Consultation Response

HEATING & HOTWATER INDUSTRY COUNCIL

HHIC response to 'A future framework for heat in buildings: call for evidence'

About HHIC

The Heating and Hotwater Industry Council (HHIC) are the leading representative body for the UK domestic heating and hot water industry, worth £3-4 billion per year. HHIC's membership base covers approximately 94 per cent of heating and hot water solutions available in the UK. HHIC are a division of the Energy and Utilities Alliance (EUA).

Full Response

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?

HHIC believe that BEIS should work with industry to transition from existing fuels to sustainable bio fuels. We do not believe BEIS need to transition homes away from their existing appliance type. This would be disproportionately expensive.

We agree that homes should no longer be heated by coal. The evidence and costs mean that this is disproportionately negative today and not sustainable in the future.

However the other high carbon fossil fuel that BEIS are looking into is oil for heating. Whilst this is a fuel with higher carbon emissions than natural gas and electricity its overall

Camden House, Warwick Road, Kenilworth, Warwickshire, CV8 1TH
T: +44 (0)1926 513777 **F:** +44 (0)1926 511923
E: info@hhic.org.uk **W:** www.centralheating.co.uk

contribution towards the UK's total CO2's emissions is approximately 0.5%. HHIC has estimated that is would cost upwards of £10,000m[1] in order to move these systems to an electric one. HHIC does not believe that this is a proportional cost in order to solve this particular problem.

We believe the focus should explicitly be on helping or encouraging the fossil fuel industry to develop a workable biofuel.

OFTEC have said that industry figures reveal that, unless wholesale and very expensive improvements are made to the energy efficiency of the home, heat pumps can cost up to 88% more to run than high efficiency oil boilers. This could leave rural consumers facing a rise in their heating bills of up to £750 per year. In addition to much higher running costs, even with the incentive payments currently available through the domestic Renewable Heat Incentive (RHI) scheme, heat pumps still cost at least £6,000 to install, making them prohibitively expensive for most households to take up. This excludes the cost of fitting the larger radiators and additional insulation often required for heat pumps to work effectively in rural properties, which tend to be older and less well insulated. Other options may require boiler upgrades, but industry will continue its work to bring to market a low carbon bio-liquid fuel to start replacing heating oil from 2022. The new fuel would work on existing high efficiency oil boilers following a relatively simple and low cost modification.

There are a number of logistical and cost issues associated with these biofuels that will need some kind of government support, not always financial. These costs are lower than that of electrification.

We believe BEIS should work closely with the industries affected in order to develop a roadmap to biofuel transition. We do not believe declaring a blanket ban on a fuel without

[1] Cost of ASHP installation assumed at £9,000, Number of Oil Boilers Off Grid (1,105,000) multiplied by the cost of replacing them all with ASHP

adequate transition planning is a helpful way forward and could create an element of confusion that may derail the overall objective.

We are aware that BEIS have started conversations with the oil heating industry and are setting up a formal forum to assist with a move from non-bio heating oil. We support this move and believe that the focus should be on a new fuel and not how to replace appliances. Moving homes heated by oil to a heat pump will be too expensive and the current carbon savings do not support such a move on a cost basis

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?

HHIC believe that a collaborative approach is the best way for engagement. We have found that close working relationships between Government and industry lead to fewer points of friction and quicker decision making. In the past this has been in the form of specific sector groups or official working and contact groups. We have been involved in several for the RHI and domestic heat.

HHIC are supportive of the current Domestic Heat Strategy Group which has enabled the heating industry and BEIS to work on developing new regulation. The Boiler Plus regulations were developed alongside consultation with this group, and we believe industry and government found the process mutually beneficial.

The Domestic Heat Strategy Group was set up in 2015 between the domestic heating industry and DECC. The concept was to have roundtable discussions between industry and government, where possible policy ideas could be suggested and discussions could then take place on how these could be implemented, or if there were potential issues, constraints etc.

In light of this, we think that joint forums that bring together interested parties are a positive way to develop policy change. Especially in complex areas such as heating.

This can then lead to new consultations and roadmaps for decarbonisation.

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

We believe that this is a very complex question that is hard to empirically answer until a clear proposal is outlined.

If we were to apply this to phasing out all new oil boiler installations, including in retrofit situations then we believe this would only be feasible if an alternative low carbon heating appliance were available.

Currently the lowest cost option would be limited to moving existing oil boiler installations to bio-LPG systems which would require changing the fuel tank, connections and boiler. This could cost an additional £2000 in comparison to an existing oil boiler replacement.

Therefore BEIS would have to calculate if they are willing to ask consumers to pay this additional fee and if there will be support for those in fuel poverty to change. A factor tied to this is that if the volume of oil boiler systems decreases then the fuel may increase in price quite significantly. Those that are able to pay for a new appliance will. Those in fuel poverty, of which there are approximately 14% in rural areas[2], will then not only have an appliance that needs changing but will be paying significantly more for their fuel.

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/639118/Fuel_Poverty_Statistics_Report_2017_revised_August.pdf

A simpler method would be to work with the industry to develop a biofuel that would not require an appliance change. The LPG industry have done this with Bio-LPG.

Therefore we do not believe that a firm date for ending high fossil fuels is necessarily functional unless the surrounding mitigating factors were considered. We understand that having a long term requirement should drive industry to reform, however the concern is that in reality it will lead to political pressure to water down or amend them which could undermine initiatives.

We realise that this was done with condensing boilers. However in that case the cost of a condensing boiler was close to parity with a non-condensing version before the regulation came into force. Also the appliance was of the same fuel so the consumer did not face any additional barriers to installation. Therefore the two cannot be considered equivalent.

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?

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)?

For urban off grid properties HHIC would recommend that where possible properties are connected to the gas grid. If this is not possible forms of direct electric heating can provide cost effective solutions.

For rural off grid the focus has to be on decarbonising the fuel supply because appliance replacement is not cost effective and creates a level of disruption that consumers will not welcome.

Overall our message is that the main choice should be to decarbonise fuel rather than changing appliances.

