QUESTIONS

Please specify whether your evidence relates to domestic or non-domestic systems.

30. Regarding heat networks, what evidence can you provide on:

a) the cost of the technology, including installation, maintenance, fuel and other running costs

b) customer satisfaction with the system

c) lifecycle and overall efficiency of the technology

31. What factors might inhibit uptake of the installation of heat networks?

32. What could be done to further encourage the development of heat networks?

33. Where and in which circumstances are heat networks the most appropriate low carbon solution in areas not using mains gas?

34. What examples can be provided to show how readily heat networks can be moved to renewables – especially in those buildings with a high peak heat load?

[48] BEIS, Heat Networks guidance, see https://www.gov.uk/guidance/heat-networks-overview

Gas Grid Extension: the roles of hydrogen and biogas as low carbon alternatives to natural gas

Natural gas is lower carbon than heating oil and LPG and, in some circumstances expanding the gas grid may be an option to reduce emissions. Gas heating systems are also relatively cheaper to run and gas connections can help to tackle fuel poverty as well as providing a more secure energy supply.

Ultimately, in order to meet emission reduction targets natural gas will have to be replaced by low carbon alternatives, for example biomethane or the grid repurposed to carry hydrogen. We do not, however, currently have sufficient evidence to understand whether such a solution for hydrogen is feasible and safe, and so there is a risk that gas grid extensions could result in stranded assets in the future.

Industrial users of energy can be a catalyst for extending gas networks to meet their needs for fuel and this can enable homes or non-domestic buildings to benefit from connection into the extended infrastructure. A number of communities in Speyside have recently benefitted via an eight-mile pipeline extension led by a number of distilleries in the area.

Recent evidence from the Committee on Climate Change has suggested that whilst there is likely to be some future for the delivery of low carbon gas through gas mains, it is not obvious that the whole scale conversion of the gas network to hydrogen represents the most effective way to decarbonise heat[49].

Today there are 15 biomethane production sites connected to the gas distribution network in Scotland, and there are trial and demonstration projects underway in a number of locations across Britain to learn about the safety, and viability of delivering hydrogen through the networks. For example, in Scotland, SGN plans to demonstrate a network that delivers 100% hydrogen in the next few years[50] whilst at Keele University in England a trial is underway to identify the level at which hydrogen can be blended with natural gas.[51]

Ultimately, investment decisions for general development of the gas network are made by gas network operators within the regulatory environment set out by Ofgem, while specific extensions or "infill"[52] projects (where the gas network is extended to a new area) are a matter for the gas network company and new connecting customers. Any investment decisions made by the gas network companies will need to consider broader policy developments for decarbonising heat in Scotland. The UK Government will take ultimate decisions on future decarbonisation of the gas grid within its reserved competence.

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[49] Committee on Climate Change (2018). Hydrogen in a low carbon economy see https://www.theccc.org.uk/publication/hydrogen-in-a-low-carbon-economy/

[50] SGN, Hydrogen 100 project, see https://www.sgn.co.uk/Hydrogen-100/

[51] HyDeploy project, see https://hydeploy.co.uk/

[52] There are currently 36 live infill projects looking at extending gas network provision to new areas in Scotland, which could potentially connect 4,719 new properties to the gas mains. These are driven by the economic advantages for consumers of using gas to heat their homes and businesses rather than oil, solid fuels or electricity, with around 1,700 supported by the Fuel Poor Network Extension Scheme

More detailed information on the role of the gas network in supporting a low carbon energy transition is given in our Vision for Scotland's electricity and gas networks[53]. This highlights the need to incrementally decarbonise the gas that flows through the networks during the 2020s, through blending low carbon gasses, including hydrogen, with natural gas. It also challenges the industry to build the evidence base around the technical feasibility and costs associated with repurposing the gas networks to carry 100% hydrogen in future.

QUESTIONS

35. What is your view on the continued extension of gas networks before low carbon alternatives to natural gas (e.g. hydrogen) are proven?

36. How should wider decarbonisation demands, including for industrial processes, be factored in when considering gas grid extension?

37. What evidence can you provide on the economic and technical viability of the existing gas grid if it was maintained and operated with low gas flows?

Innovation in low carbon heat technologies

The market for low carbon energy is continuously evolving, and evidence suggests that the cost of new technologies can drastically fall, even over a short period of time. For example, the cost of photovoltaic panels in the UK fell by a cumulative 15% to 20% in real terms over the 3 years to 2016/17. This substantial drop has been attributed to technological innovation and economies of scale driven by an increase in demand.[54]

Our Low Carbon Infrastructure Transition Programme stimulates commercial interest and investment in the low carbon sector. It helps projects to develop investment-grade business cases, and to secure public and private capital finance. To date it has accelerated the deployment of over 50 low carbon projects by providing £48 million of financial support. Building on this success we have established a Low Carbon Innovation Fund, investing a further £60 million to deliver innovative low carbon energy infrastructure.

