THE FUTURE OF LOW CARBON HEAT FOR OFF-GAS BUILDINGS: A CALL FOR EVIDENCE

RESPONSE FROM COMMON WEAL, GLASGOW CALEDONIAN UNIVERSITY, AND THE ENERGY POVERTY RESEARCH INITIATIVE, JUNE 2019

RESPONSES TO QUESTIONS

As an overall commentary on the issues associated with low carbon heat for off-gas buildings we attach our recently published policy paper on this topic, 'Carbon-free, Poverty-free: Heating options for rural Scotland', please consider this paper our full response to this call for evidence[1]. We have also attached our previous policy paper which is focused specifically on developing sustainable and equitable district heating in Scotland[2].

We would note that the term off-gas is wrongly determined as being over 63m from the gas network. Barriers such as railways and multi-storey urban properties may exclude households from accessing the mains gas despite their proximity to the network. However, off-gas properties are predominately rural which are also more likely to be in fuel poverty than urban households. The challenges these households face are exacerbated by their geographical isolation as well as their potential social isolation. We commend the Scottish Government in this call for evidence as they are recognising that there are social inequities that are not being addressed effectively through current policy responses. We have uncovered variations in behavioural geographies towards heating homes[3] that demonstrate that behavioural patterns exacerbate rural fuel poverty. We have also illustrated that current proxies for fuel poverty, used in targeting funding, favour urban areas[4] to the disadvantage of rural householders.

We have tested the correlation of the SIMD income domain with fuel poverty and show, in Section 2.2.1 of the attached document, that this is the second worst SIMD domain for identifying fuel poor households.

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

None. However, this is not to suggest that the nature of that support is not frequently problematic, and we would point to Orkney as an example of where significant progress has been made on developing renewable energy, decarbonising buildings and tackling fuel poverty whilst having to overcome some significant structural and organisational barriers (etc) to make projects and services fit with the support available and mechanisms for accessing it.

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

Section 3 of our response paper: Technology and fuel options for heating off-gas households specifically focuses on this question.

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

If the primary barrier is a financial hurdle, as it appears to be, then we would question any focus on resolving subsequent issues until the financial barriers are resolved. We believe that subsequent issues after the financial issue are likely to be site specific and may be resolved through system design.

In both our attached policy papers we cover the 'Danish model' of developing district heating systems using a multi-technology approach that combines large scale solar thermal arrays with inter-seasonal heat storage, and heat recovery, sustainable biomass, or energy from waste. This approach has been proven to be successful in overcoming financial barriers to the deployment of DHS, and further reducing emissions from low carbon heat networks.

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

This question is presumptuous on the answers to the previous questions and completely misses the fact that these technologies, their deployment, and their integration are site-specific. Rural properties are more likely, than their urban equivalents, to have multiple fuel sources to provide adequate heating and not necessarily aim to provide the recommended heating pattern. Therefore, we are being asked to describe complex, integrated solutions to complex site variables combined with complex householder variables.

In our attached report we note that solar thermal is significantly under-deployed in Scotland and the same case applies to PVs. Solar thermal and PV systems need to be sized to suit building and occupant-specific needs, which include supplying heat pumps, supplementing heat from other systems, meeting different demand patterns, etc.

We do not see any significant barriers to this beyond financial ones.

5 What do you consider to be the principal building-specific constraints on low carbon heat?

This question is entirely dependent on the measures being considered (or recommended by an EPC), and, for any given building, there is a danger in limiting a discussion (or assessment) to building-specific constraints when it is likely other factors (location, occupants' needs, financing and mechanisms for accessing finance, etc) may pose over-riding constraints, or may justify the application of measures that might be de-prioritised by a simple technical assessment.

For one example, an EPC will usually recommend installing a wind turbine on a listed building, yet a more holistic assessment would scope this option out. For another example, basic rdSAP-based assessments ('Home Energy Checks')

frequently make assumptions that do not reflect real conditions – e.g. because physical barriers to adding insulation exist that can only be captured by a visual inspection.