Our members have outlined some of key pros and cons of the main choices as:

- Heat Pumps - Full heat pumps require large investment in building fabric to insulate them, the heat pump themselves, rural electricity grid reinforcement and standby generation for when renewables are not generating at a high load factor, such as in the winter. Such investment is unlikely to pay back in financial terms, which may explain their limited take-up.
- Heat Networks - Heat networks require significant capital investment in household heat exchangers, a flow and return pipe network and a low carbon fuel source. Payback periods are very long, typically between 35-45 years, putting them beyond a consumer led route to decarbonisation.
- Gas network extension - Gas grid extension require capital investment for a pipe network, but provide an immediate carbon reduction compared to thermal electric heating, coal, oil or LPG. Combined with smart hybrid heating and green gas, decarbonised heat is a possibility with a gas mains extension (see questions 10-12). This would probably be limited to urban and semi urban areas. Rural areas would require use of either BioLPG or a bio oil.
- Biomass solid fuels - The use of biomass would appear to be a cost effective method of heating, but air quality emissions and its sustainable credentials are increasingly being questioned.

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)?

HHIC believes that the main focus should be placed upon decarbonising the fuel for existing appliances. This means bio-oil, bio-LPG, some biomass systems and decarbonised electricity.

Trying to force appliance change such as heat pumps in place of oil or LPG boilers will be disproportionately expensive and intrusive.

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?

It is certainly possible, however government has to be prepared for it to come at a higher cost than regular fossil fuels. This is because newer technologies often have higher start-up costs than existing ones, as there are costs such as licensing, securing new supply chains and research and development.

Additionally, there is a technical barrier, because bioliquids are chemically very similar to aviation fuel, and use a very similar process in their production, using the same crops. This means full scale production of it for homes could lead to shortages of it for the aviation industry, or environmental problems, due to the extra fields that would be required to produce it. Following this, there is a tension that may prove to be problematic in its production.

If government is serious about the use of bioliquids, there must be an incentive structure in place, however this does not have to be a subsidy, and it could be tax breaks for research and development sites.

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?

BioLPG and Biopropane are terms used to describe LPG which is derived from production processes that use a variety of biological materials as feedstocks, including waste streams.

Importantly, biopropane or bioLPG is chemically indistinct from LPG and so can be used as it is, just like conventional LPG. This also means that it can be 'dropped-in' to existing supply chains and appliances without the need to modify existing infrastructure or the technical specifications of LPG gas appliances. This sets it apart from bioliquids that cannot be blended with their conventional counterparts and thus require new infrastructure to transport and appliances to be fully compatible.

Unlike other forms of bioenergy, bioLPG is non-corrosive and so existing LPG storage and distribution infrastructure does not require any upgrade investment.

Although not a wholly zero carbon fuel source, biopropane could offer an opportunity for LPG households to significantly reduce their carbon footprint by up to 90% compared to fossil LPG.

The combustion of biopropane does result in carbon being emitted, but this is offset by the carbon that was removed from the atmosphere when the biomass feedstock was cultivated. However, the production of biopropane does produce carbon dioxide.

Carbon emissions will result from the fertilisation of the feedstock, as well as from the transformation of the feedstock into a useable form of bioenergy. The exact carbon footprint of biopropane depends upon all of these factors, but also upon whether it is defined as a residue or a co-product under the European Union's Renewable Energy Directive (RED).

In the following analysis, we consider the use of biopropane that has been generated as a waste product of NESTÉ Oil's HVO biodiesel refining process. This has been classified as a residue under RED, with a carbon footprint of 0.036 kgCO2e/kWh.

We consider the future emissions from three scenarios:

Scenario 1 – All households currently using LPG as their primary heating fuel continue to do so. For simplicity, it is assumed that LPG use for residential heating maintains its current level of 0.93 million tonnes per annum (approximately 12.7 x 109 kWh). Using the DEFRA carbon

factor of 0.21468 kgCO2e/kWh, this results in annual carbon emissions from residential use of LPG of 2.7 MtCo2e.

Scenario 2 - In this scenario, a tenth of the off-grid households that currently use LPG make the switch to biopropane each year. In this way, biopropane use is universal by

2025.

Scenario 3 - All households that currently use LPG make an immediate switch to biopropane. This scenario would not be technically feasible at present, but is included for illustrative purposes.

The annual carbon dioxide equivalent (CO2e) savings from each of the scenarios are presented in the table and graph below. Scenario 1 results in emissions of 2.7 million tonnes of CO2e (Mt CO2e) for each of the next ten years. The incremental switching approach in Scenario 2 reduces emissions by an additional 0.22 MtCO2e each year, resulting in annual emissions of 0.46 MtCO2e in 2025. The wholesale switching seen in Scenario 3 reduces annual emissions immediately to 0.46 MtCO2e and maintains this level until 2025.

	Scenario 1	**Scenario 2**		**Scenario 3**	
	Annual Carbon Emissions MtCO2e	Annual Carbon Emissions MtCO2e	Annual Carbon Savings compared with Scenario 1	Annual Carbon Emissions MtCO2e	Annual Carbon Savings compared with Scenario 1
Year					
2016	2.729	2.502	0.227	0.458	2.271
2017	2.729	2.275	0.454	0.458	2.271
2018	2.729	2.047	0.681	0.458	2.271
2019	2.729	1.820	0.908	0.458	2.271
2020	2.729	1.593	1.136	0.458	2.271
2021	2.729	1.366	1.363	0.458	2.271
2022	2.729	1.139	1.590	0.458	2.271
2023	2.729	0.912	1.817	0.458	2.271
2024	2.729	0.685	2.044	0.458	2.271
2025	2.729	0.458	2.271	0.458	2.271

The cumulative carbon savings are presented in the table and graph below. Scenario 1 results in cumulative carbon emissions of 27.2 MtCO2e by the end of 2025. Scenario 2 improves the situation, with cumulative emissions of 14.8 MtCO2e by 2025 – a saving of 12.5 MtCO2e in

comparison with Scenario 1. Scenario 3 results in cumulative carbon emissions of 4.6 MtCo2e – saving 22.7 MtCO2e in over Scenario 1.

	Scenario 1	Scenario 2		Scenario 3	
Year	Cumulative Carbon Emissions MtCO2e	Cumulative Carbon Emissions MtCO2e	Cumulative Carbon Savings compared with Scenario 1	Cumulative Carbon Emissions MtCO2e	Cumulative Carbon Savings compared with Scenario 1
2016	2.729	2.502	0.227	0.458	2.271
2017	5.458	4.776	0.681	0.915	4.542
2018	8.187	6.824	1.363	1.373	6.814
2019	10.915	8.644	2.271	1.830	9.085
2020	13.644	10.237	3.407	2.288	11.356
2021	16.373	11.603	4.770	2.746	13.627
2022	19.102	12.742	6.359	3.203	15.899
2023	21.831	13.654	8.176	3.661	18.170
2024	24.560	14.339	10.221	4.118	20.441
2025	27.288	14.797	12.492	4.576	22.712

Unlike other low-carbon heating alternatives, the use of biopropane does not face significant barriers to uptake.

