HEAT FRAMEWORK AND OFF-GAS BUILDINGS

BEIS Consultation

CIBSE Response

Submitted 11th June 2018

Note – for clarity, *the consultation questions are in italic black*, and CIBSE response in straight green.

Introduction

The respondent is **The Chartered Institution of Building Services Engineers (CIBSE).**

The Chartered Institution of Building Services Engineers is the professional body that exists to:

> 'support the Science, Art and Practice of building services engineering, by providing our members and the public with first class information'

CIBSE members are the engineers who design, install, operate, maintain and refurbish the energy using systems installed in buildings, including homes, and are specifically trained in the assessment of heat loss from building fabric and the design of energy using systems for the provision of heating and hot water, lighting, ventilation and cooling and small power distribution in homes. Many CIBSE members work in the public sector in general and in higher education in particular.

CIBSE has over 20,000 members, of whom around 75% operate in the UK and many of the remainder in the Gulf, Hong Kong and Australasia. Many are actively involved in the energy management of commercial buildings for larger businesses, and so this consultation is highly relevant to us and to our members.

CIBSE is the sixth largest professional engineering Institution, and along with the Institution of Structural Engineers is the largest dedicated to engineering in the built environment. Our members design, install, manufacture, maintain, manage, operate and replace all the energy using systems in buildings as well as public health systems.

As an Institution CIBSE publishes Guidance and Codes which provide best practice advice and are internationally recognised as authoritative. The CIBSE Knowledge Portal, makes our Guidance available online to all CIBSE members and is the leading systematic engineering resource for the building services sector. Over the last twenty-one months it has been accessed over 200,000 times, and is used regularly by our members to access the latest guidance material for the profession. Currently we have users in over 170 countries, demonstrating the world leading position of UK engineering expertise in this field.

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CONSULTATION RESPONSE

OVERVIEW

We welcome this consultation and are happy to continue to contribute to the work of BEIS on this issue.

We agree that buildings that are not connected to the gas grid can help define a future framework for heat that is low-carbon (as well as effective, low pollution and affordable); they can also help to create the scale needed for consumer awareness to grow and for low carbon supply chains to develop, including developing

manufacturing, design and installer skills and experience, preparing for a future wider scale roll-out[1]. **The principles in our response are largely valid in the context of a national framework, not only for buildings which are off the gas grid. Some key elements of the wider UK heat strategy will necessarily be different**, in particular:

- the opportunities for district energy schemes afforded in dense urban areas
- decarbonisation of the gas grid by injection of biomethane, hydrogen, or other low-carbon gas[1]
- the opportunities for transition technologies, such as hybrid heat pumps.

We have the following key recommendations:

- A: The UK's heat framework is a complex and inter-related system; it needs an overall vision and detailed implementation measures, "working back" from that vision to identify the measures required from today to deliver it; the framework needs **systems thinking** and cannot be defined in isolation**.**
- B: **Energy efficiency** is a key attribute of the energy system and needs to be a major part of the heat strategy; it needs more ambitious targets and a comprehensive national strategy. This would have significant benefits not only in terms of energy and carbon savings, but also in reducing the required grid capacity; it could also play a major part in helping to engage consumers with the co-benefits of low-carbon buildings, including comfort and health.
- C: The UK needs a clear, strong and consistent **regulatory framework**. Past experience from carbon reduction policies and from the heating industry shows that given the scale and timescales of the challenge, solutions cannot be left to the market alone.
- D: There needs to be confidence in the **financial incentives** in place until scale builds in the market, including support beyond 2021; incentives need to be consistent with the regulatory framework.
- E: **Lessons can and should be learnt** from past policies and incentives such as the RHI and Green Deal including, crucially, on **consumer behaviour**.
- F: Government and the public sector should **lead by example**.

Due to their significance and as they cut across several themes examined in the consultation, we expand on these points below, and refer to them more briefly in our responses to individual questions.

A - NEED FOR SYSTEM THINKING

Heat and electricity are increasingly linked; electric vehicles and battery storage in buildings mean that, increasingly, the built environment and transport sectors also will be. In addition, heating and electricity generation affect air quality as well as carbon emissions.

Furthermore, decisions made on current parameters and on an individual building basis may not be the most appropriate ones in the long-term, nor at the neighbourhood, regional, or national level.

Systems thinking is therefore required to capture the significant **synergies, co-benefits and opportunities** (e.g. energy efficiency), as well as potential **unintended consequences and trade-offs**. This can also help identify **economies of scale** (e.g. in thermal and electrical storage), scenarios that would help retain **flexibility for a diverse energy and technology mix** in the future, and likely **long-term effects**. The need for a **'System Architect'** is often advocated to help identify and coordinate the best integration solutions between the electricity, gas and heat infrastructure, nationally as well as for given geographical areas (i.e. at the scale of local networks). For extensive research on energy systems integration and architecture, we would recommend the EPSRC Heat Decarbonisation Challenge ran by the UK Centre for Research in Energy Demand (UKCRED).

In particular, the increased electrification of heating could put significant **pressure onto the grid**, both at the local and the national level, especially as grid capacity is also being earmarked for other essential carbon and air quality measures, including the wider uptake of electric vehicles; please refer for example to our response to the 2017 consultation on Electric Vehicles[2]. While heat pumps may seem like the most appropriate solution on a case-by-case basis, their widespread implementation needs to be planned and managed as there are

[1] Committee on Climate Change, *Next Steps for UK Heat Policy*, October 2016
[2] CIBSE response to BEIS consultation on electric vehicles, November 2017

already some areas of the network that are stressed and where additional demand from heat pumps may cause supply problems, adding to pressure on the grid:

- **National level**: national heating demand is of a peaky nature compared to electricity, and its current peak in the UK is about 300GW i.e. 5 times the current electrical demand peak of 60GW[3]. Even with some of this heating demand being met by other fuels (e.g. biomass), and with good practice heat pumps (say, with a Coefficient of Performance of 3 i.e. producing 3 units of heat for 1 unit of electricity), the impact of heat electrification on the required UK electricity generation capacity would be significant, easily multiplying it by a factor of 2.5-3. We are aware this is a well-known fact but have still included the illustration below to reinforce the point, especially as grid impacts are hardly mentioned in this consultation. We and others have stressed elsewhere the importance of **demand management** and **electricity storage**, and we do not therefore expand on this other than where directly relevant to this consultation.

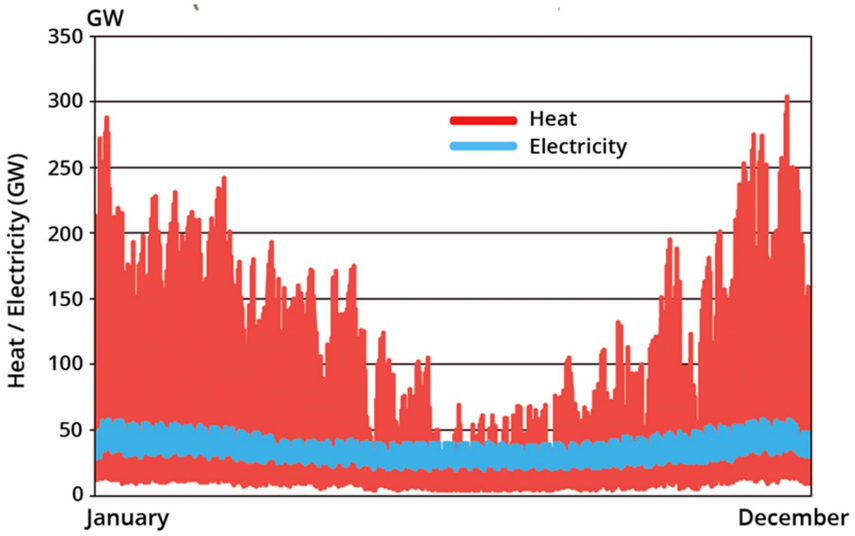

Figure 1: Heat and electricity demand comparison[3]

- **Local and regional level**: the introduction of even a relatively small number of heat pumps can trigger the need for **local network reinforcement**[4]**,** as already recommended by the Committee on Climate Change[5]. This is particularly relevant in rural locations where the majority of off-gas buildings are, and it absolutely needs to be planned; note that grid reinforcement is also required anyway in order to respond to distributed **renewable electricity generation** (especially as these areas are also likely to be suitable for wind and/or solar PV installations) and the increase in **electric vehicles**. See more details in our response to Question 25.

As a result, to reduce demand itself, heat pumps need to be installed in **energy efficient buildings** (see B), serve **low-temperature heating systems**, have **high efficiencies,** and be installed with **smart controls** and **storage** to reduce overall peak demand and costs to consumers. Evidence shows the potential for further improvements, and we expand on this in our detailed responses to this consultation.

Diversity also needs to be maintained so buildings heating demand should be met by other energy sources and systems instead where appropriate, including local heat networks. We provide more detail on this in our responses to individual questions.

[3] Samson R., quoted in MacLean, K., Sansom, R., Watson, T., Gross, R., Managing heat System Decarbonisation, Comparing the impacts and costs of transition in heat infrastructure, 2016
[4] MacLean, K., Sansom, R., Watson, T., Gross, R., Managing heat System Decarbonisation, Comparing the impacts and costs of transition in heat infrastructure, 2016
[5] Committee on Climate Change, *Next Steps for UK Heat Policy*, October 2016

We would also note that heat pumps and other forms of electric heating will only be low-carbon **if electricity is low-carbon;** maintaining the downward trend in electricity grid carbon content has been noted by the CCC as a **gap in the Clean Growth Strategy**[6]: "*plans for decarbonisation of UK power generation (… place) a high reliance on new nuclear build and net imports across interconnectors, both of which have associated risks. More is needed to provide a route to market for low-carbon electricity generation, especially lower-cost options such as onshore wind and solar, and to contract for additional low-carbon generation should the Government's expected contributions from new nuclear plants and overseas generators under-deliver*." The need for interconnection and facilitating investment in onshore wind has also been recommended to ensure low-carbon and competitive industrial electricity prices[7]. It is crucial that this gap is addressed as otherwise the wrong long-term decisions could be made today on heating systems and building design on the basis of unrealised future grid carbon factors.

All of the above also mean that it is increasingly difficult and counter-productive to consider heat decarbonisation (or indeed, many carbon reduction policies) as being under the sole remit of one government department: **collaboration and coordination across departments are paramount, in particular between BEIS, MHCLG and DEFRA, and with the National Infrastructure Commission**. We have pointed out examples throughout this consultation where our recommendations cut across government departments.