We are keen to understand what further opportunities exist for innovation in low carbon heat technologies, where support is needed to bring technologies to market and the potential for a reduction in cost of low carbon heat technologies.

[53] Scotland's electricity and gas networks: vision to 2030 (2019) https://www.gov.scot/publications/vision-scotlands-electricity-gas-networks-2030/

[54] UK Government - Solar PV cost data: median cost of panels of different size bands, adjusted for inflation using UK GDP deflator (https://www.gov.uk/government/statistics/solar-pv-cost-data)

QUESTIONS

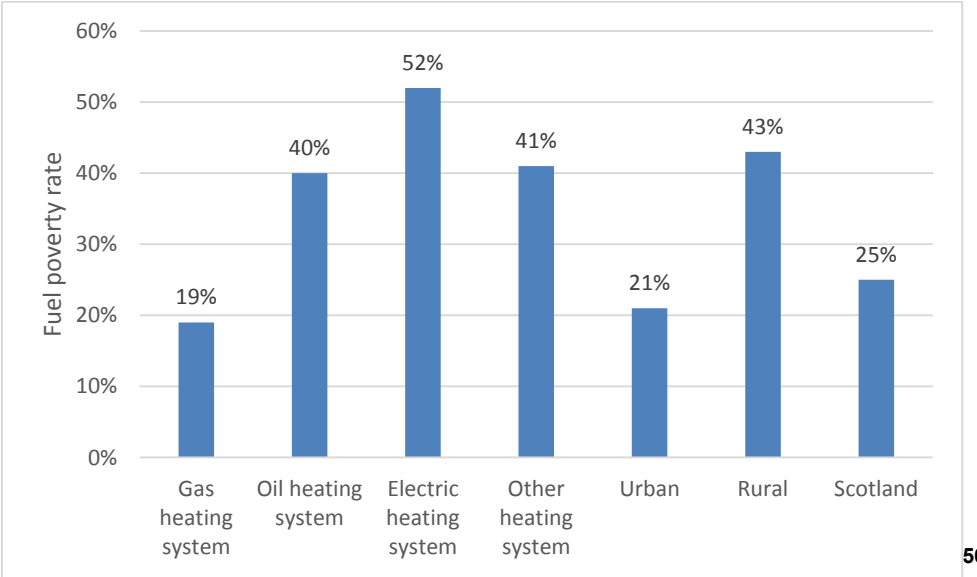
38. What evidence can you provide on the further developments needed for future market readiness and deployment of the low carbon technologies covered above?

39. What evidence can you provide to show potential economies of scale and unit cost reductions that could be achieved through increases in annual levels of deployment of the low carbon heat technologies covered in this call for evidence?

LOW CARBON HEAT AND FUEL POVERTY

Overall, all households that do not use mains gas are more likely to be in fuel poverty. In 2017, 52% of those using electric heating systems and 40% of those using oil were in fuel poverty, compared to 19% of households connected to the gas network. (Figure 4). For properties using electricity for heat the high levels of fuel poverty are connected to the high unit cost of electricity, while for oil users it is likely connected to the nature of the rural housing stock with more detached dwellings with poor energy performance[55].

Figure 4 : Fuel poverty rate by primary heating system



[56]

[55] Citizens Advice Scotland (2018). Off- gas consumers: Updated information on households without mains gas heating, see https://www.cas.org.uk/publications/gas-consumers-updated-information-households-without-mains-gas-heating

[56] Scottish House Condition Survey, 2017. Table 36

There is a risk that replacing high carbon heating systems with low carbon equivalents could increase the fuel poverty rate. The upfront cost of low carbon heating systems are often higher than the existing high carbon alternatives. The running costs of low carbon systems can, however, be comparable to (or lower than) those of high carbon or existing electric systems. It is important to improve the energy efficiency of buildings before or at the same time as installing low carbon heat to help reduce the overall demand for energy to provide a sustainable, long-term reduction in fuel bills.

We are interested in your views on how the off gas heat supply can be decarbonised while also lifting households out of fuel poverty.

QUESTIONS

40. What examples can you provide of instances where installing a modern low carbon heating systems has also lifted households out of fuel poverty?