6 What can be done to overcome these constraints?

We have previously described what we believe the potentials of the proposed national energy company might be and acknowledged that it could play a pivotal role in the delivery of low carbon heat[5].

7 What evidence can you provide on the limitations of low carbon heat technologies (e.g. heat pumps) in buildings with poor energy efficiency?

Please see Section 3.6 of the paper: Heat pumps – Domestic air source heat pumps, domestic ground source heat pumps, and alternative community-scale technologies specifically deals with this question.

8 What low carbon heat solutions are appropriate for hard-to-treat properties where there are limited opportunities to improve energy efficiency of the building fabric?

The 'Evidence on Hard-to-Treat Properties' report[6], which outlines the Scottish Government's definition of the term, was never intended to suggest there are significant technical barriers to improving the energy efficiency of the fabric or services of any building. Rather, the report points to financial costs and a number of social barriers that are far more significant. To put it simply, there will be at least one technical solution to any specific need (e.g. increasing insulation) but if this / these are too costly for the building owner or unacceptable to the occupants it will be 'hard' (although not necessarily impossible) to implement them.

Our attached report shows that, in any given circumstance, some solutions may be more technically appropriate than others, but these considerations will rarely, if ever, be limited to technical constraints. Indeed, the 'fabric first' approach puts technical considerations foremost in decision-making, when an occupant-centred ('folk first') approach may justify overcoming financial and related barriers which themselves do far more to restrict the choice of options for improving energy efficiency.

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

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

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

Our paper on off-gas households is focused on domestic systems however, the evidence on some technology options, particularly district heating, bridges the gap. Section 3 of this paper provides a review of technology options, including figures for capital and operational costs, and financial and emissions savings.

b) customer satisfaction with the system

Please see Section 3.6 of our paper.

c) lifecycle and overall efficiency of the technology

Please see Section 3.6 of our paper.

10 What factors might inhibit uptake of heat pumps?

Please see Section 3.6 of our paper.

Ground source heat pumps are limited by the suitability ground conditions. Heat pumps are

further limited through a lack of understanding of how they operate, the expectation and statutory heating model of heating and non-heating periods is not necessarily compatible with heat pumps.

For the socially isolated rural households the initial engagement with agencies from outwith their communities can represent a barrier. Without a degree of trust, an ability to explain the technology and the knowledge that there is support locally should they have any questions in the future these householders may not even consider technology they, nor anyone they know, have little knowledge of.

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

For rural, low income vulnerable households the challenges initially are centred around engaging with them and ascertaining their needs and abilities. The current provision of advice services will not meet these needs. We have researched and discussed the advice services that vulnerable householders need[7]. We are clear that there is a requirement for local ownership and responsibility for delivering face to face support to vulnerable households which may not only meet their energy needs but act as a route for better social and health service support.

We are also strongly of the view that these services should coordinated through a publicly-owned Scottish National Energy Service. This will be the subject of our next policy paper.

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

As covered in our paper, we are strongly of the view that the development of thermal storage technologies is a significantly unexploited policy option that should become central to the development and deployment of low and zero carbon heating. In particular we note the successes of large scale thermal storage as part of district heating systems (see our attached paper on DHS), and of the household system developed by Sunamp.

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

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

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

Our paper on off-gas households is focused on domestic systems however, the evidence on some technology options, particularly district heating, bridges the gap. Section 3 of our paper provides a review of technology options, including figures for capital and operational costs, and financial and emissions savings.

b) customer satisfaction with the system

Please see Section 3.6 of our paper.

c) lifecycle and overall efficiency of the technology

Please see Section 3.6 of our paper.

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

Please see Section 3.6 of our paper.