B - ENERGY EFFICIENCY & NATIONAL RETROFIT STRATEGY:

Energy efficiency has to be considered as an essential part of the low carbon heating strategy, for individual buildings and nationally, as it can help deliver a number of objectives:

- achieving the overall **carbon reduction targets;**
- reducing the required **grid capacity** (a crucial issue, as noted in A above);
- allowing a wider range of **low carbon systems to operate at high efficiencies**, in particular heat pump systems: first, reducing peak loads helps reduce system size (and associated capital costs), allowing them to operate more efficiently for more of the time; second, heat pumps operate much less efficiently in high-temperature heating systems, which may be required to provide comfortable conditions in poorly insulated buildings, and would therefore be in that case a less effective heating option for comfort and also not cost effective;
- delivering wider **co-benefits** including comfort, health[8], reduced energy bills, and lower air polluting emissions; poor building efficiency is known to be a significant contributor to fuel poverty, and **households not connected to the gas grid are more likely than the average to be in fuel poverty** (1/3rd to 2/3rd more likely, depending on parts of Great Britain)[9], hence the Government's commitment for "*all fuel poor homes to be upgraded to Energy Performance Certificate (EPC) Band C by 2030*"[10].
- crucially, through the delivery of these co-benefits, helping to ensure **consumer buy-in**, something which may be very difficult to achieve on the basis of carbon savings alone.

We understand the government's strategy and CCC scenarios are overall based on a 17% saving on energy required to heat existing buildings by 2030; this may be a safe assumption on the overall savings achievable on the total existing stock by 2030 (as not all buildings will have gone through retrofit by then), but a much more ambitious target can and should be set on individual buildings, especially as the CCC has identified that the **current heat decarbonisation scenarios do not reach the total carbon emission savings required**[1]. This 17% target is also difficult to reconcile with the commitments on improving fuel-poor homes (as quoted above), and with the wider aspirations in the Clean Growth Strategy "*for as many homes as possible to be EPC Band C by 2035*"[10]. Savings on many energy uses such as hot water and lighting will be very difficult to achieve, therefore if these overall targets are to be achieved, **significant savings have to be achieved on heating**. There are many examples of best practice energy management, of the benefits of energy consumption disclosure,

[6] Committee on Climate Change, *An Independent Assessment of the UK's Clean Growth Strategy*, January 2018
[7] UCL research Report for the Aldersgate Group, *UK Industrial Electricity Prices : Competitiveness in a Low Carbon World*, February 2018
[8] see for example the work of Professor Marmot and his team, UCL, on housing and health inequalities
[9] Ofgem, Insights paper on households with electric and other non-gas heating, December 2015
[10] Clean Growth Strategy, 2017 with April 2018 corrections

and of best practice retrofit, for example in the Europe GBC Renowiki database[11], Passivhaus retrofit projects, Energiesprong, and the "hard to treat" heritage sector[12]. We would also point to CIBSE for best practice guidance and to the annual CIBSE Building Performance Awards which recognise achievements in energy and carbon reduction in new and refurbished buildings, and in energy management.

There needs to be a national strategy to address technical, capacity, financial, policy and consumer aspects, in a consistent and coordinated manner. The strategy needs to be **consistent and stable over a number of years** to enable industry and consumer confidence, and it needs to target all the **trigger and opportunity points** when energy efficiency works and low-carbon heating options could be more readily marketed to consumers, with a **whole-building approach** wherever possible to limit overall costs and disruption. These points include:

- changes in lease[13]
- changes in ownership
- extension or refurbishment works that trigger Building Regulations and/or planning applications
- other home improvement works, especially the disruptive ones (e.g. new kitchens or wet rooms).

Except for issues of direct relevance to this consultation, we do not further expand on this as it is not the focus of this consultation; CIBSE have already provided a number of responses to past consultations and we would be very happy to engage with BEIS and other departments, including MHCLG.

C – NEED FOR A REGULATORY FRAMEWORK WHICH IS STRONG, CLEAR, AND CONSISTENT OVER TIME AND ACROSS GOVERNMENT DEPARTMENTS

Leaving it to the market alone is unlikely to result in the required changes within the required timeframe, which is becoming urgent. The policy framework needs to give certainty on the direction of travel, including future regulation, to provide adequate incentives over a realistic timescale to stimulate confidence in the market to invest in skills, capacity, products etc. It needs to recognise that past policy changes have served to undermine confidence in long term policy stability.

The regulatory framework needs to include:

- Clear statements on the end goal and upcoming regulations, with timescales;
- Consistency of policy, with cross-departmental coordination and agreement. This applies in particular to coordination between MHCLG, BEIS, DEFRA, and the National Infrastructure Commission, as well as Treasury;
- As far as possible, delivery of policy measures and regulatory commitments in line with the long-term plan;
- Alignment with financial incentives: see D.

There are many reasons why we believe that regulatory interventions are required, an important one being that many but not all of the changes required will have a direct benefit to deciders (e.g. owners of tenanted buildings) or to **individual consumers (**though they will benefit society as a whole); in addition, consumers may not be fully aware of these benefits and, importantly, it may not be enough to overcome other factors including initial capital costs and hassle. As a consequence and because of the nature of the heating industry, substantial changes take a long time to happen.

A simple parallel can be made and lessons can be learned from the **adoption curve of boilers**, as illustrated below: RHI installations in Great Britain are currently just over 60,000, of which just over 43,000 are in off-gas properties[14]. This means the current domestic RHI installations, 4 years after the opening of the scheme, represent just under 4% of oil-heated domestic properties (there are around 1.1 million oil heated households

[11] http://buildupon.eu/initiatives/
[12] see for example case studies and guidance from the National Trust, Historic Scotland , and the Fit for the Future network
[13] see for example our CIBSE response to the recent consultation on MEES, which could result in missed opportunities for improvements to the worse-performing private rented housing sector
[14] Domestic RHI deployment data as of December 2017, Table 2.7, taken from RHI monthly official statistics, December 2017

in Great Britain), or 1% of total off-gas dwellings (around 4 million in Great Britain[15]). This **very low RHI take-up** shows that more drastic action is required if rapid and effective change is to happen. Some action relates to other aspects, including consumer engagement and finances. However, we believe regulations are also essential: by comparison, condensing boilers also had a 4% adoption rate in 2005, following a very slow progression in their take-up in the previous 4-5 years; they became mandatory in April 2005 for new and replacement installations, which led to a sharp increase in their adoption rate; an initial, albeit slower increase even started in mid-late 2004 in anticipation of the regulatory changes. Even at the improved rate post regulation, due to natural building cycles it took a further 10 years for them to represent 50% of total boiler installations; this highlights the **power of and need for regulations** to drive effective change in the heating landscape, especially in the domestic sector.

This experience also demonstrates the urgency of action if we are to see a substantial reduction in high emission fossil fuel installations off gas grid by 2030.

Figure 2.10: Boiler types, 1996 to 2016

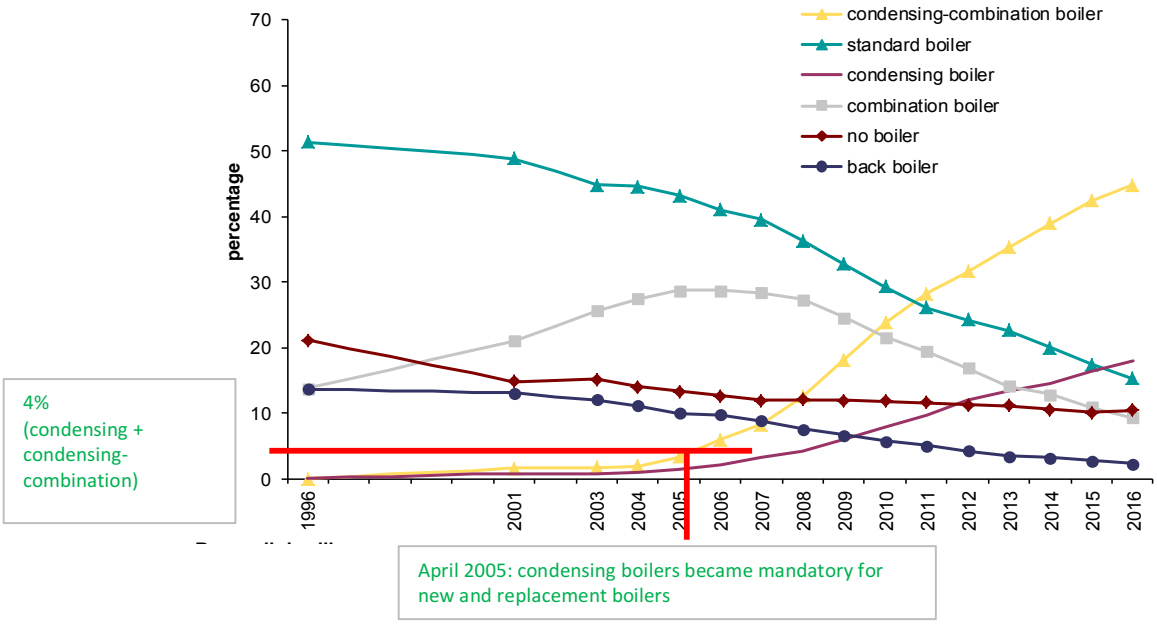

Figure 2: Take-up of condensing boilers, with CIBSE mark-ups to highlight the parallels with current take-up of RHI installations among oil-heated properties (4%)[16]

As a consequence, our **recommendations are for a strong and clear regulatory framework** including the following key measures, which require collaboration with MHCLG.

For new buildings and for works to existing buildings subject to Building Regulations, the requirements under **Part L of Building Regulations** should be increasingly tightened, with the first step in the upcoming revision expected late 2018. CIBSE will be engaging with this revision and we would recommend an **overall review of the requirements and methodology**; we do not include detailed recommendations here except those directly related to this consultation, in particular the need to **better reflect the carbon cost of high fossil fuel installations**; this should help to significantly reduce their numbers and their contribution to overall emissions (for example, they may still be installed in some cases but only used in peak demand scenarios rather than for the base load), as we move towards a potential ban on new installations in a few years (e.g. starting with the most-abled, such as large non-domestic users):

- **Fuel factors** currently provide an allowance for higher carbon emissions for buildings heated by oil and LPG: for example, buildings heated by oil boilers are allowed heating emissions that are 17% higher than

[15] Committee on Climate Change, Heat in UK Buildings Today, Annex 2, 2017
[16] Graph from the Domestic Housing Survey 2017, with CIBSE mark-ups in red

those heated by gas. While we understand the initial desire to accommodate constraints in buildings not connected to the gas grid, this is inconsistent with the intended direction of travel, and the fuel factors allowance should be removed so that all buildings are evaluated on their own merit i.e. their overall carbon emissions performance. Removing this allowance would be a simple change driving projects to evaluate alternatives to oil boilers and to apply further energy efficiency measures so that, if an oil boiler was still installed, its higher emissions would have to be compensated by lower energy consumption.