It requires no additional capital outlay, nor does it require the householders to change the way in which they use their heating system. Alternative technologies, such as heat pumps, may require new radiators and better levels of insulation in order to facilitate a lower temperature heating circuit. Instead, householders will merely purchase a different fuel and their heating system will continue to function as before.

Consequently, eliminating the price differential between LPG and biopropane would provide sufficient incentive to stimulate the uptake of biopropane.

When discussing biofuels, it is often mentioned that their mass production can result in land-use changes. These changes could exacerbate climate change, decrease biodiversity and have a negative impact on food security. However, as stated in DECC's 2014 Evidence Report: Biopropane for Grid Injection: "biopropane has an advantage in this respect, because it can be sourced to a large degree from non-food feedstocks, such as inedible fractions of palm oil, animal fats and wastes (such as used cooking oil)." As long as adequate sustainability

criteria are imposed – such as those imposed upon biomass under the RHI – the use of biopropane should have no negative ecological consequences.

As with any new energy source, it is necessary to evaluate the current capacity and potential scalability of the UK market. Initially, it is estimated that 40,000 tonnes of biopropane will be available within Europe annually. The vast majority of this would be destined for the British market and would be sufficient to heat 30,000 homes. Calor introduced BioLPG to the UK in March of this year demonstrating that this is not a future technology, but one available to homes today[3]. Over the coming years, global production of biopropane could be increased dramatically by taking advantage of worldwide HVO production and developing new path-ways for production. For example, biopropane can be produced through the conversion of biomass feedstocks into syngas using gasification; followed by catalytic conversion of the syngas into methanol, di-methyl ether and finally biopropane. Initial industry research shows that waste derived (using household waste) biopropane could cost slightly less than current prices for fossil LPG and significantly less that technologies such as heat pumps.

A report published by GreenEA[4] in September 2015 estimated that the production capacity of HVO within Europe will increase by 88.5% in the next three years. This rate of growth would be sufficient to sustain the deployment detailed in the second scenario in our analysis.

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

Burning wood for biomass emits 2.4X more PM 2.5 pollution than traffic.[5] The European environment agency estimates that PM 2.5 pollution caused 37,800 premature deaths in the UK in 2012.[6] Further, a single log burning stove emits more PM 2.5 per year than 1000 petrol cars and has estimated heath costs in urban areas of thousands pounds per year.[7] New

[3] https://www.calor.co.uk/news/calor-introduces-biolpg-to-the-uk-market-and-sets-path-to-be-fully-renewable-by-2040/
[4] Is HVO the Holy Grail of the world biodiesel market?; GreenEA; available at http:// www.greenea.com/en/articles/category/2-biofuel.html?download=83:is-hvo-the-holy-grailof-the-world-biodiesel-market
[5] http://www.bmj.com/content/350/bmj.h2757/rapid-responses
[6] http://www.bmj.com/content/350/bmj.h2757/rapid-responses
[7] http://www.bmj.com/content/350/bmj.h2757/rapid-responses

stoves pollute less than old stoves but a recent paper found limits for eco-design wood burners allow 6 times more particulate pollution than the exhausts of HGVS, and 18 times more than new diesel cars.[8] Moreover, recycled construction wood contains harmful metals to prevent rot and old painted wood can contain lead, this gets emitted in the smoke and is highly toxic. Additionally, burning wet wood is more polluting than dry wood.[9]

A study has also shown that real world emissions from the same appliances are 4-5 times higher than under lab conditions, and the review showed only 22% of stoves only met their lab test limits, in real world tests. [10] Therefore we urge caution over the use of biomass systems especially in urban or semi urban areas.

As bioLPG is chemically indistinct from LPG, its emissions are identical. When used to heat a home, LPG's particulate matter and NOx emissions are lower than heating oil and biomass. A study by the Italian research institute INNOVHUB showed that that biomass appliances' PM emissions can be 600 times higher than LPG ones.

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?

HHIC are aware of the Western Power Distribution/Wales & West Utilities Freedom project which is testing smart hybrid heating systems – i.e. use a heat pump powered by renewable electricity when available and the existing boiler (preferably using a bio fuel) the rest of the time. Tests indicate that renewable electricity may be available 75% of the time in the future 2050 scenarios. WWU report that there would not appear to be any reason why smart hybrid heating can't be retro-fitted to an oil fired system as the technology in Bridgend has been

[8] https://www.theguardian.com/environment/2017/oct/08/pollutionwatch-log-fires-are-cosy-but-their-days-may-be-numbered
[9] https://www.theguardian.com/environment/2017/oct/08/pollutionwatch-log-fires-are-cosy-but-their-days-may-be-numbered
[10] https://uk-air.defra.gov.uk/assets/documents/reports/cat11/1708081027_170807_AQEG_Biomass_report.pdf

developed with retrofitting in mind. The majority of the 75 installations are actually two independent systems dovetailed and controlled by the smart software[11].

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?

The Freedom Project, run by Wales and West Utilities and Passiv Systems, is a project assessing the use of hybrid heat pumps in and around Bridgend in Wales. Most of the installations are for on gas-grid properties, however three are off gas grid. A normal heat pump is installed in the property and the smart controls switch between using the heat pump and the gas boiler (running on either LPG or natural gas), dependent on the cost of the electricity, the demand in the network or the carbon intensity. The project has been running for well over a year and the initial feedback from occupants is that they are paying less for their bills. For the off gas grid property, the householder has noticed not having to arrange as many gas deliveries, with LPG consumption down by about 70%.