ENABLING THE UPTAKE OF LOW CARBON HEAT

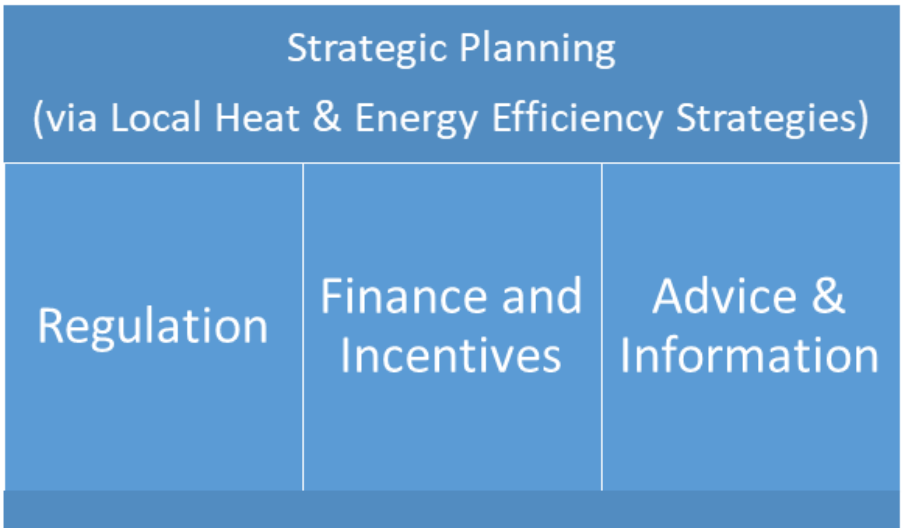
This section explores:

- The way a future Scottish framework can best support the uptake of low carbon heat in buildings not currently using mains gas, in particular the role of:
    - Phasing and leadership
    - Strategy in guiding investment and delivery
    - Finance and incentives in supporting uptake
    - Advice and information in enabling consumers to make informed choices
    - Regulation in giving market certainty
- Ways to support Scotland's supply chain and ensure the local economy benefits from new opportunities

The Scottish Government wants to understand the elements that will be needed to create a future framework to support the uptake of low carbon heat in buildings not currently using mains gas, in particular the role of:

- Phasing and leadership
- Strategy in guiding investment and delivery
- Finance and incentives in supporting uptake
- Advice and information in enabling consumers to make informed choices
- Regulation in giving market certainty

Figure 5: The Scottish Government's approach to strategic planning



Phasing & Leadership Delivery

Historically, transitions of a similar nature and scale have progressed over a period of years with major roles for both industry and government.[57] When industry has played a leading role in driving change, those participants have profited from the opportunity to shape emerging markets, and regulation has been lighter touch. When industry has played a smaller role, it has been legislation that has driven progress.

We are interested to hear how the transition can be driven and what the roles of government and industry should be in driving it. In addition, we are interested in understanding how the transition should be phased. For example, a part of Energy Efficient Scotland involves setting long-term targets for improving the energy efficiency of Scotland's buildings, including a proposed phased approach to regulation, which is preceded and supported by enabling policy action.

QUESTIONS

41. How should we phase in the policy framework in order to better support the decarbonisation of heat supply to off gas buildings? Please reflect on whether or not a similar approach to that proposed for energy efficiency remains the best option.

The role of strategy in guiding investment and delivery

The Scottish Government has already proposed that investment and delivery of heat decarbonisation should be guided by Local Heat & Energy Efficiency Strategies. We have proposed that local authorities undertake a socio-economic assessment to determine future energy efficiency and heat decarbonisation objectives across their areas. The Strategies would enable local authorities to zone areas according to the most appropriate form of low carbon heat technology, and would also enable them to plan delivery programmes. The majority of Scotland's local authorities are now piloting these Strategies, including in off gas buildings, so that the eventual approach to supporting installation of energy efficiency and low carbon heat measures in these areas can be planned and phased properly.

QUESTIONS

42. How could Local Heat & Energy Efficiency Strategies (LHEES) help to prioritise early phasing of uptake of low carbon heat in areas not currently using mains gas?

[57] Such as the transition from manufactured gas to natural gas in the second half of the 20th century.

Funding, Finance and Incentives

We currently run a number of schemes to pilot, test and support the deployment of low carbon heat, including the Low Carbon Transition Programme, District Heating Loan Fund and our Home Energy Scotland and Resource Efficient Scotland loan schemes (Table 4). In addition our national fuel poverty programme, Warmer Homes Scotland, provides funding to fuel poor households including for renewables, including low carbon heat measures.