- **The carbon factor for grid electricity** should be updated to be more reflective of true carbon emissions; it is currently 0.519kgCO_2/kWh i.e. over twice the 2017 average of 0.237 kgCO_2/kWh[17]. This can lead to counter-productive decisions as electrical heating (including with heat pumps) is unfairly penalised. At the same time, the fuel factor for grid electricity should also be removed, as per above point.
- In order to better reflect actual carbon emissions and encourage demand management, the forthcoming update of Part L of the Building Regulations should also review whether the current system of factors adequately balances average and peak conditions (and their timing in relation to actual peak demand, on a daily and seasonal basis), and consider a move to more **dynamic carbon factors and targets** in the medium term**;** future grid decarbonisation scenarios could also be considered, for example following the methodology established by BEIS for work under the Heat Networks Delivery Unit.
- **Tightening of overall requirements** for new and existing buildings, as recommended urgently by the Committee on Climate Change to meet carbon budgets[6], including reviewing the potential for introducing peak load requirements. The review could be based on a whole life cost appraisal, for example as part of the upcoming update to Part L of the Building Regulations and following requirements for optimal cost review under the Energy Performance of Buildings Directive.
- **Better enforcement of and compliance with the requirements of Part L in general, and in particular relating to refurbishment**, so that opportunities for energy efficiency improvements are maximised.
- Moving to reward **actual operational performance**, rather than design intentions and practical completion figures alone.

For a consistent and effective message, the regulatory framework should also address works subject to **planning applications**. The National Planning Policy Framework (NPPF) should allow local authorities to set more ambitious carbon reduction targets, where appropriate, and it should encourage energy efficient refurbishment. We have provided more detail on this in our response to Question 23; see also our recent response to MHCLG's consultation on the revised NPPF[18].

D – FINANCIAL INCENTIVES IN LINE WITH THE REGULATORY FRAMEWORK, SUPPORTING ENERGY EFFICIENCY AND LOW-CARBON HEATING, AND GRADUALLY ENDING SUPPORT TO HIGH-CARBON BUILDINGS

Product and cost improvements to low-carbon heating technologies are already being seen. However, BEIS' own analysis shows that capital costs are still a significant hurdle for customers[19], therefore we believe continued financial support is required until significant cost reductions can be achieved through economies of scale and learning rates.

In particular and in the immediate term, **government should confirm its commitment to the RHI (or some alternative support mechanism) post 2021**: new build or significant refurbishment projects easily take 2-3 years from early design stage and budgeting to completion, when the RHI application can be made, therefore take-up may already be starting to be affected as project teams are uncertain that the RHI (or other support) will be in place by the time they will be able to apply for it. Heating system replacements will have a shorter timeframe, but **a decision should nonetheless be made very soon** to provide confidence to customers and industry so they keep developing skills, capacity and products.

There also needs to be a better overall **alignment between financial incentives and policy objectives**. In line with the UK's G7 commitment and as recommended by the Environmental Audit Committee[20], and as is also likely to be relevant to addressing the latest revisions to the Energy Performance of Buildings Directive, we recommend an **overall review of those current financial support mechanisms** which, directly or not,

[17] http://electricinsights.co.uk/#/reports/report-2017-q4/detail/carbon-emissions-down-12?_k=ewxyjo
[18] CIBSE response to the NPPF consultation, May 2018
[19] BEIS, RHI Evaluation: Synthesis, A report by Frontier Economics, Revised, September 2017
[20] Environmental Audit Committee, Energy subsidies, Ninth Report of Session 2013–14

encourage the continued installation and use of fossil fuel systems. This would help release funds for low-carbon heat and signal consistency and resolve in government. Examples where opportunities may be found include the Winter Fuel Payments, which currently total on average £2bn per year, and more in years with Cold Weather payments[21] or, for example, government could examine the feasibility of measures such as gradually escalating VAT on fossil fuels, in small increments until 2050, until it reaches closer rates to those on other consumables. Note that, also highlighted by the Environmental Audit Committee, this does **not** mean we recommend weakening commitments to end fuel poverty, but instead we recommend more effective targeting of support and a better alignment with other policies including carbon reduction; in particular, opportunities should be sought to apply these funds on energy efficiency improvements; this would also bring benefits in comfort and health, crucial for vulnerable populations such as the fuel poor and the elderly. This has potential benefits to both the health and social care budgets.

Furthermore, **financial support for low-carbon heating should increasingly be linked to tighter requirements for building energy efficiency**: the requirement for a minimum Energy Performance Certificate (EPC) of D to benefit from the Feed-In Tariff should be tightened (B or better) as soon as possible for new buildings, and there should be a timescale for tightening requirements in existing buildings and/or tiered payments in line with the building's efficiency (in line with or faster than the Clean Growth Strategy's overall ambitions and timelines); similar requirements should be introduced on RHI payments, as this would not only help reduce energy consumption and carbon emissions, but also help reduce the size and capital costs of low-carbon heating systems. There does need to be some consideration to avoid the possible perverse impact of this, that those who are willing to take action to install low carbon heating then find that because they occupy an energy inefficient home, access to funding is reduced, when in practice these willing pioneers need more encouragement and support to address the energy efficiency and the carbon emissions of their heating system.

Finally, our members highlight the importance of **supporting demonstrator projects**, particularly if they are available in different regions (so they become local or regional exemplars and people can easily visit them) and with a number of examples in each region to attract attention and easily draw comparisons.

E – LEARNING FROM THE RHI AND THE GREEN DEAL

As highlighted above, the RHI has only led to a relatively small take-up of low-carbon heating. The Green Deal had a very limited impact on improving the efficiency of the existing building stock. There are multiple reasons for this, and lessons need to be learnt for the design of the low carbon heat framework to avoid similar missed opportunities and inefficient use of finances and efforts.

We very much welcome the work commissioned by BEIS (*Synthesis Report*)[19] to analyse the take-up of the RHI, including the focus on **consumer experience** and reasons for installing (or not) low-carbon heating. Similar analysis by the Energy Saving Trust on heat pumps had also been very useful at informing the RHI[22].

This type of analysis should inform regulations, financial incentives, engagement with consumers, training of the supply chain, and possible partners beyond the "standard" supply chain. Works to heating systems and building energy efficiency can be expensive and disruptive, and consumer decisions will not only be governed by simple "rational" long-term economic decisions. This is also why we advocate a whole-house approach which would target the various trigger and opportunity points, as laid out in B above. Where relevant we have referred to lessons from the RHI in our responses to the individual questions, including on **capital costs**, **supply chain training, competence and certification**, and **product performance**. see in particular our response to Question 37 on certification of installers and products, which highlights possible needs for further development of supply chain and product certification.

[21] Department for Work and Pensions, Winter Fuel Payment, Data for winter 2016/17

[22] Energy Saving Trust, Heat Pump Field Trial Reports: Phase 2: Heat is On, 2013 ; Phase 1: Getting Warmer, 2010

There has been considerable research into the consumer acceptance of low energy refurbishment and heating technology through the CALEBRE project[23], led by Loughborough University, and the i-Stute project[24], one of the End Use Energy Demand Centres that is in its final months, led by Warwick University. Both of these programmes have done considerable work on consumer behaviour in relation to low carbon and low energy interventions in homes, and should be used to inform future policy design.

F - LEADING BY EXAMPLE

The public sector should lead by example and publicise lessons learnt, giving profile to the government's commitments and helping to develop the supply chain and support economies of scale, as recommended by the CCC[1]; it represents a significant part of the overall heating demand (a third of non-residential heating needs and almost a fifth of heating energy in non-residential leased buildings[1]). Early action (i.e. well ahead of the late 2020s timeline for other buildings) should be taken in public sector buildings such as schools, hospitals, council housing, care homes etc and also, even if they represent small numbers, in high-profile off-gas government buildings such as those of the MoD, which have a non-negligible consumption of fuels other than gas and electricity[25].

This is also important to the government's wish for the UK to lead in clean growth technologies and to develop export potential in this area. The public sector can help to provide the initial markets that are needed to support innovative products in this field.

Chapter 2: A pathway to regulation?

Government's long term aim is that no one should install a high carbon fossil fuel heating system. However this is an ambitious energy transition which will require industry leadership to deliver. In the future, regulation may be necessary to ensure this happens.

1. Do you agree that the policy framework should focus initially on enabling the market to drive the transition away from high carbon fossil fuels, and in the longer term on helping consumers and industry to comply with regulations?

No. Leaving the market to drive it is unlikely to result in the changes required, within the timeframe required. The policy framework needs to give certainty on the direction of travel, including future regulation, to provide an incentive to the market and enough confidence to invest in the changes required in terms of skills, capacity, products etc. **Please refer to C in our executive summary for more detail on the need for regulations.**

2. How should government best engage with existing and emerging heating markets, consumers and other stakeholders, to ensure regulations are designed in a way that works for everyone?

Engagement must be consistent to give markets, consumers and stakeholders confidence, as detailed in B of our executive summary.

It is essential that the engagement includes the whole of the built environment supply chain, including designers and people in charge of procurement, operation and maintenance.

In particular, **local and regional authorities** have extensive experience of procuring the installation and maintenance of some low-carbon heating systems, and they could be valuable partners for central government; they also need to be engaged early in order to ensure that their procurement frameworks are aligned with policy objectives, so that the public sector can be seen to lead by example.

In terms of regulations, the Ministry of Housing, Communities and Local Government (MHCLG) has recently undertaken some work looking at the way that guidance to support the Building Regulations is presented, in

[23] http://www.lboro.ac.uk/microsites/enterprise/calebre/
[24] http://www.i-stute.org/
[25] Ministry of Defence, *Sustainable MOD, Annual Report 2016/17*, Annex A

response to Dame Judith Hackitt's review of Building Regulations interim report. This makes various recommendations relating to the structure and format of guidance, and this may also inform BEIS considerations on this point.