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

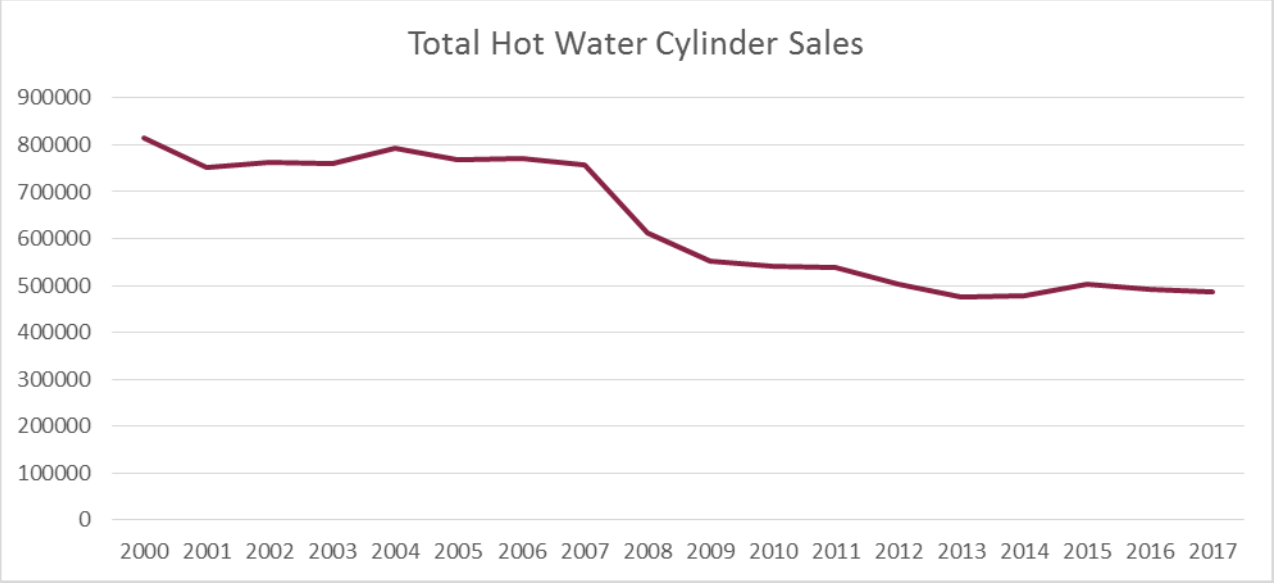
The results coming from Western Power Distribution and Wales & West Utilities on the Freedom project indicate that smart hybrid systems could offer a low cost pathway to decarbonise heat off-grid alongside gas decarbonisation.

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?

[11] http://www.wwutilities.co.uk/about-us/our-company/publications/the-future-of-energy-research/

The three or four major issues when replacing a boiler in an existing heating system with an Air or Ground Source Heat pump are;

1. The radiators are almost certainly too small as they would have been sized to run on an 80/60c flow and return regime. A Heat pump typically runs most efficiently at a flow and return regime of around 40/30c. Therefore unless the radiators were originally grossly oversized and also significant insulation upgrades have taken place within the house then they will need upgrading.
2. It is quite rare for the heating system to be replaced and not unusual for the third or fourth boiler to be connected to the same heating system and radiators.
3. With nearly 17m Combi's installed in UK properties then it is a real issue to replace one of these with a Heat pump. You cannot get Heat pump Combi's so now you will have to find a location within the already too small house to locate a hot water storage cylinder. Further hot water cylinders are not as popular as they used to be and sales have declined steadily since 2001.



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?

In 2016 DECC published a report that outlined the cost reduction potential for heat pumps (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/498962/150113_Delta-ee_Final_ASHP_report_DECC.pdf)

HHIC broadly agrees with the assumptions in this report. Air conditioning and heat pump technology is not new, nor is it in niche production. Therefore most of the costs are already at a low point through mass production.

There may be technological developments that bring down the costs for certain components, but this will be limited. This technology is extremely mature and in production across the world, any innovations to bring down costs are probably already factored in.

Industry will always look to produce product at the lowest possible cost as long as the product remain safe and efficient. The aim of the heat pump manufacturers is to maximise sales, therefore they will already be acting to ensure lowest cost.

HHIC believes that BEIS should be cautious about pursuing too much cost reduction in mature markets. Often this can lead to promotion of products that may not meet certain safety or efficiency criteria and ay be inferior products.

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?

HHIC's position on storage heaters is as a product they have a number of significant drawbacks which in our opinion render the use of electric heating in this form sub-optimal

with regards to off grid homes. Through conducting in house cost analysis of storage heaters, particularly investigating replacement costs of an old storage heater with a newer more efficient one. We found that storage heaters are not a cost effective measure when attempting to meet the government's decarbonisation targets.

They require two electric supply cables which will incur additional installation costs which is unavoidable if the fan is installed as supplementary heat. Typically Storage Heating properties will be solid walls/floors which makes it difficult to add the additional cable required to power the fan. Controls can be difficult to understand and as such better/more education for the end user is required. More complex internal components potentially increase future repair costs. Due to the Load required for Storage Heaters they require double the load of Direct Acting Radiators these can use approximately 50% less energy compared to Night Storage heaters

Ofgem (2018) suggest there to be 1.7 million storage heaters in situ off grid, for modelling purposes we take the assumption of a 50/50 split of the storage heating population in terms of new vs old and also further assume the cost of installing a new storage heater to be approximately £4,500. Given this e calculate the cost of replacing 850,000 traditional storage heaters (half the population of storage heater in situ) to be £3,825,000,000.

In terms of carbon savings, Ofgem 2018 suggest that old storage heaters require 7453kWh/yr on average, with this and the carbon factor of electricity being (0.4 kgCo2/kWh) as suggest by the Energy Savings Trust. We find the average carbon emissions of a single traditional storage heater is calculated to be approximately 2.981 tonnes. Further multiplication by 850,000 suggests that the aggregate carbon emissions of all traditional storage heaters to be 2,534,020 tonnes

In a similar vein, we calculate the carbon emissions of new storage heaters. Ofgem 2018 suggest that new storage heaters require 6682kWh on average, therefore putting the average carbon emissions of a single new storage heater at 2.672 tonnes and the aggregate carbon emissions of all new storage heaters at 2,271,880 tonnes.

Differencing the aggregate carbon emissions of all traditional storage heaters with new storage heaters gives us the level of carbon savings if replacement were to take place.