14 What factors might inhibit uptake of hybrid heat pumps?

One of the strongest influencing factors of domestic energy use is behaviour[8, 9, 10]. This is particularly relevant in relation to hybrid heating systems where the success and effectiveness is dependent on the ability of the householders

to actively manage each component of these systems. Though it is wrong to underestimate the ability of householders to adapt to new technologies it is also wrong to assume that there are no unsurmountable vulnerabilities that will exclude householders from adapting.

Please also see Section 3.6 of our paper.

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

Section 3 of our paper on off-gas households includes summary tables with SWOT analyses of all the technology options reviewed. Section 4 covers barriers and opportunities for enabling these technologies, as appropriate, for decarbonising domestic heating supplies.

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

Please see Section 3.6 and Section 4 of our paper.

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

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

Our paper on off-gas households is focused on domestic systems however, the evidence on some technology options, particularly district heating, bridges the gap. Section 3 of this paper provides a review of technology options, including figures for capital and operational costs, and financial and emissions savings.

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

Please see Section 3.2 of our paper.

b) customer satisfaction with the system

Please see Section 3.2 of our paper.

c) lifecycle and overall efficiency of the technology

Please see Section 3.2 of our paper.

18 What factors might inhibit uptake of electric storage heating?

Please see Section 3.2 and Section 4 of our paper.

Our principle concerns about converting households to all forms of electric heating relate to the high operational costs to householders, increasing the demand for renewable electricity, and locking emissions from households to the (UK) electricity grid emissions factor.

Whilst we are of the view that the grid emissions factor should be devolved, potentially sub-nationally, as this would significantly affect Scotland's reportable emissions and better reflect its renewable energy capacity, if this is secured it should not be used as a justification for converting large numbers of households to electric heating, due to the risk of creating a 'perfect storm' for renewable energy demand in Scotland in the mid to late 2020s[11].

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

Please see Section 4 of our paper.

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

Please see Section 3.2 of our paper.

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

Please see Section 3 of our paper.

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

Commenting on these technologies, which serve to decarbonise electricity supplies in general, was deemed largely outwith the scope of our paper. However, Sections 3 and 4 include some evidence and commentary on using these technologies specifically in conjunction with domestic heating systems.

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

See our previous answer.

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

Regarding Bioenergy technologies, what evidence can you provide on:

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

Our paper on off-gas households is focused on domestic systems however, the evidence on some technology options, particularly district heating, bridges the gap. Section 3 of this paper provides a review of technology options, including figures for capital and operational costs, and financial and emissions savings.

b) customer satisfaction with the system

Please see Sections 3.5 and 3.8 of our paper.

c) lifecycle and overall efficiency of the technology

Please see Sections 3.5 and 3.8 of this paper.

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

Please see Sections 3.5 and 3.8 of this paper. Further evidence on this is included in our associated paper on DHS.

25 What factors might inhibit uptake of bioenergy technology?

Please see Sections 3.5, 3.8 and 4 of our paper. Further evidence on this is included in our associated paper on DHS.

As regards the uptake of bioLPG and biopropane (Section 3.5), we would draw particular attention to our Conclusions (Section 5) and Recommendations (Section 6) as regards potential unintended consequences of restricting gas connections and heating systems where fossil gas supplies can simply (and inexpensively) be switched for non-fossil gas supplies.

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

Please see our answer to Q25.

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

Please see our answer to Q25.

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

Please see our answer to Q25.

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

Please see our answer to Q25.

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

Regarding heat networks, what evidence can you provide on:

This is covered in summary form in Sections 3.4, 3.5, and 4 of our paper. Our previous policy paper on developing equitable and sustainable district heating systems in Scotland[12] provides a more detailed coverage of this subject, and further commentary on how the design and development of heat networks should be leveraged by the Scottish National Energy Company and a Scottish Energy Development Agency is covered in our previous policy paper[13].

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

This is covered in summary form in Sections 3.4, 3.5, and 4 of our paper. Our previous policy paper on developing equitable and sustainable district heating systems in Scotland[14] provides a more detailed coverage of this subject.

b) customer satisfaction with the system

Please see our answer to Q30.

c) lifecycle and overall efficiency of the technology

Please see our answer to Q30.