TABLE 4: CURRENT SUPPORT FOR LOW CARBON HEAT	
District Heating Loan Fund	To help overcome financial and technical barriers to installing district heating projects. Current budget of £7.0 million for this financial year.
Salix	Provide loans for public sector for Energy Efficiency measures.
SME Loans	Issued through Resource Efficient Scotland. The SME Loan budget is £3.0 m and is projected increase to £3.5 million with demand.
Home Energy Scotland Loans	Domestic loans for Energy Efficiency and renewable technologies. The HES Loan Energy budget currently (2018/19) £6 million.
Energy Efficient Scotland Transition Programme and Decarbonisation Fund	Local Authority pilots HEEPS area based schemes – focussed on fuel poverty, LHEES, non-fuel poverty households or new clients. 2 year project.
Community and Renewable Energy Scheme (CARES)	Aims to support and grow community and local energy projects throughout Scotland, as well as aiming for a considerable increase in the number of shared ownership energy installations across the country.
Low Carbon Infrastructure Transition Programme	Grants and repayable grant –Provide a range of support, from expert advice to financial support to assist the development and delivery of private, public and community low-carbon projects across the country.
Resource Efficient Circular Economy	The Resource Efficient Circular Economy SI aims to protect the environment, promoting resource efficiency, environmental innovation and performance management in the public and private sectors.
GB Energy Company Obligation	ECO UK Home initiative. Home energy efficiency advice.
Energy Investment Fund	The Energy Investment Fund (EIF) provides investment and funding for energy projects throughout Scotland, via either loans or equity investments

Resource Efficient Scotland	Combines support to small & medium businesses and the public sector on energy, water and material efficiency with an aim to reduce carbon emissions, prevent waste and realise financial savings for organisations and increase economic competitiveness.
Non Domestic Public Sector Energy Efficiency Framework	Supports Public and Third Sector organisations procure Energy Efficiency retrofit work. The NDEE Support Unit, accelerates the number of projects and the delivery timescales and supports energy demand reduction.
Renewable Heat Incentive (RHI) *Domestic and Non-domestic*	UK Government financial incentive scheme, which promotes the use of renewable heat by paying for the amount of clean, green renewable heat produced.

As set out above, the Renewable Heat Incentive (RHI) supports and drives the majority of investment in low carbon heat at present. We are currently assessing future models for financing support for low carbon heat, post-RHI which is due to end in 2021.

Significant additional investment – from public and private sources – will be needed to achieve our long term vision to decarbonise Scotland's building stock. We are already investing over £0.5 billion through Energy Efficient Scotland over the four years to 2021, and have restated our commitment to continuing to target funding to low income households to improve their homes, with low cost loans made available to self-funding households and SMEs to help them spread the upfront costs of investing.

We are interested in evidence from stakeholders about the best routes to create a positive climate for investment, including the types and operation of funding, finance and incentives that could be introduced to support low carbon heat deployment.

QUESTIONS

43. How should the deployment of low carbon heat be funded? i.e. what relative contribution should come from central public funding, energy consumer's bills and private recipient funding?

44. What is needed to encourage private investment in low carbon heat?

45. Of the current sources of finance which are currently available for low carbon heat, which are working well and which are not? Are there successful examples of attracting private sector finance to support low carbon heat deployment that should be explored?

The role of advice, assessment and information

The Scottish Government currently has a well-established national advice and information programme provided through Home Energy Scotland and Resource Efficient Scotland, who provide households and businesses with independent and impartial advice and information on improving the energy efficiency of their properties and the installation of low carbon heat technologies. Advice is currently offered in a range of different formats, including online and face-to-face advice for homes and businesses.

In addition, building owners are also required to obtain an Energy Performance Certificate (EPC) at the point of sale or rental, which provides information about the energy efficiency of a building, its expected running costs and a list of suggested improvements, including low carbon heat, to make it more energy efficient and to reduce the building's environmental impact.

As part of Energy Efficient Scotland we are considering what additional assessment is required for domestic buildings to support the operation of energy efficiency standards. We have established a Short Life Working Group to consider this and plan to consult on the principles underpinning an additional assessment during 2019.

We are interested to hear from stakeholders how the advice and information building owners and occupiers receive can be strengthened to support the uptake of low carbon heat. This includes evidence on how the current EPC assessment or any new assessment as part of Energy Efficient Scotland could be used to support uptake of low carbon heat supply in off gas buildings.

QUESTIONS

46. How should off gas buildings be assessed for their suitability for low carbon heat technologies?

47. To what extent should the assessment of suitability for low carbon heat relate to the proposed Energy Efficient Scotland assessment?

48. What wider information and advice should be supplied to inform consumers seeking to install low carbon heat supply in buildings that are off gas?

THE ROLE OF REGULATION IN SUPPORTING UPTAKE OF LOW CARBON

Existing Buildings

We want to consider evidence on the role that regulation could play in helping to support uptake of low carbon heat in *existing* buildings (domestic and non-domestic). Any regulation that was developed would need to be within devolved competence and could not cover matters reserved to the UK Government. We would be interested in evidence on the form that regulation could take, and on the extent to which regulation could operate in isolation, or alongside additional policy measures.