Engagement must include groups serving the public good interest, including professional institutions (such as CIBSE), sectoral research and technology organisations such as BSRIA and the BRE and organisations representing consumers such as the Heat Trust. It is also important to engage with relevant trade bodies such as the Association for Decentralised Energy (ADE) and the Ground Source Heat Pump Association (GSHPA), and biomass suppliers organisations.

3. How could a firm end date for high carbon fossil fuel installations be delivered through regulations? How much time do manufacturers, suppliers and installers trading in high carbon fossil fuels need to prepare for a firm end to new installations?

The example of condensing boilers shows that it took them about 10 years from being mandatory to reach 50% of the market. A similar period should be assumed as starting point. This is why we recommend that regulations should be introduced as soon as possible for a chance to achieve the government's objectives to end all installations of high-carbon heating systems within the 2020s, which we support. We think that in the first stage regulations should focus on outcomes (i.e. overall carbon emissions and air quality), letting the supply chain best response to each project and to the overall market, before banning particular types of systems in the future if required, once a supply chain for alternatives is well-established. **Please refer to C in our executive summary for more detail on the need for regulations, and recommended actions.**

The technologies that will be deployed during the 2020s are, in very large part, already available on the market, therefore there is no reason why, given certainty, the whole of the supply chain could not respond to the challenge through capacity building, skills training, product development etc.

Chapter 3: Cleaner heating technologies for off gas grid properties

The government wants to continue to develop its evidence base on technologies that can be used as alternatives to oil and coal heating systems, including the barriers to uptake. We seek to understand what further innovation and cost reduction is possible for existing technologies, and whether there are innovative new technologies we should be considering.

Non-domestic buildings

4. What is the potential for non-domestic buildings to transition away from the use of high carbon of fossil fuel heating? Is the use of high carbon forms of fossil fuel driven by process heating requirements, with space and water heating requirements secondary to this? Are different solutions required for different heat uses and are there cleaner alternatives?

We do not have evidence on the prominence of process heating requirements driving the use of high carbon fossil fuel. We expect the main reasons for use of oil are similar as in domestic buildings i.e.:

- Ease of design and installation, real or perceived, compared to the alternatives
- Higher capital costs of the alternatives
- Lack of sufficient incentives, and lack of consistency in the policy framework
- Lack of consumer awareness about the alternatives
- Lack of national, regional or local infrastructure alternatives (e.g. gas pipes, electricity capacity) and the practical logistics of moving a storing fuel with a sufficient energy density – i.e. oil is energy dense and may be moved via road with moderate ease.

The alternatives include a variety of technologies – see response to Question 5. Some, such as heat pumps, will be much more efficient at meeting low temperature space heating than at producing process hot water (or steam) or domestic hot water. The best suited technologies for each project can be determined by the supply chain (including designers).

There is great potential for non-domestic buildings to use alternatives to high-carbon fossil fuel systems; specific characteristics that can support this, compared to the domestic sector, include:

- Their larger size will typically allow a wider range of technically and financially viable options; in particular, they may be more able to accommodate ground source heat pump systems, whose capital costs may be prohibitive in small domestic settings over air source heat pumps but which would typically be able to achieve higher coefficients of performance. Similarly, they would also have more flexibility to accommodate ancillary equipment such as thermal stores, which can greatly increase the efficiency and technical viability of technologies such as heat pumps, biomass boilers, and solar thermal panels.
- Typically, they will have better maintenance resources, on-site or through contract.
- Non-domestic buildings will often have cooling as well as heating needs, which can offer opportunities for efficient systems offering both heating and cooling – see more details for example in our response to Question 29.
- At least in some organisations, there will be the technical and financial ability and/or desire to take decisions based on long-term benefits, whether for financial, environmental or other reasons.

However, many non-domestic buildings will not be owner-occupied but instead rented out, often to multiple tenants. This reinforces our argument that the substantial changes required cannot be left to the market alone, and that incentives and regulations are required as the owners would otherwise have little reason to make significant capital investment and potentially disrupt tenants during the works s– see C and D in our executive summary.

Please refer to Question 26 for considerations specific to the local authorities and the public sector.

A notable example is the National Trust, whose portfolio includes a high proportion of buildings off the gas grid; their 2013 energy strategy commits them to half fossil fuel use by 2020 and to generate 50% of their energy from renewable energy sources[26]; they have already made very significant progress towards this: all their large properties in Wales have transitioned away from oil to other systems, and the remaining 12% of properties in Wales, all small, are also planned to make the transition[27]. The alternative systems are very varied and demonstrate the range of approaches available, particularly in off-site buildings which by their nature tend to be isolated, often with more space available, and with renewable energy generation potential; case studies are publically available with information on lessons learnt, capital costs and cost savings, supply chain issues etc; technologies are installed after energy efficiency improvement works and the responses are site-specific including lake water source heat pumps, ground source heat pumps, biomass boilers, PV, hydro-turbines etc…

Alternatives to oil and coal systems in domestic and non-domestic buildings

5. What do you think are the main technology choices for reducing heating emissions from off gas grid households, businesses and public sector organisations (eg transitional technologies)?

Energy efficiency

We are aware this consultation focuses on heating systems. However, **energy efficiency HAS** to be considered as an essential part of the low carbon heating strategy, for individual buildings and nationally. **Please refer to B on energy efficiency recommendations & C on regulations in our executive summary.**

Low-carbon heating options

We think the main established options, i.e. those that would be readily available during the 2020s, are the following (in no particular order of preference):

- **Community heating**, from a variety of fuel sources; these may allow the capture of waste heat or the use of a variety of alternative fuels, and could also use a variety of technologies, including communal Heat

[26] https://www.nationaltrust.org.uk/features/were-cutting-our-fossil-fuel-use-in-half-by-2020
[27] https://www.nationaltrust.org.uk/features/castle-heralds-a-victory-over-fossil-fuels-in-wales

Pumps, or possibly Combined Heat and Power (subject to carbon savings compared to heat pumps, for example in the case of existing buildings with high temperature heating systems that cannot be replaced, and/or where heat pumps would not be feasible for a reason or another); see more details on communal heating in response to Q16

- **Solar thermal**, best suited for domestic hot water needs and where there is a reliable summer demand
- **Heat pumps**, whether ground, surface water, borehole water or air source.
- **Biomass boilers** subject to good quality systems and fuel and in areas which do not have existing air quality issues; this should be quite site-specific and make use, for example, of opportunities for co-benefits such as encouraging local forestry management. Biomass CHP may be suitable in some cases but only in large schemes with good maintenance facilities, and it is not as mature a technology.
- **Electric heating** from low-carbon electricity, whether it is grid electricity or, much preferably, electricity generated from renewables (wind, hydro, solar), on- or near-site and if required linked to batteries.

New LPG boiler installations should ultimately be discouraged as they retain the reliance on fossil fuel heating.

Other technologies may become available but they are currently at earlier stages of development and/or more expensive; they could therefore be encouraged as possible innovators to build capacity for longer-term solutions, but should not be relied upon for the 2020s objectives, as also recently recommended by the Committee on Climate Change[28] – see also response to Q20 on innovation.

6. What do you think are the main technology choices for achieving near zero emissions from off gas grid heating (technologies which are consistent with our 2050 targets)?

Same as above, but with heat pumps fed by electricity from renewable energy sources; no gas- or LPG-fuelled systems.

For consistency with other UK targets, including the ambitions of the 25 Year Environment Plan[29], waste-to-energy plants as a source of community heating and power should only be expected to make a small contribution in the long-term, as the UK should aim for a significant reduction in the waste produced and a significant increase in re-use, upcycling and recycling of that waste.

As noted in the previous question, other technologies may emerge in the future, however this is much more likely to be the case for the 2030s onwards than for the 2020s timeframe of this consultation. See also response to Question 20 on innovation.

Biomass, bioliquids and biopropane

7. What evidence is there that bioliquids can provide an affordable and sustainable alternative to fossil fuel heating? What are the technical barriers and what might the impacts on domestic and business consumers be? How scalable are sustainable supply chains and is there a maximum amount of bioliquids which can be supplied?

We are aware of concerns about a**ffordability and sustainability of bioliquids**, particularly in the early generations of biofuels; we are not aware of evidence of the contrary, but this is not our specialist area. Alternative fuels would need to be covered by standards to account for whole-system consequences including land use (i.e. displacing other uses such as forestry, biodiverse land, and food production), environmental impact in production (i.e. growing, processing and transport), and air quality. It is likely that these would likely **restrict their scalability**. Lessons should be learnt from the RHI and their sustainability criteria for fuels[54].

Overall, due to the likely costs of bioliquids but also their potential ease of transport and storage, we recommend retaining these options for other uses that have much fewer options for energy sources and systems, in particular for **long-distance transport** (air, marine). There is much the built environment can and should do first in reducing its energy use and using low-carbon energy sources to meet the remaining demand.

[28] CCC, *Overall Assessment of the Clean Growth Strategy*, pp 37-38, January 2018
[29] https://www.gov.uk/government/publications/25-year-environment-plan/25-year-environment-plan-our-targets-at-a-glance

8. What evidence is there that biopropane can provide an affordable and sustainable alternative to fossil fuel heating? What are the technical barriers and what might impacts on domestic and business consumers be? How scalable are sustainable supply chains and is there a maximum amount of biopropane which can be supplied?

We are not aware of easy availability of biopropane in the UK. We note a relatively recent report by the Energy and Utilities Alliance on the potential for biopropane in the off-grid sector[30], which concluded that biopropane would be a suitable option as replacement for properties currently served by LPG boilers. This would therefore only be a limited portion of the market.

In a similar logic as for bioliquids, any biopropane (or indeed other liquid or gas biofuel) is likely better kept for **long-distance transport** uses.

9. Do you have any evidence on the air quality impacts of the use of solid biomass, bioliquids and/or biopropane?

There are many sources of information, but we would in particular recommend that produced by government themselves[31], which was used in the recent consultation on the impact of solid biomass and other solid fuels[32]. The Air Quality Strategy recently published by DEFRA for consultation assesses the impact of different types of biomass and other fuel in more details[33], highlighting significant opportunities to reduce the impact of biomass heating, so BEIS should collaborate with them on this issue.

Hybrids and gas driven heat pumps

10. Are there any oil and heat pump hybrids currently on the market (in the UK or elsewhere), and if so how does the cost compare with conventional systems or with a heat pump? Could they be used with bioliquids? What impacts do they have for domestic and business consumers, for example in terms of ease of use and comfort levels?