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

This is covered in summary form in Sections 3.4, 3.5, and 4 of our paper. Our previous policy paper on developing equitable and sustainable district heating systems in Scotland[15] provides a more detailed coverage of this subject, and further commentary on how the design and development of heat networks should be leveraged by the Scottish National Energy Company and a Scottish Energy Development Agency is covered in our previous policy paper[16].

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

Please see our answer to Q31.

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

Please see our answer to Q31.

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

Please see our answer to Q31.

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

Please see our answer to Q25.

Whilst we support the elimination of fossil gas from all energy supplies our paper on off-gas households raises some important concerns as regards the potential unintended consequences for developing bioLPG, biopropane, and other biogases of constraining gas connections and banning gas boilers where fossil gas supplies could seamlessly be switched for non-fossil gas supplies.

As regards hydrogen, Sections 3.7, 5 and 5 of our report raise significant concerns that lead us to conclude, with some location-specific caveats, that the large-scale adoption of hydrogen for domestic heating is neither viable nor necessarily desirable. Furthermore, whilst we note there are valid arguments for the development of hydrogen for other applications (e.g. transport) we also note that if much of this is to be in the form of electrolytic (blue) hydrogen (as opposed to biogenic 'green' hydrogen) then the associated significant and substantial uncertainties associated with the need to develop and deploy carbon capture and storage (CCS) technologies pose serious risks to the decarbonisation of Scottish energy supplies. We urge the Scottish Government to apply the Precautionary Principle as regards all proposals regarding electrolytic hydrogen.

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

Although our attached papers do not cover the supply of heat beyond domestic properties, we would draw attention to the evidence included on heat networks and thermal storage. Further commentary on decarbonisng heat supplies generally in Scotland is covered in a recent book chapter[17].

With regards to this, we are strongly of the view that if people could see waste heat piling up as waste in landfill sites there would be a public outcry over the need to recover and recycle it. As detailed in our attached papers, to enable this we strongly recommend that the Scottish Government adopts a Danish-style Heat Supply Act to leverage the co-location of sources of waste heat with sources of demand for heat.

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

This is not covered specifically by our research however, our attached paper on off-gas households includes evidence on the future development of non-fossil gas that relate to this question.

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

Please see Sections 4, 5 and 6 of our paper.

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

As covered in both our attached papers, we would draw particular attention to the role of

inter-seasonal thermal storage in significantly reducing the unit costs of heat supplied by 'Danish-style' multi-technology heat networks.

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

Section 2 of our attached paper on off-gas households provides a review of evidence on the characteristics of off-gas and rural households, the extent of and influences on the urban-rural fuel poverty divide, and the implications of current proposals for addressing fuel poverty in rural and island areas.

As covered in this paper, our associated submission to the Energy Efficient Scotland consultation, our previous policy paper on energy performance certificates[18], our recent open letter to Minister Kevin Stewart[19], and many of our other publications[20], we are strongly of the view that current proposals will serve to exacerbate the inequalities between fuel poor householders in urban and rural / remote areas.

At the time of writing we note that uplifts for rural and island areas may be included in the final Fuel Poverty (Target, Definition and Strategy) (Scotland) Bill. We welcome this development and strongly urge the Scottish Government to apply the same understanding to all areas of energy policy.

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

Please see Sections 5 and 6 for a number of conclusions and recommendations in relation to this, including our recommendation to include a ban on new coal and oil heating systems as of 2021, part of the current revisions to the Building Standards.

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

Given the diversity of rural homes and households where neighbouring properties may require different solutions the universality of LHEES will quickly fail to deliver the solutions to meet the actual needs of the households.

We would point the Scottish Government to our previous consultation response on LHEES[21], and our associated response to the Energy Efficient Scotland consultation. We are strongly of the view that there are significant problems with LHEES, including the placing of significant responsibilities on local authorities without committing the necessary enforcement powers, finances and resources to deliver on them.