Aggregate Carbon Emissions of all old storage heaters (tonnes)	**Aggregate Carbon Emissions of all new storage heaters (tonnes)**	**Carbon Savings (tonnes)**
2,534,020	**2,271,880**	**262,140**

In order to monetise the aggregate carbon savings, a simple division of the carbon savings with the cost of replacement puts the cost per tonnes of carbon saved at approximately £14,591 per year. Further, discounting the cost of carbon saved across the lifetime of a new storage heater which we assume to be 25 years. We determine the cost of carbon saved of a full off grid replacement at approximately £583.66 per tonne.

From the above deductions, our view is that despite the benefit of newer storage heaters being more energy efficient our belief is that the total cost on government in order to benefit from the carbon saving far outweigh the carbon savings. Our view is that in order to viably and effectively reach the government's decarbonisation targets, those primarily utilising electricity as means of heating should be converted to mains gas where possible as a more cost effective fuel option. However, we understand that where this not feasible and if electricity is the only option governments should utilise Direct Acting Electric Products which are cheaper to install and have lower running costs based on evidence provided to us by the Electric Heating Company who have conducted detailed analysis in this area within 289 Flatted Properties/Sheltered Housing Dwellings. The Electric Heating Company are happy to share this information if required. They also would not need conversion to a wet central heating system as would be the case with conversion to a Heat Pump.

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?

HHIC believes that rural heat networks would be complicated and expensive. Whilst it can be argued that a rural heat network has fewer constraints with regards to installation, there are still significant barrier to implementation.

Firstly there has to be a sufficient energy source. It has been discussed that water source heat pumps could be used in local rivers and lakes. However these require significant upfront costs. They would then have to be connected to homes which would necessitate the digging up of all the roads in a small conurbation. Given smaller locations do not have access to alternative routes and access, this could be worse than similar works in more built up areas.

Then the economics of a rural heat network would be complicated. To offset the high upfront cost of the heat source the provider would have to assume that all people in the town of village, or at least a significant number would have to sign up to the scheme. Additionally, there needs to be a fairly high density of housing (+50 per hectare) in order for the heat network to economic – most rural locations do not meet this threshold. There are a number of competition issues here. What happens is a new home owner doesn't want to be part of the network. Will people be required to sign up in advance? Who will pay for the new heating system?

We are aware that the CMA are looking into this area and will present options for new heat networks. However we think given the limited number of customers on a rural heat network and the relatively high cost of heat it is unlikely to be a viable option.

Other options to be considered will be tough local planning restrictions, areas of natural beauty and other listed restrictions.

We believe that prior to BEIS making any recommendations on rural heat networks, a full independent review should be undertaken in order to assess any potential barriers and costs.

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

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?

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?

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?

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

The Renewable Transport Fuel Obligation has been successful in driving the production of biofuels for vehicles. A similar scheme to encourage biofuels to decarbonise off gas grid homes would help support innovation, research and eventually lead to cost reductions as production is increased in scale.

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?

A clear definition of what is 'clean heating' would be helpful for this question. Otherwise there are many different directions this question could take.

If the focus is purely on how to obligate the transition away from oil boilers then the Government need to weigh up their options on which sector to target first. HHIC believes that this is the wrong approach as oil installations can be converted to bio oil systems at a lower cost than converting to electric heating or heat pumps.

If BEIS wish to obligate changes then the regulation needs to be simple and incremental. The technology targeted needs to be at the point of near market maturity and the price differential has to be close to negligible.

The change to condensing boilers and the recent boiler plus regulations are examples of this.

Of the obligations listed, the majority would not pass this test or are actually in operation.

The DNOs and GDNs are already effectively obligated though the RIIO programme to provide long term decarbonisation options. Therefore there is no benefit for BEIS to be adding additional obligations on these companies.

ECO currently provides funding for vulnerable homes. HHIC supports this and believes that greater funding should be provided to upgrade as many homes as possible. We do not believe the focus needs to be on clean heating, as the majority of qualifying measures are

insulation and new boilers which should be classified as clean heating. It should also place a greater emphasis on rural homes, which have historically missed out on the installation of ECO measures.

The other options appear unworkable in practice and in some cases counterproductive and so we would urge BEIS not to pursue them.
Our belief is that simple, decisive obligations work best and this should be BEIS's focus.

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

HHIC does not believe this is a sensible obligation. Heat Pump installations are more than double the price of a standard boiler installation. Therefore putting the two prices side by side will only reinforce the view that other heating options are far more expensive. It may even put consumers off for future system replacements due to the perceived cost.

Installers could be obligated to provide information about other heating systems, but this would have to be BEIS information to provide the needed trust and for it not to be seen as a sales technique.

There is also no way to police this and therefore it would be a waste of resources. Installers are concerned about ensuring safety requirements are met and that the installation meets building regulations. They may pass on the information but there is no way to dictate how this will happen. Also, if this is obligated, installers may feel resentful towards having to provide it so actively dismiss the 'clean' options.

Example 2 – Funding for energy efficiency of homes

HHIC does not support ECO money being spent on heating systems that don't offer the lowest energy bills for that household. Currently heat pumps do not offer lower bills for the

majority of households in the UK on and off the grid, therefore it would be unfairly punitive to provide fuel poor homes with systems that are more expensive to run.

Example 3 – A role for Distribution Network Operators (DNOs) or Gas Distribution Networks (GDNs) in supporting the takeup of clean heating

HHIC believes that the RIIO programme already actions this point and so any future obligation needs to be worked through this scheme.

We agree with BEIS that utilising the networks would be a very productive way forward as they have interests in ensuring a future for their assets.

Example 4 - Obligation on manufacturers or suppliers of oil systems

This obligation appears very difficult to implement. It requires a level of market knowledge or control that manufacturers do not have.

It could be run in a similar manner to recycling regulations, so placing a nominal target based on expected sales. However we are not sure that manufacturers can force consumers to buy certain products. If heat pumps or biomass systems cannot be sold would the manufacturer be penalised?

It appears that BEIS envisage this to be similar to a carbon tax. Whilst this could work, the net result will almost certainly be certain companies going out of business. Whilst this may be seen as an unfortunate consequence of decarbonisation and one that has to happen in order for us to meet our carbon reduction goals, we are wary of the political impact of the business department of government actively pursuing policies that harm business.

There are probably other means of achieving this same goal without adding potentially damaging political pressure.

We would suggest BEIS work with the manufacturers of oil heating systems to ascertain a collaborative way forward that could achieve the above outcome without the need for an obligation that could become too punitive.

Example 5 – Obligation on suppliers of oil

See our response to the question above.

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?