Products have been on the UK market since 2011 but they are so far in very limited application; see recent *CIBSE Carbon Bite 37* on this issue, which includes a list of references[34]. The majority of products we are aware of from members are gas- rather than oil-hybrids, but we understand oil boiler & heat pump systems (not necessarily as single hybrid systems) are more common in Germany.

We are not aware of comprehensive studies on relative costs other than the recent one commissioned by BEIS themselves[35]; we would note that the comparison includes systems where heat pumps operate without replacing heating systems to run at low temperatures – as noted elsewhere in this consultation, we would advocate switching to low-temperature systems wherever possible, to improve the efficiency (and therefore energy consumption and running costs) of the heat pumps (and indeed nearly all heating systems).

As a side point in response to the last sub-question, comfort levels should not be impacted by the heat source i.e. for suitably designed and installed systems, there should be no difference in the heat delivered whether the heat pump is electric, oil, or hybrid.

11. We understand there are gas heat pump hybrids on the market that can be used with LPG. How widespread are these (in the UK or elsewhere) and how does the cost compare? Could they be used with biopropane or other biogases? What impacts do they have for consumers, for example in terms of ease of use and comfort levels?

As per response to Question 10.

[30] EUA, Biopropane for the off-grid sector, 2016
[31] National Atmospheric Emissions Inventory for 2015 http://naei.beis.gov.uk/data/
[32] https://cibse.org/getmedia/d361f2b7-2827-4d7f-8077-b6dadf247566/Call-for-evidence.pdf.aspx
[33] DEFRA, Draft Clean Air Strategy, May 2018
[34] Carbon Bite 37 from the CIBSE Energy Performance Group, Roger Hitchin, May 2018
[35] Element Energy Limited, Hybrid Heat Pumps, Final report for BEIS, December 2017

12. What role might hybrids have in the short term to facilitate the longer term transition to clean heating off the gas grid?

There may be some individual cases where their installation would be appropriate, in particular on existing properties that are hard to treat and with high peak heating loads, where as a result a heat pump sized to meet the peak demand alone would be prohibitively large, expensive, and likely to operate inefficiently a lot of the time; however, in large part and as a broad strategy we do not recommend relying on installing hybrid heat pumps in off-gas properties, and certainly not without exploring all opportunities for reducing heating demand first (see **B in our executive summary)**:

- This is another level of complexity, with associated skills requirements in design, installation and maintenance
- It would require flues, losing one of the advantages of heat pumps for some developers and local authorities
- It would require fuel deliveries (e.g. gas canisters), reducing one of the key attraction points of heat pumps for consumers: ease of use
- It would prolong reliance on fossil fuels and would require another technology change to a true low-carbon option in the longer-term.

We note the CCC identified them as potential transition technology[5]; however, they highlighted that this should be subject to trials to assess technical performance and consumer attitudes, and they were specifically referring to properties with an existing gas boiler. In that scenario there may indeed be a place for hybrid heat pumps, with a key advantage at the systems level being to reduce peak demand on the electricity grid; another advantage, for example if they were branded as "smart boilers", could be to help increase market penetration of heat pumps into existing buildings.

Electric heating, including heat pumps

13. To what extent are space requirements an issue during a heat pump installation? How often are heating distribution systems replaced (hot water tanks, radiators and/or pipework)? How often are additional thermal efficiency measures for the building required?

I**nternal space** can be a barrier in homes that have instantaneous water heating rather than hot water storage tanks, as are required by heat pumps (not hybrid systems, which do not need storage); this is more likely to be the case in homes with gas boilers; in the case of off-gas properties, space for a hot water tank may be found at least partially in the space previously taken by the alternative system (e.g. oil boiler, oil tank or coal store). Block or communal heating offers further space saving opportunities.

Suitable external space may also be a barrier i.e. requirements for a large area for horizontal ground source systems, including access for trenching equipment; outer wall for air source heat pumps (including noise and aesthetic considerations); space for boreholes for vertical ground source systems, including access for drilling equipment. We would note however that in the specific context of this consultation, i.e. off-gas properties, external space is much less likely to be an issue than in on-grid urban areas.

Frequency of replacement: CIBSE Guide M[36] provides guidance on expected economic lives, which helps plan for replacement; in practice, timescales are expected to be slightly longer than those, particularly for heating distribution systems, which reinforces **B of our executive summary** on the need for an overall **national retrofit strategy, targeting all the trigger and opportunity points** when works can happen to a building and energy efficiency improvements could be made minimising overall costs and disruption, including changes to the heating system and distribution.

Thermal efficiency measures are not strictly speaking technically required for the installation of heat pumps, however inefficient buildings and high-temperature heating systems will lead to oversized and less efficient systems – see more details also in **B**.

[36] CIBSE Guide M, Appendix to Chapter 12

14. What potential is there for heat pump costs to come down (both kit and installation)? How can industry show leadership in making this happen?

Heat pump costs have come down, albeit slowly. It is believed there is much potential for significant cost reductions with economies of scale through larger numbers of installations. Some of our members have advised that there are early signs that this may happen, in particular as most of the large boiler manufacturers now also offer heat pumps on their portfolio: the involvement of these large players may help increase sales and reduce costs.

We would also highlight the role for **government and the public sector to show leadership**, not only industry – refer to **F in our executive summary**.

15. Are there any drawbacks of smart/more efficient storage heaters, vs other types of electric heating? And, if so, how are these to be overcome? What are the benefits of smart and more efficient storage heater products compared to traditional storage heaters? In which types and tenure of buildings are storage heaters most likely to be useful? Would storage heaters be a likely solution where electric heating is not currently used? How about where electric heating is currently the secondary heating source?

Smart products can offer two significant advantages:

- Demand management, for the DNOs, particularly if the system is fully integrated with the DNO, allowing change with patterns of change of grid supply and demand, as opposed to more simple systems such as timers allowing the system to run in the current 'off-peak hours' i.e. overnight
- Better control and user-friendly experience. Lack of responsiveness and controllability is otherwise a notable drawback of storage heaters for consumers.

Smart storage heaters can be a short-term transition technology, on properties that already have storage heaters, with the advantage of minimum disruption and helping with grid management. However, they are a low efficiency use of electricity compared to heat pumps, since they only convert 1 unit of electricity into 1 unit of heat, compared to heat pumps that can achieve as a minimum 2.5 times this, and typically more (as seasonal performance, and with 2.5 the very minimum required for RHI eligibility, with potential for further improvements – see Question 18).

Rural heat networks

16. Is there scope for more use of rural heat networks and communal heating systems? What are the barriers and how might they be overcome?

Heat networks are best in high heat density areas, such as urban areas. As a rule, energy efficiency savings should be achieved first, after which the load density may be too low to be economically viable in rural or low-density suburban areas; distribution losses are also likely to be higher, relative to the total load delivered, than in denser areas. However, there are instances where small rural communal networks may be used successfully where, although less economic, they can help as part of wider regeneration and community involvement projects. There are a number of examples in Scotland. They may also help reduce carbon emissions in other hard-to-treat heritage properties.

At the block or small communal scale, a single central heat pump might be an option to avoid decentralised individual dwelling heat pumps, with benefits in capital costs, overall space take, and maintenance.

One of the main barriers is **capital costs**; community energy schemes or some form of long-term financial model is likely to be required, rather than a more typical commercial model. Note however that, again, **system thinking** can help as, in some areas, the costs of grid reinforcement to allow distributed renewable energy generation and the uptake of heat pumps (alongside other electrical demand, including electrical vehicles) may justify, instead, investment in local heat networks. See Question 25 for more on grid networks.

In some areas, there may be opportunities for local networks to be fed by waste heat from local electricity generation plants, especially those installed to meet peak demand which otherwise only operate for short periods of time, making their economics difficult[37].

Another essential requirement is for **leadership** to develop a strategy and bring together multiple stakeholders. Ideally this would be linked to local authority policy, allowing gradual build-up, planning support for connecting new properties etc.

17. Are there specific ownership and funding models that may be suitable for heat networks and communal heating systems in off gas grid areas?

We cannot comment in detail but as noted above, community energy models are likely to be one of the appropriate options.

Innovation

18. What evidence is available about further innovations to improve the performance, efficiency and customer proposition of heat pumps? Are there opportunities for innovation in delivery and installation, particularly those innovations that might reduce kit and installation costs or hassle for consumers?

It is crucial to note that beyond heat pumps themselves, there is a need for **systems** improvements and innovations, especially for **grid management, including peak demand management**. Some solutions will be associated to heat pump installations (e.g. controls, thermal storage) but others will be needed in other parts of the systems, from buildings to local and national grids. **See A on systems thinking in our executive summary**.

In terms of reducing overall **installation costs and hassle** for consumers, we would again stress that this is best achieved if works are promoted as part of other trigger or opportunity points, such as change in ownership or lease, refurbishment, or other home improvement works; these can and should also provide the opportunity to carry out energy efficiency works, further reducing the size and therefore costs of the heat pump installation – **see B on energy efficiency in our executive summary**.

In terms of **incremental innovation in efficiency**, there is already evidence indicating scope to tighten the current **requirements for RHI eligibility and Building Regulations compliance** (which are aligned with each other): the median and average Seasonal Performance Factors in domestic RHI heat pump installations are 3.2 and 3 respectively[38], compared to a minimum of 2.5 required for the RHI. This is design data rather than operational, but gives a good indication of improvements. This is supported by evidence of higher measured field performance, for example in Germany and Sweden, especially for new buildings where low-temperature heating can be used but also in existing buildings[39].

There are many areas of potential improvements to the heat pump themselves and to their installations, with key ones identified as follows; note these do not only relate to **technological changes, but also skills, design, installation, and integration**; some of these changes would also **benefit the wider system**, which is crucial as noted above[39]:

- Heat pump sizing to avoid over-sizing e.g. using dynamic thermal modelling.
- Heat pump technology: 3rd generation technology using variable speed compressor drives and electronic expansion devices
- Heat pump integration: increased buffering through the use of phase change materials; better storage may help reduce peak demand, and could also help consumers access cheaper electricity tariffs
- System controls: e.g. using Artificial Intelligence (AI) methods rather than simple thermostats

[37] Peak load plant is predicted to have a utilisation factor of less than 15%, which may favour high-carbon plant such as diesel generators – see for example Aurora report, March 2017

[38] Table 2.12 in RHI Deployment Data, December 2017

[39] Chris Underwood, *Heat pumps and their role in the decarbonising of heat*, CIBSE North-east region technical meeting, January 2018, using UK data compared with data from Gleeson, C.P., & Lowe, R. (2013) *Meta-analysis of European heat pump field trial efficiencies*. Energy and Buildings 66, 637-47.