Please also see our paper on the need for a Scottish Energy Development Agency[22], which would overcome many of the problems inherent in LHEES.

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

The answer to this question is partially dependent on the future demand for, and nature of, decarbonised heat supplies.

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

Please see Sections 4, 5 and 6 of our paper on off-gas households, along with our paper on the need for a Scottish Energy Development Agency.

The short answer is strategic planning at a national level and long-term (>30 year) policy and investment commitments.

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

As we noted in our introductory section, the current proxies used to identify the fuel poor are amongst the weakest (see Section 2.2.1 of our paper on off-gas households, Table 1 Correlations of SIMD domains and SHCS loft insulation metric with the fuel poverty metric ranking, for datazones in the lowest quintile) proxy metrics for identifying the fuel poor. The use of weak proxies means that the available funds are directed towards urban areas to the disadvantage of rural households.

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

Individually, and by a chartered engineer or building services specialist with a comparably high professional qualification.

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

Please also see Sections 2.3, 4 and 5 of our paper, and our separate response to the Energy Efficient Scotland consultation.

We have serious concerns regarding the validity of EPCs as a measure of actual energy performance[23]. If the Energy Efficient Scotland assessments are built upon EPCs then they will generate the same list of measures and technologies which are potentially conflicting (listed in our response to Question 48). Since these are not specific solutions they are relatively meaningless. Without clear direction on the technology solutions specific to the buildings' needs and householders' needs much of the 'recommendation reports' will not be acted on.

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

Please also see Sections 2.3, 4 and 5 of our paper, and our separate response to the Energy Efficient Scotland consultation.

The bullet points below are the recommendations we have been provided in an EPC for a listed non-domestic building in central Edinburgh. Generally, they do not reflect a low carbon strategy approach and some of the recommendations may be superseded by technology, for example the installation of LEDs (first bullet point). The existing advice therefore does not support the Scottish Government's proposed goals. Before addressing additional advice requirements, the Scottish Government must first acknowledge the short comings of the existing advice.

- Consider replacing T8 lamps with retrofit T5 kit
- In some places the solar gain limit defined in the NCM us exceeded, which might cause overheating. Consider solar gain control measures such as the application of reflective coating or shading devices to windows.
- Add time control to heating system
- Add optimum start/stop to the heating system
- Introduce HF ballasts for fluorescent tubes: reduced number of fittings required.
- The default heat generator efficiency is chosen. It is recommended that the heat generator system be investigated to gain an understanding of its efficiency and possible improvements
- Install more efficient water heating

- Some windows have high U-values - consider installing secondary glazing
- Add local temperature control to the heating system
- Add local time control to the heating system
- Add weather compensation controls to heating systems.
- Consider replacing heating boiler plant with a condensing type
- Carry out a pressure test, identify and treat air leakage. Enter result in EPC calculation.
- Some glazing is poorly insulated. Replace/ improve glazing and/or frames.
- Consider installing an air source heat pump
- Consider installing a ground source heat pump
- Consider installing building mounted wind turbines.
- Consider installing solar water heating
- Improve insulation on HWS
- Consider installing pv.
- Replace 38mm diameter (T12) fluorescent tubes on failure with 26mm (T8) tubes
- Replace tungsten GLS lamps with CFLs: Payback period dependent on hours of use
- Some walls have uninsulated cavities - introduce cavity wall insulation
- Some solid walls are poorly insulated - introduce or improve internal wall insulation
- Consider replacing HWS with point of use system
- Roof is poorly insulated. Install or improve insulation of roof.
- The default chiller efficiency is chosen. It is recommended that the chiller system be investigated to gain an understanding of its efficiency and possible improvements.
- Consider replacing heating boiler plant with high efficiency type.
- Ductwork leakage is high. Inspect and seal ductwork.
- Some loft sapces are poorly insulated - install/improve insulation.
- The default chiller efficiency is chosen. It is recommended that the chiller system be investigated to gain an understanding or its efficiency and possible improvements.