As stated above incremental and simple regulation would be the most effective.

HHIC believes that the next step should be further actions as outlined in the Boiler Plus regulation. Looking at overall system design and how to maximise performance. We also believe that BEIS should carry out a full review of how hot water is heated and stored and the optimal methods for this.

Once systems are upgraded and working more effectively then other innovative technologies such as hybrids or heat pumps would face lower barriers to entry.

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

Currently the networks are obligated to deploy low carbon heating and to increase work in this area. They are also aware that the UK has to decarbonise by 2050. For the GDNs this means finding an alternative to natural gas.

The drive for hydrogen and biogas is coming from the GDNs. Therefore we don't think BEIS need to do any more than they currently do in order to motivate the GDNs.

The long term 2050 targets means that all the networks have a goal that has to be achieved in order to maintain value in their asset. For the GDNs this is more acute as they have more control over the product in their network and the most to lose if it is not decarbonised. The challenge for the DNO's is to upgrade their network for the likely increased demand in electricity.

Due to the pressure electric cars will place on the system, especially in rural locations, we believe the DNOs should have that as their primary objective, rather than installing heating measures.

We are also aware that increasingly the networks are working towards a whole systems future and this will have very positive outcomes for decarbonisation, such as hydeploy and Freedom Project.

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

HHIC believe that from an economic stand point the encouragement of capital markets to provide green investments comes as a result of a harmonisation between both supply and demand side stimuli.

Initial analysis of the supply side shows that capital markets and the companies within them, inherently operate under the main objective of profit maximisation. Therefore, in order to foster private investment on financial products that promote energy efficiency measures, such initiatives should also be seen to deliver low risk capital gains for the company that is offering them. Only then will the private sector be willing to engage in such operations.

Evidence from green mortgage initiatives suggest that leading mortgage lenders perceive green mortgages as carrying a lower financial risk. The reasoning behind this is twofold. Firstly, increasing the energy efficiency measure of a property means home owners demand

less energy and benefit from lower energy costs, in turn increasing their disposable income levels. Home owners in this position pose a lower lending risk as they are less likely to default on mortgage repayments due to the windfall of extra money. Secondly, there have been studies to show that improvements in the EPC ratings of houses have a positive correlation with property value, further improving their risk profile.

As mortgages are the heart of the EU economy accounting for approximately a third of EU banking assets, involvement in green mortgages appears to be a lucrative business opportunity from a supply side perspective.

From the viewpoint of demand, sufficient consumer interest in green finance needs to be in place for the private sector to engage in offering it. Social behaviour plays a pivotal role in what is offered by the capital markets. Therefore, it is important to educate people on the importance of energy efficiency and the long term future of finite resources. A consumer insight study was carried out by the UK Green Building Council across United Kingdom. Italy and Sweden. Upon which consumers were asked to rank a number of factors they consider to be important when buying a property. The outcome showed that 'how energy efficient a property is' was ranked least important out of 8 factors within the United Kingdom. This suggests that changes in social behaviours can only come as a result of improvements in education and the national curriculum putting a higher emphasis on the importance of energy efficiency and its impact on the climate change.

HHIC remain ambivalent on the use of private finance as a means of fostering the uptake of energy efficiency measures by consumers. Previous green finance initiatives such as the green deal scheme failed to deliver the expected energy savings. Whilst government subsidy has a proven track record in delivering energy and carbon savings, we believe government should err on the side of caution when intrusting in private finance to promote energy efficiency savings.

Our belief is that financing energy efficiency measures through consumer credit is a sub optimal strategy when attempting to increase consumer demand. We believe there is very little evidence to support a relationship between financial measures which incorporate the use of consumer credit and the demand for energy efficiency measures.

Focusing on domestic gas boilers, a recent market survey on how boilers are financed showed that a very small percentage of consumers used private finance for their purchase. The Green Deal also failed to create a finance market for boiler installation. Private finance for boilers is also widely available and at a competitive interest rate so Government intervention in this market is not necessary.

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?

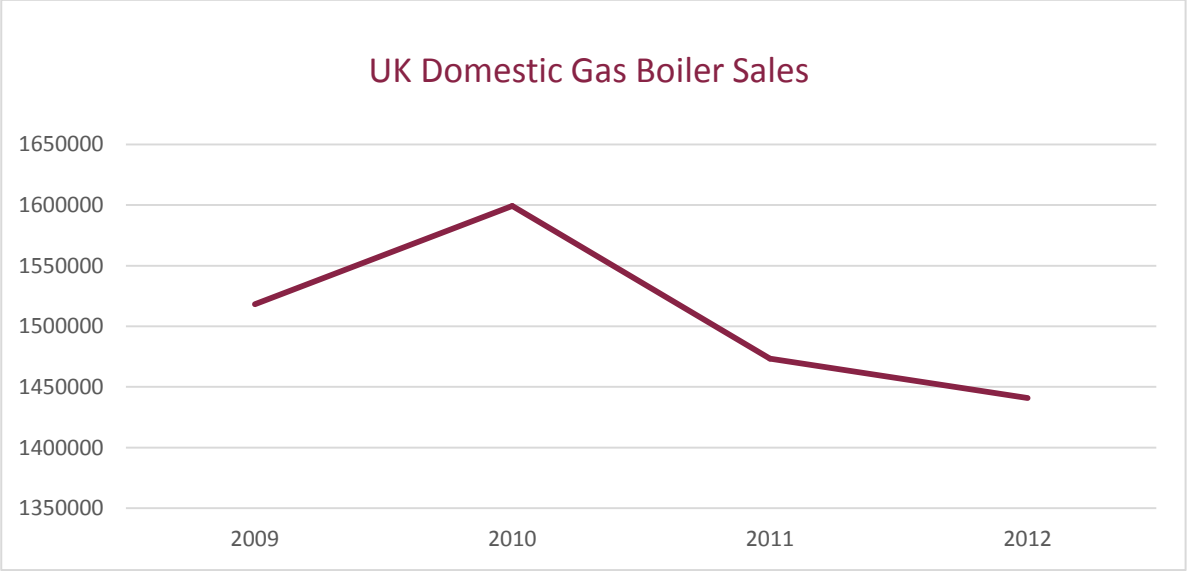
HHIC believes that subsidy is necessary to ensure that low income or vulnerable households can access measures to improve their domestic heating. With fuel poverty impacting nearly 2.5 million households, and mortality rates associated with cold homes being extremely high (cold housing kills over four times as many people as road and rail accidents each year), it is vital that the mechanisms are put in place to support such households (proposed ECO3 measures go some way to address the issue but subsidy could also be utilised).