- Ground array design: simplified but reliable design-sizing tools, including more accessible computational modelling.
- Heat pump systems that can provide simultaneous heating and cooling, which could be useful especially in non-domestic situations
- 5th generation "5DHC ambient loop", which can allow the interchange of heating and cooling across a thermal grid. This has been done abroad (e.g. Sweden; Heerlen, Netherlands) and we are also aware of projects our members are working on in the UK to try and implement this. This 5th Generation approach is expected to play an important role in the future heat network sector

19. What is the role of the heating industry in delivering cost reduction through innovation? What steps is the industry already taking and what more could be done?

Significant reductions can be achieved in overall capital and running costs through **energy efficiency and whole-house approaches**; opportunities are therefore not only with the heating industry but also the wider supply chain, from designers to contractors.

Examples of leadership and innovation should be supported and promoted, including by professional institutions such as CIBSE and by government and public bodies (as policy makers, influencers AND clients themselves).

CIBSE have a leading role in **collaborating with academia and other R&D** initiatives, **promoting examples of best practice and innovation** through its annual Building Performance Awards and events such as Build2Perform and the Technical Symposium, contributing to **continuous professional development** and producing **best practice guidance**, including the following publications; our guidance continually evolves:

- *Guide B*, which provides best practice guidance on heating and cooling services in general
- CP1, *Heat Networks: Code of Practice for the UK,* 2015[40] - in collaboration with the Association for Decentralised Energy (ADE) and supported by BEIS; revision currently underway
- CP2, *Water source heat pump*: *Code of Practice for the UK*, 2016[41] - in association with the Heat Pump Association (HPA) and the Ground Source Heat Pump Association (GSHPA), and supported by DECC.
- TM51, *Ground source heat pumps*, 2013[42]
- AM15 *Biomass Heating*, 2014[43].
- AM12 *Combined Heat and Power in Buildings*, 2016[44]
- HVSH Solar heating design and installation guide, 2016[45]
- KS15 Capturing solar energy, 2010 [46]

A number of examples of steps already being taken by industry to innovate are included in our response to the previous question, some of which leading to cost reduction for example if over-sizing is avoided and if energy efficiency measures are applied first, reducing the size and cost of the low-carbon heating system itself. However, this needs to be supported and, crucially, significant cost reductions will only be achieved through economies of scale; it is also crucial that installers (especially the smaller ones) see a profitable low-risk market in order to justify the expense of obtaining specialist training and accreditation – see our response to Question 21, and **C AND D on regulatory framework and incentives in our executive summary**.

20. What other innovation opportunities and innovative technologies are available for rural homes off gas grid? At what technology readiness level are they and do they require government support to move them towards the market?

[40] CIBSE CP1, with associated information and training courses
[41] https://www.cibse.org/Knowledge/knowledge-items/detail?id=a0q200000090NmPAAU
[42] CIBSE TM51
[43] https://www.cibse.org/Knowledge/knowledge-items/detail?id=a0q20000008I76dAAC
[44] CIBSE AM12, 2013 with 2016 addendum
[45] HVSH https://www.cibse.org/knowledge/knowledge-items/detail?id=a0q20000008I7fjAAC
[46] CIBSE KS 15

As noted in our response to Question 18, innovation opportunities need to be considered as part of the whole system, not only the heating technology or heating installation, and must therefore include:

- **Energy efficiency** innovations, including "deep retrofit" whole-house approaches, for which examples can be found from sources such as Renowiki and the Passivhaus Trust and Energiesprong;
- Whole-system improvements to **grid and demand management**, storage; for example, aggregators who make use of distributed storage, both as heat and in batteries delivering this as a service to network operators whilst charging individuals directly for using their 'stores' should not be underestimated and need to be embedded in future solutions, possibly with incentives such as through energy tariffs or "availability rewards". We would also highlight that, at the moment, the evidence indicates that "smart" meters and appliances may contribute to displacing up to 10% of the peak demand, subject to available incentivising tariffs[47]; while this will undoubtedly be beneficial, it clearly would not make up for additional demand from electric vehicles and the electrification of heating. Furthermore, it seems realistic to assume that most gains from demand management will be realised "behind the meter", without relying on changing consumer behaviour. More research is needed to understand what can be achieved from a "smart grid", both technologically and in terms of what may encourage helpful consumer behaviour.
- **Heat networks:** see for example the Balanced Energy Networks project[48] led by London South Bank University, which combines next generation heating and cooling networks with "smart grid" technology, and was created in response to an Innovate UK call for Integrated Supply Chains for Energy Systems.

Due to the timescale for innovation, it should be assumed that the technologies that will meet the objectives for the 2020s are those that already exist on the market, even if further improvements and small developments may occur: as the Committee on Climate Change noted[49], based on UKERC research[50], "*Across the 14 innovations considered, the average time from invention to commercialisation was 39 years. For energy generation technologies the average time was significantly longer, at 48 years, due to a longer market deployment and commercialisation phase*". The CCC recommendation is then that "*it is sensible to plan to meet the fourth and fifth carbon budgets /i.e. by 2032/, and the 2050 target, through currently-known technologies*", even if flexibility should be retained as evidence emerges in the future of the most effective options.

It is considered there is much potential for increased use of **alternative sources for heat pumps**, such as surface water (river, canals, sea) and ground water (borehole, mine water). See response to previous question for references of CIBSE guidance on this issue.

Possible contenders adding to the mix of solutions include **hydrogen** that could be used to for fuel cells, or boilers, which would rely on deliveries, or injected in the gas grid (though this is not relevant to this consultation). We do not expand on this here as at the moment both fuel cells and the production of hydrogen have high capital costs and still at early stage of market introduction.

21. What can government do to ensure that future policy encourages and supports future innovations and cost reductions in technologies?

- Government should provide **strong, clear and consistent regulatory framework**: **See C in our executive summary.** It is important that policy be **outcome-based** (e.g. carbon emissions, energy bills, carbon emissions) rather than technology-specific, allowing the industry to develop responses that best meet the desired outcomes; this is true in general but also in particular when looking at a timeframe of 2050, as solutions may still emerge.
- Government should provide **incentives that are reliable** (i.e. changes should be announced well in advance as part of a clear direction on travel), and **consistent with the regulatory framework** - **See D in**

[47] House of Commons, Science and Technology Committee, Evidence Check: Smart metering of electricity and gas, Sixth Report of Session 2016–17
[48] http://www.lsbu.ac.uk/research/centres-groups/sites/ben-project
[49] CCC, *Overall Assessment of the Clean Growth Strategy*, pp 37-38, January 2018
[50] UKERC, *Innovation timelines from invention to maturity*, 2015

our executive summary. In particular and in the immediate term, it is crucial that government confirm its commitment to **the RHI (or some alternative support) post 2021**.

- **Support innovation and demonstrator projects**, particularly those requiring capital investment, significant coordination and multiple-stakeholder involvement, such as 5DHC. The sector can be significantly influenced by real demonstrators that are "seen to work"; it is particularly useful if these demonstrators are found in every region, supporting local supply chains and providing easy visits and case studies.
- **Lead by example, particularly to address issues of supply chain capacity, consumer awareness and consumer confidence (e.g.** market penetration of heat pumps in existing dwellings is about an order of magnitude lower than in new dwellings). **– see F in our executive summary.**

Chapter 4: Enabling uptake of clean heating

The government is keen to understand what can be done to support domestic and non-domestic consumers to replace their high carbon fossil fuel heating systems with clean alternatives. We are seeking evidence and views on early stage proposals to encourage uptake, unlock private sector finance and support new market approaches.

Targeting the key barriers

Nearer term regulatory approaches

22. Please provide views and evidence on how different obligation approaches could be used to drive the transition to clean heating during the early 2020s? Are there any areas worth specifically targeting? Are there situations in which obligations would be counter-productive? Do you have any views on other short term regulatory options that could be pursued, besides those considered above?

Please refer to **C in our executive summary** and to our response to Question 1 for recommended approaches.

C also details the urgent need to review the **carbon factors and fuel factors in Building Regulations Part L,** which may currently lead to **counter-productive decisions** on the installation of heating systems – in particular, by attributing to grid electricity more than twice the amount of actual carbon emissions.

As general rules, policy should be **outcome-based** (e.g. carbon emissions reduction) and there should be much more emphasis than currently on **monitoring the implementation** of policy and the **operational performance** of systems and buildings.

It is also important that government supports a robust **framework for the market to address product development** in order to avoid unintended consequences. In particular, the impact of refrigerants used in heat pumps needs careful consideration; most legacy HFCs have Global Warming Potential, and therefore leaks need to be avoided in manufacture, installation, operation and end of life; some are flammable (e.g. R32, propane) making large quantities in bigger heat pumps potentially problematic; some are toxic; and the long term environmental impacts of others via degradation are not yet fully understood (we understand this is one of the challenges facing some of the 'new' HFO refrigerants). This really needs to be considered, including monitoring of product development and installations and the use of product standards, to avoid ending up with similar unintended consequences such as those with CFCs (e.g. R22), and HFCs (e.g. R410, R404) which have had wide market penetration which then required an expensive retrofit or replacement programme.

23. What do you think about the options set out above for an obligation? Do you have any evidence as to potential impacts, burdens or unintended consequences?

Example 1 - Information provision obligation on fossil fuel boiler installers

We agree that information on options needs to be made much more available to consumers to address some of the reasons for low uptake; in particular, this is required to address choices made in emergency replacements, where consumers will tend to choose what they are already familiar with (i.e. probably like-for-like). However, information would need to be provided through other means too and other parts of the whole supply chain too to capture the trigger and opportunity points (see **C in our executive summary**), e.g. energy suppliers (for example on energy bills), home works supply chain, estate agents etc.

Information should cover **energy efficiency**, to maximise energy and cost saving opportunities before installing low-carbon systems; it should also include the **co-benefit**s of the systems, rather than simply focus on carbon savings e.g. air quality, maintenance. It should also include the **direction of travel**, so that consumers are aware that alternative systems are future-proofing their property against upcoming regulations.

We agree that this would require **training among installers and the rest of the supply chain**; we also think that government should continue to provide support, such as through the Microgeneration Certification Scheme for installers. We do not have a strong view on whether additional support from government to develop skills would be required: this may be beneficial, but we also think that much could be achieved though consistent government messages on the direction of travel, giving confidence to the supply chain to invest in training; in many cases in the past, the supply chain did invest in training only to find it was not a valuable investment due to low consumer demand.