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

Please see sections 4, 5 and 6 of our paper.

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

Please see our previous comments in relation to EPCs. We are firmly of the view that any regulations reliant on EPCs (as they stand) will not only fail, but will serve to exacerbate fuel poverty amongst many Scottish householders.

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

As detailed in our paper, we are generally strongly supportive of the recent advice from the

CCC in its 'Net Zero' report however, we are more sceptical of the CCC's views on the potential of heat pumps, and we are strongly of the view that the report is not sufficiently cognisant of the significant uncertainties and risks associated with the development of electrolytic hydrogen.

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

Please see our evidence and papers on EPCs.

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

This is included in Section 3 of our attached paper.

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

Our paper on off-gas households does not specifically consider these differences however, our findings as regards bioLPG and biopropane (Sections 3.5, 5 and 6) are relevant to this question.

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

There should be no need to 'future proof' new buildings for retrofitting if the Building Standards are strong enough, and enforced, to ensure that new buildings have low energy demands.

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

We would suggest that the Scottish Government considers the Building Standards, and associated enforcement powers, which are within its competences. Invariably any revisions of regulations re watered down in the response to heavy pressure from commercial buildings while the enforcement continues to grow ever weaker. There should be no self-certification, all new buildings should be inspected during construction by appropriate council officers.

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

Please see Sections 3.5, 3.8, 4, 5 and 6 of our paper on off-gas households and our associated paper on DHS for evidence on development of supply chains for low / zero carbon fuels. In particular we would point to our findings on the environmental, economic and social benefits and co-benefits of developing local and sustainable biogas and biomass supply chains in deprived rural areas.

REFERENCES

1 Baker, K.J., Mould, R., Dalzell, C., McAlpine, R., & Shafi, J., 2019. Carbon-free, Poverty-free: Heating options for rural Scotland. A policy paper for Calor by Common Weal, Glasgow Caledonian University, and the Energy Poverty Research initiative. Available at: https://commonweal.scot/policy-library

2 Baker, K.J., & Mould, R., 2019. Just Warmth: Developing equitable and sustainable district heating systems in Scotland. A Common Weal policy paper, 12th May 2019. Available at: https://commonweal.scot/policy-library/just-warmth

3 Mould, R., & Baker, K.J., 2017b. Documenting fuel poverty from the householders' perspective. Energy Research and Social Science, 31, (2017), pp.21–31.

4 Mould, R., Baker, K.J., & Emmanuel, R., 2014. Behind the definition of fuel poverty: understanding differences between the fuel spend of rural and urban homes. Queen's Political Review, Vol 2, No. 2, pp.7-24.

5 Baker, K.J., Morgan., G., Mould, R., & Wright, I., 2019. Powering Our Ambitions: The role of Scotland's Publicly Owned Energy Company and the case for a Scottish Energy Development Agency. A Common Weal policy paper. Available at:http://139.59.184.70/sites/default/files/2019-02/National%20Energy%20Company.pdf

6 Roaf, S., Baker, K.J., & Peacock, A., 2008. Evidence on Hard to Treat Properties. Report for the Scottish Government. Available at: http://www.gov.scot/Publications/2008/10/17095821/0

7 Baker, K.J., Mould, R., Stewart, F., Restrick, S., Melone, H., & Atterson, B., 2019. Never try and face the journey alone: Exploring the face-to-face advocacy needs of fuel poor and vulnerable householders. Energy Research and Social Science, Vol. 59, (2019) pp. 210-219. https://authors.elsevier.com/a/1YhpP7tZ6ZjK7R

8 Faiers, A., Cook, M., Neame, C., 2007. Towards a contemporary approach for understanding consumer behaviour in the context of domestic energy use. Energy Policy, 35, 8, 4381-4390. https://doi.org/10.1016/j.enpol.2007.01.003