Further, subsidy is vital- schemes where there has been an upfront cost to the consumer have, typically, not fared well as very few households have the disposable income, or the inclination, to access measures that involve an upfront capital cost. This is illustrated by the lack of success seen under schemes such as the RHI and Green Deal. Conversely, schemes where funds have been available to the householder (such as ECO, CERT & Boiler Scrappage) have been far more successful; the principles of these are sound and should be emulated if we are to encourage consumers to improve their domestic heating. Given that the existence

of the Energy Company Obligation, any subsidy should be raised through general taxation as opposed to generated through suppliers.

In terms of fiscal levers, our belief is that providing a direct subsidy for energy efficiency measures would be the best choice to increase demand. In addition to the Green Deal Home Improvement Fund, the Boiler Scrappage scheme also provides evidence to suggest that subsidies do have a significant influence.

The boiler scrappage scheme introduced in early 2010 aimed to stimulate the replacement of old inefficient (G-rated) boilers with more energy efficient models through a voucher scheme. According to the EST the stand alone scheme generated 118,000 boiler installations. Looking at the graph below we can see the impact the scheme had on domestic gas boiler sales between 2009 – 2012.



The same year the boiler scrappage scheme was introduced domestic gas boilers sales hit a four year peak of 1.6 million boiler sales, thus providing evidence of the impact the scheme had on the uptake of energy efficient boilers.

It is clear that when direct subsidies have been used in the past they have been very successful. Our belief is that in order to maximise the effectiveness of a direct subsidy it

should be financed through general taxation rather than the taxing energy companies. The progressive nature of income tax means that higher earners would contribute more than lower earnings towards financing the subsidy. This would promote more equality in comparison to simply taxing energy companies who would then increase their energy prices thus putting low income households at a disadvantage.

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?

There is little evidence to support the statement that novel business models work for heating appliances. A lot of faith is being placed on selling heating in a different way without the empirical evidence to support it.

The two models that exist are buying in full from an installer or buying on credit. The latter is growing popularity but report HHIC has seen show that it is still a fraction of the market.

We suggest BEIS ask companies such as British Gas what information they can provide on this point.

Further to that, it is hard to envisage another model entering this market. This is because it would require the existing supply chain to embrace it, or develop a new supply chain.

New entrants to the market are using internet selling as the key innovation. Boxt for example are selling boilers through a simple form on their website, offering a fixed price for installation and a guaranteed installation date. The push from Boxt is also for monthly payments. Our understanding is that they remain an outlier at the moment, but with a lot of potential for growth.

It is hard to see other models for providing heating systems that could be compatible with this market, or other models that have been proven in other markets.

For other big purchase items, credit is the main driver. This is something that is already available in the heating industry.

The other model that has been proposed is one where consumers don't own the appliance but pay a heating charge to a supplier. For clean heating the supplier would take the renewable heat incentive if one were available. The charge to the consumer may be smaller therefore that the total repayment cost of the appliance.

Whilst there is an appeal to this model it is still effectively a credit arrangement just repackaged.

The barrier to these models is not the models themselves, but consumer apathy to innovation in this space. People want heat, they are comfortable with the current model and effectively buy it as a package already when using comparison websites. When the appliance breaks they will choose the model appropriate to them at the time. However we believe that consumers are wary of products that are new to them and models that add complications like the non-ownership of the appliance. Unlike with cars where a consumer has a new car every few years, heating appliances have far less social value.

BEIS don't need to stimulate this market. They tried with the Green Deal and it failed. If the market demands alternative payment models, they will emerge and the ones that work best will succeed.

The role of Government is to ensure novel models do not exploit vulnerable consumers or lead to inappropriate selling.

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?

As outlined above there are few international examples that support the concept of alternative approaches to selling heating appliances. As the BEIS commissioned work by Vivid Economics found[12].

The question for BEIS is what approach are they looking for? If the goal is to install more efficient boilers then the current approach could be improved by encouraging private landlords to change their heating, and this could be regulated. The current ECO scheme then offers assistance for vulnerable households, even if the evidence suggests there is still not enough funding to help all those in need.

If BEIS are looking for a way to mitigate the upfront cost of a heat pump then they are going to need to first reduce the heat demand from UK homes. The Danish model cited in the call for evidence works presumably because the low heat demand of the homes allows for cheap and small appliances to be installed. This is not the case in the UK where the most popular sizes of heat pumps are still over 7kw[13].

Therefore the only alternative approach would be for government to fund new heat pumps, which would not be cost effective.

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

[12]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/699674/050218_International_Comparisons_Study_MainReport_CLEAN.pdf
[13] Bsria sales data

Whole house approaches are a fantastic concept, but one that does not seem to happen in reality. The Green Deal Home Improvement Fund offered incentives for multiple measures and this was not successful.

ECO typically only delivers a single measure per home.

Evidence from installers is mostly that consumers want either a new heating appliances or insulation. These tend to be at purchases made at different times, purchased from different people and with different motivations.

Whilst it is tempting to offer incentives for insulation when a boiler is installed, or to attempt to enforce it, in practice the consumer is not motivated to do multiple measures.

One comment from installers is that insulation is not an attractive business proposition. The additional income is not substantial and the work is messy and cumbersome. If they have been asked to replace a boiler that is the work they will undertake.

BEIS could look to try and incentivise multiple installations, or attempt regulation again, however the evidence is that consumers are not demanding this approach.

We are also concerned that attempts to regulate for this could lead to a backlash against the policy as has been seen with other attempts at consequential improvement legislation.

HHIC does however agree with BEIS that a whole house approach would be beneficial and we will work with our members and installers to see if there are any further ideas or innovations that emerge that could assist with this concept.

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

HHIC believes the government must ensure that local authorities, and communities, have the resources and capacity to best support households, and businesses in terms of ensuring that their heating needs are met. Flexible eligibility, introduced as part of the Energy Company Obligation (ECOT2) in April 2017, provides a tool for local authorities to target measures to households most in need with regards to affordable warmth (if this results in them gaining a new boiler then the associated efficiency can also reduce domestic heating emissions).