This latter approach is what we have proposed for introducing new energy performance standards for existing buildings in the Energy Efficient Scotland Routemap – (e.g. that all domestic buildings should reach an EPC 'C' standard by 2040). The Routemap makes it clear that regulation for these standards will be supported by a universal end-to-end offer made by either a local authority or the Scottish Government, which will include advice, finance, and delivery programmes, ensuring consistent, quality level of service to customers. The same comprehensive approach to supporting regulatory standards applies for the non-domestic sector.

In seeking further evidence on the role that regulation could play in supporting uptake of low carbon heat in new and existing buildings, we are not changing our commitment to introducing regulation for energy performance standards that have already been announced. Rather, any evidence for regulation of low carbon heat would be considered alongside, *and in addition to* already-proposed Energy Efficient Scotland energy performance standards.

QUESTIONS

49. What evidence can you provide on the role that regulation could play in helping to support uptake of low carbon heat in *existing* buildings (domestic and non-domestic)? What form should this regulation take?

50. To what extent could any regulation to support uptake of low carbon heat in existing buildings link to the already-proposed Energy Efficient Scotland energy performance standards? How could a link be made?

New Buildings

Continued action on new build is important to maintain a credible pathway to achieving our climate change targets, which will require all buildings to be near zero carbon by 2050. This includes the setting of challenging energy standards to further reduce emissions associated with new buildings and action that can reduce the need to retrofit new buildings over forthcoming decades.

The Committee on Climate Change (CCC) report, "Next Steps for UK heat policy" sets out that action now on new build is sensible regardless of the longer-term heat decarbonisation pathway. The CCC suggests that "Buildings constructed now should not require retrofit in 15 years' time. Rather, they should be highly energy efficient and designed to accommodate low carbon heating from the start".

Through our building regulations, energy standards for new build properties were improved in 2007, 2010 and most recently in 2015 and mean that new buildings today emit 75% less carbon than similar buildings constructed to 1990 standards. A review of Section 6 (Energy) standards of Scottish building regulations commenced in June 2018, with a 'call for evidence'[58]. For 2021, the review is considering the next steps to further enhance the energy performance of buildings and contribute to greenhouse gas emissions reduction

[58] Scottish Building Regulations: Review of Energy Standards: 'Call for Evidence', see https://consult.gov.scot/local-government-and-communities/building-standards-energy/

targets set under the Climate Change (Scotland) Act 2009 and proposed in the new Climate Change Bill.

In 2017, 17,650 new homes were completed in Scotland, and if build rates continued at this rate, approximately a quarter of a million new homes would be built over the next 14 years.

Each year, completion of new buildings only account for a small proportion of the total building stock. However, there are good reasons to start phasing out higher carbon forms of heating in new buildings, as part of a broader overall strategy.

- There are few technical restrictions to the type of heating system that can be provided in a new building (subject to the right solution being selected for the type of building and intended use);

- Installation as part of a new building means that the solution should function as an integral part of the overall design approach for that building; and

- The prescription of low carbon heat solutions for new builds can help to develop the wider market for these technologies in existing buildings.

Installing low carbon heating in new buildings would reduce the need for more costly and disruptive retrofit installation later on. However, there may be situations where it might still make sense to allow new homes to connect to the gas grid or other more carbon intensive solutions. Given that it can be expensive and disruptive to retrofit buildings for low carbon heat, we are keen to explore options for 'future proofing' of new buildings to simplify subsequent adoption of low-carbon heating.

Examples of futureproofing include, larger heat emitters to support circulation of heat at lower temperatures or providing space for hot water storage or battery storage of energy. There may also be actions which support future addition of smart building systems. Futureproofing should be considered relative to the costs and benefits of simply installing a low carbon heating system when built.

QUESTIONS

51. How should the Scottish Government respond to the CCC's advice and the UK Government announcement in the Spring Statement that new buildings constructed now should "accommodate low carbon heating from the start"?

52. Have you encountered any specific examples of barriers to the installation of low carbon heating systems in new buildings?

53. Can you provide evidence on the comparative cost of installing low carbon heat solutions in new buildings rather than high carbon systems?

54. Can you provide evidence on the comparative cost of installing low carbon heat solutions in new buildings compared to retrofitting to install low carbon heat at a later date?

55. Are there particular actions that you would identify for consideration as part of any action to 'future proof' new buildings for low carbon heat retrofit?

Consumer Issues

Although heat is a fully devolved matter, under the current devolution settlement, the Scottish Government cannot regulate to protect domestic heating customers because of the reservation on consumer protection.