In any case, while information provision is necessary for consumer acceptance, **we do not think this would be sufficient, by a large margin**: information provision does not guarantee that people would select alternative systems; in particular, it would not in the short term address the key hurdle of capital costs of alternative systems (it may in the future, as the market grows and economies of scale start being achieved).

Example 2 - Funding energy efficiency of homes

We agree in principle, but think the proposals laid out in the consultation fall significantly short of what is required. There needs to be a national low-energy and low-carbon retrofit plan, not only a funding obligation such as ECO targeting fuel-poor homes – **see B on energy efficiency and D on financial incentives in our executive summary**.

Example 3 – Role of Distribution Network Operators and Gas Distribution Networks

We agree there may be a role for DNOs and GDNs in the delivery of clean heating, for example by liaising with large energy users and by identifying areas where load profiles, densities and numbers of users may represent opportunities for communal systems, or where localised low-carbon gas networks could be introduced due to particular local circumstances, for example local hydrogen networks in industrialised areas; however, we think their main role is in planning and managing the transition to a low-carbon grid, including planning for overall capacity and distributed generation, and supporting the potential role of a "systems architect" – see more details in our response to Question 25.

Example 4 - Obligation on manufacturers or suppliers of oil systems

We are not convinced about this option, in particular because of its administrative costs to implement and police. We think that if government put in place a clear and consistent regulatory framework and associated timeline (**see C in our executive summary**), then manufacturers, suppliers, and the rest of the supply chain would adapt to respond to this framework, developing products and skills and offering them to customers – see also comments on Example 1.

Example 5 – Obligation on suppliers of oil

As per Example 4, we are not convinced about this option. We think that an obligation to provide information would be beneficial, in a similar way as in Example 1, but that ultimately government should set clearly the desired policy outcomes (i.e. no new fossil fuel installations), with associated regulatory framework and timeline, giving confidence to the supply chain to adapt and develop new offers.

24. What further options for short term regulation exist that we have not considered in this call for evidence? Do you have any evidence as to the associated impacts or burdens of any further options suggested?

See C in our executive summary for details on our recommended approach.

It is also crucial NOT to further increase and prolong reliance on high-carbon heating systems, and therefore government should act now to **prevent installations in new buildings** – see also responses to Chapter 5.

25. How can DNOs or GDNs take a leading role in deploying clean heating?

DNOs and GDNs have a crucial role in supporting the transition to a low-carbon grid:

- Ensuring **grid capacity and reliability**, including planning for and coordinating the increased demand and connections of heat pumps but also electric vehicles and distributed electricity generation, which are expected to require **grid reinforcement** – we refer in particular to an assessment of this issue by Imperial College[4]. This could, for example, involve increasingly promoting and requiring that smart management solutions (e.g. controls, storage) should be part of low-carbon heating installations, and driving the standards for these.
- Supporting the take-up and connections of distributed low-carbon generation, through technical standards, communications and timely responses to applications.
- In addition, they may help by liaising with large energy users and identifying areas where load profiles, densities and numbers of users may represent opportunities for communal systems.

Each DNO has "heat maps" highlighting areas where the local electricity network would need reinforcement to be able to embed more distributed generation and/or to distribute more power[51]; in many rural areas most of the DNOs have both limited ability to add distributed generation (e.g. CHP, PV) AND many sub-stations are also demand limited – i.e. need upgrading for new electrical loads (transportation, heat pumps). This is why it is often advocated that a 'System Architect' is needed reviewing the best integration solutions between the electricity, gas and heat infrastructure fields for a given area.

Financing clean heating

26. How can we encourage and unlock private sector finance in the absence of a subsidy?

We recommend the recent major report of the Green Finance Task Force[52] which highlights the need to create a 'pipeline' of deliverable projects for both domestic and non-domestic sectors in the shortest possible time. It is clear that capital cost is a key hurdle for the take-up of low-carbon heating options, as highlighted by BEIS analysis[19]. We cannot advise in detail on financial options, however financial models and cost reductions will typically occur if there is:

- policy certainty, to build investors confidence and allow new models to emerge: see **C in our executive summary**.
- Sufficient volume to create worthwhile opportunities: this will itself result from policy certain, as per see **C in our executive summary**.

We have also commented on the two above points throughout the other questions of this consultation.

Government also needs to strongly encourage the public sector to make sure of existing initiatives such as the Salix finance for energy efficiency and low-carbon energy.

27. If there was some targeted subsidy, such as for low income or vulnerable households or for building local supply chains, what would this need to look like? Do you have any evidence that subsidy is necessary?

[51] see for example that of UKPN, the DG Mapping Tool
[52] https://www.gov.uk/government/publications/accelerating-green-finance-green-finance-taskforce-report

Analysis by BEIS themselves[Error! Bookmark not defined.] highlights capital costs as one of the main hurdles to the take-up of low-carbon heating. Therefore, until volume brings capital costs down or unless regulations are in place mandating it, it is very likely that some form of financial incentive will be required for general customers, and even more so for low income or vulnerable households.

We would like to point out however that financial support and subsidies need not be entirely additional – as pointed out previously and in **D of our executive summary** and as recommended previously by the Environmental Audit Committee[20], we would recommend an overall review of current subsidies which, directly or not, encourage fossil fuel installations: while support will continue to be required for fuel-poor households, this could be restructured so that **subsidies are aligned with overall policy goals**, i.e. they should encourage low-carbon heating options and, crucially, **energy efficiency improvements**: the latter would bring significant co-benefits particularly for low income and vulnerable population (e.g. the elderly) in terms of energy bills but also **comfort and health**. Government could also, for example, examine the feasibility of gradually escalating VAT on fossil fuels, in small increments until 2050, until it reaches closer rates to those on other consumables

We would also highlight the BEIS analysis[19] which found that, in addition to capital costs, a hurdle to low-carbon heating installations in social housing is the use of **SAP ratings** to inform decisions on heating solutions, as indicator of fuel poverty reduction potential; this should be addressed through a review of the SAP methodology (as is expected and long-overdue), a better alignment of incentives with low-carbon outcomes, and information dissemination among social landlords.

We also have feedback from members that the **Heat Networks Investment Project** is administratively cumbersome and has set very high bars, and that as a result it seems likely the £320m will not all get spent. Members have suggested reviewing the procedures and reallocating parts of the budget to a fund which could be accessed more quickly by small district heating schemes. This is another example to highlight that financial may not be wholly additional, but also better allocated.

New market approaches

28. Novel business models for selling clean heating have not taken off in the UK market, why is this? What is needed to stimulate the development of this market in the UK?

The heating industry is quite traditional, and it typically will need confidence, and evidence of demonstrator projects that work. See also our point on supporting local or regional demonstrator projects in Question 21.

As per responses throughout this consultation, including Question 26: a key aspect of allowing finance and business models to emerge is to give confidence through stable, clear and consistent policy, including a **regulatory framework** and associated timeline – see **C in our executive summary.**

Leading by example should also be considered, including central government buildings, other public buildings, and council housing – **see F in our executive summary**.

There also needs to be a concerted effort to address consumers awareness and perceptions, with actions throughout the supply chain targeting the trigger and opportunity points for low-carbon retrofit and low-carbon heating installations – see **B and C in our executive summary**.

As mentioned in our response to Questions 16 and 17, **community energy schemes** should be encouraged, for example to encourage investment in rural networks.

29. What could be done, apart from subsidies, to encourage new approaches? Are there any approaches that have worked particularly well in other countries and that could be replicated in the UK?

See response to Question 28.

As a general comment, we would encourage a move in policy towards more monitoring and verification of **operational performance**. This would drive better performance in practice but may also help the development of **performance contracts including energy and carbon clauses**, which could ensure operational performance

as well as, potentially, release capital funds; they exist to a small extent in the UK but are much more developed in continental Europe as performance contracting, or in Australia (under the NABERS scheme).

In addition, there may be opportunities in encouraging approaches that address **both heating and the growing cooling demand**, for example in communal schemes with heat pumps that can operate in both modes. This may be encouraged through demonstrator projects and, possibly, future iterations of the RHI (or other form of financial support mechanism) - In particular, not penalising heating systems which make use of co-incident cooling (i.e. produce useful heat and coolth, the sink and source being both useful outputs) as this is one way high system COPs (i.e. 5-8+) may be achieved.

For **energy efficient retrofit**, which we insist is a key part of delivering low-carbon heating at an individual and national level, a database of interventions in Europe is available at the Europe Green Building Council Renowiki[11], classified against policy, capacity building, technical, and financial.

30. What could be done to support a whole-house approach of combining interventions and technologies?

See **B of our executive summary**, and responses throughout this consultation, including question 29. Training of the **wider** supply chain interacting with consumers will be essential, so that whole-house approaches can be promoted at various opportunity points such as changes in lease or home ownership, refurbishment, and other home works.

Local approaches

31. How can government best tap into and support community and local authority efforts? Are there any successful examples that can be build upon?

We would refer to the work of the Greater London Authority and of individual Boroughs such as Tower Hamlets, Camden, Islington and Westminster. They have over the years shown consistency in encouraging low-carbon heating options as part of an overall carbon reduction strategy, including through the planning system. Where possible they have also encouraged collaboration between stakeholders, for example to encourage community energy.

There also a number of innovative local or regional authority efforts in joining up health and energy improvement efforts, for example using trained individuals in the health service to identify that the home environment may be contributing to health conditions, and using this as opportunity to trigger both home improvement works (e.g. accessibility works for elderly patients) and energy efficiency works.

See also our point on supporting local or regional demonstrator projects in Question 21.

32. What could be done to drive action from local planning? What are the pros and cons of approaches that rely on local planning? What evidence is there that such approaches produce desired outcomes?

There is ample evidence that local policy can drive additional carbon reduction strategies, as is the case in London. There should however be more monitoring of actual delivered carbon savings; implementation of policy is not sufficient as a general rule (not only related to carbon savings), in part due to local authority resources.

As suggested by MHCLG in the recent consultation on the National Planning Policy Framework (NPPF) and detailed in our response to it[18], the NPPF (§149b) should be amended to reflect the ambitions of the Clean Growth Strategy. While ultimately, achieving substantial carbon reductions in new and existing buildings will require regulations, in the meantime there are local authorities that can and wish to apply more ambitious carbon reduction savings, sooner. This should be encouraged in view of benefits for carbon emissions, empowering local authorities, and using early adopters to drive technical and financial improvements that the rest of the market can then also adopt and benefit from.