9 Yohanis, Y. G., 2012. Domestic energy use and householders' energy behaviour. Energy Policy 41 654-665. https://doi.org/10.1016/j.enpol.2011.11.028

10 Mould, R & Baker, K 2017, 'Uncovering hidden geographies and socio-economic influences on fuel poverty using household fuel spend data: a meso-scale study in Scotland' Indoor and Built Environment., 10.1177/1420326X17707326

11 Baker, K.J., 2017. Renewable heat: The Perfect Storm? In Wood, G., & Baker, K.J. (eds), 2017. A Critical Review of Scottish Renewable and Low Carbon Energy Policy. Palgrave Macmillan, Aug 2017.

12 Baker, K.J., & Mould, R., 2019. Just Warmth: Developing equitable and sustainable district heating systems in Scotland. A Common Weal policy paper, 12th May 2019. Available at: https://commonweal.scot/policy-library/just-warmth

13 Baker, K.J., Morgan., G., Mould, R., & Wright, I., 2019. Powering Our Ambitions: The role of Scotland's Publicly Owned Energy Company and the case for a Scottish Energy Development Agency. A Common Weal policy paper. Available at:http://139.59.184.70/sites/default/files/2019-02/National%20Energy%20Company.pdf

14 Baker, K.J., & Mould, R., 2019. Just Warmth: Developing equitable and sustainable district heating systems in Scotland. A Common Weal policy paper, 12th May 2019. Available at: https://commonweal.scot/policy-library/just-warmth

15 Baker, K.J., & Mould, R., 2019. Just Warmth: Developing equitable and sustainable district heating systems in Scotland. A Common Weal policy paper, 12th May 2019. Available at: https://commonweal.scot/policy-library/just-warmth

16 Baker, K.J., Morgan., G., Mould, R., & Wright, I., 2019. Powering Our Ambitions: The role of Scotland's Publicly Owned Energy Company and the case for a Scottish Energy Development Agency. A Common Weal policy paper. Available at:http://139.59.184.70/sites/default/files/2019-02/National%20Energy%20Company.pdf

17 Baker, K.J., 2017. Renewable heat: The Perfect Storm? In Wood, G., & Baker, K.J. (eds), 2017. A Critical Review of Scottish Renewable and Low Carbon Energy Policy. Palgrave Macmillan, Aug 2017.

18 Baker, K.J., & Mould, R., 2018. Energy Performance Certificates - An Alternative Approach. A Common Weal policy paper. Available at: https://drive.google.com/open?id=13NC1J2U2S_WB_O-xAQYoqgtHr_07SX5d

19 Baker, K.J., Mould, R., Restrick, S., & Melone, H., 2018. Open letter - The need for an adjustment for rurality in the new definition of Fuel Poverty. Open letter to Kevin Stewart, Minister for Local Government, Housing and Planning, Scottish Government, by the Energy Poverty Research initiative (and signatories). Available at: http://energypovertyresearch.blogspot.com/2018/06/open-letter-need-for-adjustment-for.html

20 A full list of publications by members of the Energy Poverty Research initiative can be found at: http://energypovertyresearch.blogspot.com/p/publications.html

21 Available at: https://drive.google.com/file/d/1klryIBl3lX17BvP428llb9BAQPjVl3jX/view

22 Baker, K.J., Morgan., G., Mould, R., & Wright, I., 2019. Powering Our Ambitions: The role of Scotland's Publicly Owned Energy Company and the case for a Scottish Energy Development Agency. A Common Weal policy paper. Available at:http://139.59.184.70/sites/default/files/2019-02/National%20Energy%20Company.pdf

23 Baker, K.J., & Mould, R., 2018. Energy Performance Certificates - An Alternative Approach. A Common Weal policy paper. Available at: https://drive.google.com/open?id=13NC1J2U2S_WB_O-xAQYoqgtHr_07SX5d