We have already seen in our parallel consultations on regulation of heat networks that this is one part of the heat market where there is arguably a case for regulation – something that the Competition & Markets Authority recently endorsed in its recommendations to the Scottish and UK Governments in summer 2018, following its market study[59].

In off gas buildings, only those customers using electrical heat are currently protected by a regulated market (with Ofgem as the electricity regulator, ensuring consumer protection on issues such as pricing, billing, transparency and consumer redress mechanisms). For customers of other forms of heat – such as solid fuels (coal, biomass), heating oil (kerosene) or gas (LPG, LNG, biokerosene, biogas), there is currently no regulation for consumer protection.

As the off gas heating market transitions towards low carbon heat, the Scottish Government wants to hear evidence of what further consumer protection provisions may be needed to ensure that households and businesses receive fair and transparent prices for low carbon heat, and to ensure accurate billing and appropriate consumer redress mechanisms.

As we have recognised in the case of heat networks, where regulatory powers to protect consumers are held by the UK Government, the Scottish Government wants to work with the UK Government to ensure that new regulation can be introduced to protect Scottish consumers. The evidence from this consultation will inform discussions with the UK Government on the protection of off gas heat consumers, as they transition to low carbon heat.

QUESTIONS

56. In light of the reservation of consumer protection powers, how else could the Scottish Government ensure consumer protection on a robust basis? For example, through commercial agreements.

GROWING AND SCALING THE SUPPLY CHAIN

There are potentially significant economic opportunities for local businesses and the supply chain as we decarbonise the supply of heat in Scotland. The Scottish Government wants to ensure that decarbonising heat is done in a way that supports Scotland's wider socio-economic objectives and helps to develop the Scottish supply chain.

The scale and ambition, even when only focussed in areas not currently using mains gas for heating, is significant and presents both opportunities and challenges for the supply chain to scale up to meet the level of demand. Our existing energy efficiency and low

[59] Competition and Market Authority. Heat Networks market study (2018), see https://www.gov.uk/cma-cases/heat-networks-market-study

carbon heat schemes have shown that there are potential opportunities to realise economies of scale and to develop and engage local supply chains.

It will be important to ensure that delivery agents are trusted and that we continue to learn lessons from past delivery schemes here in Scotland, but also across the wider UK. Work is on-going to develop a quality assurance framework for Energy Efficient Scotland and there is scope to extend this to cover the supply of low carbon heat measures in off gas buildings.

We are interested in understanding how to phase policies to ensure that the Scottish supply chain is able to respond adequately to the increased demand. We are also interested in understanding what gaps currently exists in the Scottish skills base and supply chain and in how best to engage SMEs and develop local supply chains across Scotland.

QUESTIONS

57. What actions should we undertake to ensure the Scottish supply chain has the skills and capacity to capitalise on the future increase in demand for the installation of low carbon heat?

RESPONDING TO THIS CALL FOR EVIDENCE

We are inviting responses to this consultation by 18 June 2019.

Please respond to this consultation using the Scottish Government's consultation platform, Citizen Space. You can view and respond to this consultation online at: https://consult.gov.scot/better-homes-division/the-future-of-low-carbon-heat/

You can save and return to your responses while the consultation is still open. Please ensure that consultation responses are submitted before the closing date of 18 June 2019.

If you are unable to respond online, please complete the Respondent Information Form (see 'Handling your Response' below) to:

The Future of Low Carbon Heat in Off Gas Buildings

Scottish Government

3F South

Victoria Quay

Edinburgh EH6 6QQ

It would be helpful to have your response by email or using the electronic response form. The electronic response form can be accessed at the following website address: https://consult.scotland.gov.uk. You can also email your response to LowCarbonFuture@gov.scot.

Handling your response

If you respond using Citizen Space (http://consult.scotland.gov.uk/), you will be directed to the Respondent Information Form. Please indicate how you wish your response to be handled and, in particular, whether you are happy for your response to published.

If you are unable to respond via Citizen Space, please complete and return the Respondent Information Form included in this document. 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.

To find out how we handle your personal data, please see our privacy policy: https://beta.gov.scot/privacy/

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 at http://consult.scotland.gov.uk.

If you use Citizen Space to respond, you will receive a copy of your response via email.

Following the closing date, all responses will be analysed and considered along with any other available evidence to help us. Responses will be published where we have been given permission to do so.

Comments and complaints

If you have any comments about how this consultation exercise has been conducted, please email them to LowCarbonFuture@gov.scot OR send them to:

The Future of Low Carbon Heat in Off Gas Buildings

Scottish Government

3F South

Victoria Quay

Edinburgh EH6 6QQ

Scottish Government consultation process

Consultation is an essential part of the policy-making process. It gives us the opportunity to consider your opinion and expertise on a proposed area of work.