The potential drawbacks usually put forward against relying on local planning are linked to the risk of multiple and inconsistent standards between local authorities; this can be avoided with a framed approach to give a common overarching goal and methodology across the country, with local authorities able to reflect their

individual circumstances and request further improvements than minimum national standards. This is for example the case in Greater London, Cambridge, Brighton, or Exeter, where the nature of the market allows more ambitious carbon targets without affecting viability.

Furthermore, and while we acknowledge this is under a different government department, we insist on the need for cross-department consistency and we therefore strongly recommend retaining in the NPPF the current wording on the **Climate Change Act**, i.e. that local authority policies should be "in line with objectives and provisions of the 2008 Climate Change Act", **not** the current proposed revised wording that they should be set "within the context of" the Act – this is far too loose a wording and indeed almost anything could be presented as being "in the context" of the Climate Change Act, even if contradictory to it.

33. Do local approaches provide a possible model for delivering a firm end to fossil fuel installations through regulation? For example, by establishing oil free zones starting where it is most deliverable, and joining them up over time.

Possibly, although this would rely on local authority resources, which have been under constant and significant strain for several years, compounded by additional responsibilities such as those of health under the Health and Social Care Act 2012, and likely to be exacerbated by new government ambitions such as air quality and housing delivery (although we generally welcome these ambitions).

Specifically on the suggestion of "oil-free zones", we think this would be better done as part of overall objective-based policies, for example low- or zero-carbon zones, or clean air zones.

Building the consensus around clean heating

34. How can we increase consumer awareness and interest in clean heating technologies?

While demand will on occasion be triggered by other concerns (e.g. breakdowns, environmental concerns or running costs), overall consumers need to be engaged at the main trigger and opportunity points of changes in ownership, changes in lease, refurbishments, and other house works; this will maximise opportunities for whole-house approaches and help reduce overall capital costs and hassle – see **B and C in our executive summary** for recommendations.

In addition to providing information, it is crucial for consumer engagement that low-carbon heating be seen as part of an appealing story, highlighting co-benefits such as reduced maintenance or deliveries, or improved comfort. See also E in our executive summary on the importance of understanding consumer triggers and behaviours, learning from the RHI, Green Deal, and other previous schemes, as well as research projects on consumer acceptance of low energy refurbishment and heating technology such as CALEBRE[23], and i-Stute[24].

35. What are the best methods of engaging directly affected consumers?

As per response to question 34.

36. How can we best work with heating engineers to benefit from their knowledge and experience, and their access to customers?

There are various trade groups, as well as CIBSE and CIPHE representing professionals in the field. The wider domestic installer base may be reached through the competent persons schemes, and CIBSE has a Domestic Building Services Panel with some very experienced practitioners in the field.

Sector skills

37. What steps are needed to ensure installers, manufacturers and the entire supply chain have access to new skills frameworks?

Skills should be throughout the supply chain, not just installers and manufacturers.

As highlighted above, including in our response to Question 23, we agree on the need for **training among installers and the rest of the supply chain**; we also think that government should continue to provide support,

such as through the Microgeneration Certification Scheme for installers. We do not have a strong view on whether additional support from government to develop skills would be required: this may be beneficial, but we also think that much could be achieved though consistent government messages on the direction of travel, giving confidence to the supply chain to invest in training; in many cases in the past, the supply chain did invest in training only to find it was not a valuable investment due to low consumer demand.

The BEIS analysis of the RHI[Error! Bookmark not defined.] pointed out that installers are generally not confident of skills across the industry, but confident in their own skills; it would be useful to understand whether, among RHI installations, there are still repeated failings that would point to a need for changes to the MCS-installer accreditation or other competence schemes.

The CHPAQ, RHI and FIT schemes have been very useful at establishing a framework for product performance, skills among installers, and consistent metering; however, we have carried out an initial review of existing schemes, summarised in the table below, which indicates important still gaps in certification of products and installers, notably for installations that are not "small" i.e. over 45kWth or 50kWe. We recommend a review should be carried out of the performance of "not-small" RHI and FIT installations, similar to that which led to the establishment of the MCS scheme, in order to assess whether additional installer training, installer certification, and product accreditation schemes would be required and if so, whether they already exist or need to be developed.

Systems		**Supply chain guidance or code of practice** (selected references only)	**Installation**			
			Installers		**Products** (other than relevant CEN)	
			Small installations	**Medium and large installations**	**Small**	**Medium and large**
Heat pump	Ground source	CIBSE TM51[42], 2013	<45kWth: MCS	-	<45kWth: MCS	-
	Air source	-	<45kWth: MCS	-	<45kWth: MCS	-
	Water source	CIBSE CP2[41], 2016	<45kWth: MCS	-	<45kWth: MCS	-
Biomass boilers		CIBSE AM15[43], 2014	<45kWth: MCS	-	<45kWth: MCS	-
					All plant: air quality requirements + Biomass Suppliers List	
Solar thermal		HVSH, 2016[45]	<45kWth: MCS	-	<45kWth: MCS CEN Solar Keymark	CEN Solar Keymark
PV (included here as low-carbon source of electric heating)		CIBSE KS15, 2010 MCS & ECA Guide to the installation of photovoltaic systems, 2012	<50kW: MCS		<50kW: MCS	
CHP		CIBSE AM12, 2016[44]	CHP Quality Assurance Programme (CHPQA)[53]			
District energy		CIBSE CP1, 2015[40]	-		Depending on system, as above	
Alternative fuels		n/a			For fuel in biomass boiler only - Sustainable Fuel Register[54]	

[53] https://www.gov.uk/guidance/combined-heat-power-quality-assurance-programme
[54] https://www.sfregister.org/

38. What should the respective roles be for the fossil fuel market and the low carbon heating market in ensuring installers have the skills they need for the future?

No comment

Other Options

39. What other options should we be considering to target key barriers to taking up clean heating?

See our **B-C-D-E-F in our executive summary**. Key recommendations are to give more emphasis on energy efficiency and on whole systems thinking, and to engage consumers with co-benefits, including comfort and health.

As highlighted in E in our executive summary, lessons should be learnt from past schemes on **consumer behaviour and acceptance** of low-carbon heating systems. There has been considerable research into the consumer acceptance of low energy refurbishment and heating technology through the CALEBRE project[23], led by Loughborough University, and the i-Stute project[24], one of the End Use Energy Demand Centres that is in its final months, led by Warwick University. Both of these programmes have done considerable work on consumer behaviour in relation to low carbon and low energy interventions in homes, and should be used to inform future policy design.

40. What intervention would make the biggest difference ahead of any regulation?

We would recommend making existing Building Regulations **more effective**:

- Updating the electricity carbon factor used in Part L, so it is representative of the electricity grid's actual carbon factor, instead of the current value which is over twice the actual factor; see details and more suggestions in B of our executive summary);
- Better monitoring and implementation of Part L through Building Control, including L2B and L1B to maximise opportunities for energy efficiency and low carbon heating improvements triggered by other works. This should include better enforcement of commissioning and handover requirements; for more fundamental changes, including moving to operational performance, see response to previous questions, and our executive summary.
- We would also refer to the recommendations of the recent report by Dame Judith Hackitt, including structuring of the Building Regulations and new Gateway process.

Chapter 5: New build

There are a range of opportunities for the decarbonisation of new build. This chapter seeks evidence on options to prevent all installation of high carbon heating fuels in off gas grid new build. It also explores options for encouraging the uptake of clean heating systems, including through futureproofing. This would help to avoid the high costs and hassle of retrofit in the future.

Phasing out high carbon fossil fuels in new build

Futureproofing new build homes

41. Why is oil being installed in some new buildings currently? Are there particular factors or characteristics that are leading to oil being chosen over lower carbon alternatives? What are the barriers to installing a clean heating technology in these buildings?

We do not have particular evidence other than that already available and mentioned by BEIS themselves, including the fact that oil boilers are a well-established product and supply chain, the capital costs of alternatives, lack of consumer awareness etc[Error! Bookmark not defined.]. We would also point to the fact, as detailed in C of our executive summary, that Building Regulations Approved Document L does NOT account for the

whole carbon burden of oil boilers compared to gas boilers, which reduces the incentive for investigating alternatives.

42. Do you have any evidence of the cost of retrofitting clean heating in current new build, compared to the cost of building to that standard now?

No; we would point out however that the costs of retrofitting are likely to be significantly higher than in new build, not only for the heating source itself but also if the distribution and heating systems need to be redesigned.

43. What are the relative costs and benefits of installing clean heating systems in new build compared to installing futureproofing measures?

Given the scale of the challenge and the timescale, we do not think that future-proofing measures should be considered in new building. This would set back low-carbon heating options by another cycle, i.e. 10-20 years. **New buildings need to be installed with clean systems now, as per available best practice**; this will save resources and efforts for the huge majority of the remaining stock; it will also allow capacity building on new, easier, installations, so that harder-to-treat properties can ultimately benefit from costs reductions and improved performance.

In any case however, new buildings should be installed with low temperature heating systems (<55C flow) as this will facilitate the efficient integration of heating systems, whether renewable or not.

44. What would be the most cost-effective and affordable measures to decarbonise new buildings? Please make reference to specific forms of clean heating or futureproofing measures.

An obvious way to drive decarbonisation of new buildings is through **Building Regulations**; BEIS should therefore collaborate with MHCLG on this, and in particular on the **upcoming review of Part L.** Key measures which we think should be considered include the following:

- Energy and carbon savings from **passive design and energy efficiency** need to be maximised first, to a level of Passivhaus or equivalent (possibly geographically dependent and taking account of optimum whole life costs).
- Building regulations and planning requirements need to move towards **monitored operational performance**, rather than being based on design and practical completion information. As a first step before regulatory and contractual operational requirements, **disclosure of operational performance** should be required; this would in itself drive improvements, and pave the way towards stricter approaches.
- Building regulations should include requirements for reductions in **peak load** (kW/m^2) as well as annual energy consumption and carbon emissions.
- New heating systems must be designed to operate at low flow temperatures, to maximise the efficiency of heat pump (and other conventional) heating systems (if they are installed now) or increase flexibility for alternative sources in the future.

END

Response collated and submitted by:

Dr Julie Godefroy

CIBSE, Head of Sustainability Development

JGodefroy@cibse.org

Please do not hesitate to contact us for more information on these responses.