You can find all our consultations online: http://consult.scotland.gov.uk. Each consultation details the issues under consideration, as well as a way for you to give us your views, either online, by email or by post.

Responses will be analysed and used as part of the decision-making process, along with a range of other available information and evidence. We will publish a report of this analysis for every consultation. Depending on the nature of the consultation exercise the responses received may:

- indicate the need for policy development or review;
- inform the development of a particular policy;
- help decisions to be made between alternative policy proposals; and
- be used to finalise legislation before it is implemented.

While details of particular circumstances described in a response to a consultation exercise may usefully inform the policy process, consultation exercises cannot address individual concerns and comments, which should be directed to the relevant public body.

Next steps

The Scottish Government will review responses to the call for evidence and the issues raised during engagement with stakeholders to inform the phased development and implementation of the Energy Efficient Scotland Programme over the next 15-20 years.

The future of low carbon heat for off gas buildings: a call for evidence

RESPONDENT INFORMATION FORM

Please Note this form **must** be completed and returned with your response.

To find out how we handle your personal data, please see our privacy policy: https://beta.gov.scot/privacy/

Are you responding as an individual or an organisation?

☐ Individual

☐ Organisation

Full name or organisation's name

Phone number

Address

Postcode

Email

The Scottish Government would like your permission to publish your consultation response. Please indicate your publishing preference:

☐ Publish response with name

☐ Publish response only (without name)

☐ Do not publish response

Information for organisations:

The option 'Publish response only (without name)' is available for individual respondents only. If this option is selected, the organisation name will still be published.

If you choose the option 'Do not publish response', your organisation name may still be listed as having responded to the consultation in, for example, the analysis report.

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?

☐ Yes ☐ No

Annex 1

Summary of Questions

1	**What evidence can you provide of low carbon heat technologies being taken up without government support?**
2	**What other barriers may impede the uptake of low carbon heat in buildings not currently using mains gas?**
3	**What could we do to remove these barriers and support the uptake of low carbon heat? Can you give examples of successful low carbon heat implementation?**
4	**How can complementary systems, such as solar PV and heat pump systems be deployed to overcome such barriers?**
5	**What do you consider to be the principal building-specific constraints on low carbon heat?**
6	**What can be done to overcome these constraints?**
7	**What evidence can you provide on the limitations of low carbon heat technologies (e.g. heat pumps) in buildings with poor energy efficiency?**
8	**What low carbon heat solutions are appropriate for hard-to-treat properties where there are limited opportunities to improve energy efficiency of the building fabric?**
9	**Please specify whether your evidence relates to domestic or non-domestic systems.** **Regarding ground source, air source and water source heat pumps, what evidence can you provide on:** **a) the cost of the technology, including installation, maintenance and running costs and alignment with costs related in the RHI data in tables 2 and 3** **b) customer satisfaction with the system** **c) lifecycle and overall efficiency of the technology**
10	**What factors might inhibit uptake of heat pumps?**
11	**What do you propose as solutions to overcome any barriers to uptake?**
12	**What innovations could reduce the operational cost of heat pumps, i.e. higher performing heat pumps, new refrigerants, 'time-of-use' tariffs coupled with thermal storage, 'heat-as-a-service' business models, etc**
13	**Please specify whether your evidence relates to domestic or non-domestic systems.** **Regarding hybrid heat pumps, what evidence can you provide on:** **a) the cost of the technology, including installation, maintenance and running costs** **b) customer satisfaction with the system** **c) lifecycle and overall efficiency of the technology** **d) the ability of hybrid heat pumps to reduce peak demand for electricity whilst also reducing carbon emissions**

14	**What factors might inhibit uptake of hybrid heat pumps?**
15	**What do you propose as solutions to overcome any barriers to uptake?**
16	**Can you share any evidence on the types of buildings where hybrid heat pumps may best be deployed?**
17	**Please specify whether your evidence relates to domestic or non-domestic systems.** **Regarding electric storage heating, what evidence can you provide on:** **a) the cost of the technology, including installation, maintenance and running costs** **b) customer satisfaction with the system** **c) lifecycle and overall efficiency of the technology**
18	**What factors might inhibit uptake of electric storage heating?**
19	**What do you propose as solutions to overcome any barriers to uptake?**
20	**Can you provide any evidence of electric heating technologies not already described that should be considered as potential future heating solution?**
21	**Can you comment on the comparative installation, operating and maintenance costs of these technologies in relation to other electric heating sources? As well as their lifetime and efficiency?**
22	**Can you provide evidence on the performance of integrated systems such as heat pumps used in conjunction with battery storage and solar PV?**
23	**How could locally integrated systems, such as those mentioned above, help to overcome electrical grid constraints and what market mechanisms could be used to promote on site generation and use for low carbon heat?**
24	**Please specify whether your evidence relates to domestic or non-domestic systems.** **Regarding Bioenergy technologies, what evidence can you provide on:** **a) the cost of the technology, including installation, maintenance, fuel and other running costs, and the extent to which costs of biomass boilers are in line with those in tables 2 and 3 above** **b) customer satisfaction with the system** **c) lifecycle and overall efficiency of the technology** **d) type of feedstock used, and whether this is grown in Scotland or imported**
25	**What factors might inhibit uptake of bioenergy technology?**
26	**What do you propose as solutions to overcome any barriers to uptake?**
27	**What evidence can you provide to show whether there is a strong potential for growth of the biogas supply?**
28	**Can you provide evidence on the relative cost of using Scottish produced bioenergy feedstocks compared with conventional fossil fuels?**

29	**Can you provide any evidence on the potential to supply bioliquid fuels sustainably at reasonable cost? With reference to specific fuels such as bio-LPG and different types of bio-diesel.**
30	**Please specify whether your evidence relates to domestic or non-domestic systems;** **Regarding heat networks, what evidence can you provide on:** **a) the cost of the technology, including installation, maintenance, fuel and other running costs** **b) customer satisfaction with the system** **c) lifecycle and overall efficiency of the technology**
31	**What factors might inhibit uptake of the installation of heat networks?**
32	**What could be done to further encourage the development of heat networks?**
33	**Where and in which circumstances are heat networks the most appropriate low carbon solution in areas not using mains gas?**
34	**What examples can be provided to show how readily heat networks can be moved to renewables – especially in those buildings with a high peak heat load**
35	**What is your view on the continued extension of gas networks before low carbon alternatives to natural gas (e.g. hydrogen) are proven?**
36	**How should wider decarbonisation demands, including for industrial processes, be factored in when considering gas grid extension?**
37	**What evidence can you provide on the economic and technical viability of the existing gas grid if it was maintained and operated with low gas flows?**
38	**What evidence can you provide on the further developments needed for future market readiness and deployment of the low carbon technologies covered above?**
39	**What evidence can you provide to show potential economies of scale and unit cost reductions that could be achieved through increases in annual levels of deployment of the low carbon heat technologies covered in this call for evidence?**
40	**What evidence can you provide of instances where installing a modern low carbon heating systems has also lifted households out of fuel poverty?**
41	**How should we phase in the policy framework in order to better support the decarbonisation of heat supply to off gas buildings? Please reflect on whether or not a similar approach to that proposed for energy efficiency remains the best option.**
42	**How could Local Heat & Energy Efficiency Strategies (LHEES) help to prioritise early phasing of uptake of low carbon heat in areas not currently using mains gas?**
43	**How should the deployment of low carbon heat be funded? i.e. what relative contribution should come from central public funding, energy consumer's bills and private recipient funding?**

44	**What is needed to encourage private investment in low carbon heat?**
45	**Of the current sources of finance which are currently available for low carbon heat, which are working well and which are not? Are there successful examples of attracting private sector finance to support low carbon heat deployment that should be explored?**
46	**How should off gas buildings be assessed for their suitability for low carbon heat technologies?**
47	**To what extent should the assessment of suitability for low carbon heat relate to the proposed Energy Efficient Scotland assessment?**
48	**What wider information and advice should be supplied to inform consumers seeking to install low carbon heat supply in buildings that are off gas?**
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50	**To what extent could any regulation to support uptake of low carbon heat in existing buildings link to the already-proposed Energy Efficient Scotland energy performance standards? How could a link be made?**
51	**How should the Scottish Government respond to the CCC's advice and the UK Government announcement in the Spring Statement that new buildings constructed now should "accommodate low carbon heating from the start"?**
52	**Have you encountered any specific examples of barriers to the installation of low carbon heating systems in new buildings?**
53	**Can you provide evidence on the comparative cost of installing low carbon heat solutions in new buildings rather than high carbon systems?**
54	**Can you provide evidence on the comparative cost of installing low carbon heat solutions in new buildings compared to retrofitting to install low carbon heat at a later date?**
55	**Are there particular actions that you would identify for consideration as part of any action to 'future proof' new buildings for low carbon heat retrofit?**
56	**In light of the reservation of consumer protection powers, how else could the Scottish Government ensure consumer protection on a robust basis? For example, through commercial agreements.**
57	**What actions should we undertake to ensure the Scottish supply chain has the skills and capacity to capitalise on the future increase in demand for the installation of low carbon heat?**

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