Yet this measure is not currently being utilised to its full potential (currently only 2% of ECO funding is being allocated under flex) – this could be down to the complexity associated with writing a statement of intent, and also levels of local authority funding. Furthermore, there are a range of charities that serve to support communities in terms of accessing information and funds available to them (such as Beat the Cold, Turn2Us, Citizens Advice, Marches Energy Agency).

Whilst the work these organisations do should be lauded, reliance on community organisations to tackle inefficient homes and fuel poverty does not provide a sustainable model, and we are concerned that it may be the case that charities are having to step in to the role of a local authority. Moreover, given the localised nature of many of these organisations, and the widespread, national scale of fuel poverty, we could see a postcode lottery coming into play here.

As a result, HHIC encourage BEIS to conduct an investigation into the capacity of local authorities to deliver energy efficiency measures. Government must refrain from passing the buck onto councils or local authorities, whilst ensure requirements pertaining to domestic heating are made clear.

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?

HHIC are aware that Wales & West Utilities have created a whole energy simulator that could be used to create local plans that maintained security of supply, reduced carbon to the desired level and can estimate the investment required[14].

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.

HHIC do not see the benefit in a patch work of local regulations across the UK. Energy policy can be perceived to be a complex network at the moment and this would just complicate it further.

If BEIS want to ban new oil boiler installations then they should enact that as a policy, creating local pockets where it is banned and others where it is not does not seem to operate as effective policy.

Given that banning oil heating will only save 0.5% of total UK CO^2 emissions then we would question the efficacy of local bans that would save even less in carbon.

A patch work approach also reduces benefits from economies of scale and could, on the opposite spectrum, unfairly penalise installers from one region and not another.

Our members want as much uniformity of policy across the United Kingdom and ideally as possible, Europe. Creating different regulations across different regions does not allow for this.

Also for emerging technologies small pockets of demand will not be high enough to alter pricing or increase the UK skill set. These require national action.

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

[14] http://www.wwutilities.co.uk/media/2661/2050-energy-pathfinder-short-paper.pdf

A number of partners have been attempting to create awareness in clean heating for decades and the empirical evidence shows that consumers still just want to replace their existing appliance for the same one. [15]

The evidence points out that consumers are happy enough with the service from most existing appliances. They are cost effective to run, relatively cost effective to purchase, and they understand how to use them.

Our members tell us that consumers are increasingly interested in smart heating controls and the ability to control these with their phone. However this level of interest does not extend to their heating appliance.

In order for consumers to become interested then the alternative has to offer a radically different set of outcomes. Electric cars are becoming more popular because they are cheaper to run, have better performance in some cases and technically can be charged anywhere there is a power socket.

Heating options are not currently in that space. A heat pump will offer no additional benefits to a consumer over a gas boiler. It will heat the house to a comfortable temperature and provide hot water, however it will be more expensive to run and more expensive to buy.

Heating remains a deeply functional service and so consumer awareness will remain low. BEIS could spend a lot of money promoting new heating systems but there is little evidence this will make any difference to consumer purchasing behaviour. This is also supported by consumer research in this area (references).

[15] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/191541/More_efficient_heating_report_2204.pdf

This is one reason why HHIC supports the move to decarbonise the fuel rather than the appliance. Decarbonising gas would mean that consumers would not have demand a new product, they can continue to make the same purchasing decisions and yet their heating would become decarbonised. This seems simpler and more achievable than changing consumer behaviour and trying to raise awareness of new products that offer the same service just at a much higher cost.

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

Working with delivery partners such as installers, networks and energy companies is the most effective way to engage directly. However there is little evidence that this will change consumer's attitudes in a meaningful sense.

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

Feedback from installers to HHIC indicates that they would like government to work with them by actively seeking their views and working on communications plans they are comfortable to deliver. There is concern that they will either be sidestepped or ignored. HHIC knows that BEIS have spent a lot of time seeking installer views on these issues and that they should continue to meet and engage with groups of installers.

Installers are also very active on social media which could be another way to engage.

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

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?

The industry will ensure that installers have the skills necessary. When changes to the industry are made such as regulation for new products the market will and has provided the required upskilling.

When condensing boilers were mandated and today with boiler plus, manufacturers will provide installers with the skills needed to safely and correctly install the measures.

Currently manufacturers train over 30,000 installers a year. Even more are trained by private training companies. Heating engineers also have to be retrained every 5 years and so there is the option to add new modules to their existing courses.

All the industry asks from Government is to not add additional red tape to training and skills requirements. Initiatives such as MCS and the upcoming Each Home Counts Quality Mark will add too much additional cost and bureaucracy meaning most installers will not engage, which could lead to fewer accredited installers and a growth in unqualified and possibly untrained engineers. It could also disincentivise people from joining the industry because of the high upfront costs and maintenance costs of operating in the sector. We know that there are more renewables installed than are registered through MCS, suggested an unregulated part of the market. Some estimates put it at more than 50% of installations.

We would ask that BEIS learn from the Gas Safe Register approach which has been effective and not adding a layer of red tape installers can't engage with.

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

Unless BEIS can make heat pumps the same price as gas boilers, require less remedial work to the home, and work effectively in cold temperatures, whilst adding the required electricity production and reinforcement, this approach will not work. We are not sure what else can be done to target these barriers.

The best way to tackle these options is to decarbonise the fuel and so allow households to keep their appliances.

HHIC are further concerned about the EPC mechanism and the Standard Assessment Procedure (SAP). Our principal concern is that the overridsing mechanism is no longer fit for purpose. One of the most common complaints from our members and people working in the energy industry is how bad SAP is and how it doesn't either recognise products properly in terms of energy saving, but how it distorts the market in favour of certain technologies without enough basis in actual savings. This is concerning because it can lead to incorrect reporting on energy savings and promotion of products that do not actually offer value for money.

We are also concerned because this mechanism is the basis for EPCs. HHIC is concerned that the assessments for these are superficial and often incorrect. This means that potential energy savings are probably overstated, as often insulation is not checked for. This can lead to policy positions not based on correct empirical data.

HHIC and UKLPG has however had longstanding concerns about the off-grid implications of EPC calculation methodology, which places disproportionate focus on the cost of the input fuel rather than building fabric. This directly impacts off-grid home owners and effective policy implementation.

The EPC calculation methodology places primary focus on running cost (£) rather than units of energy consumed (kWh) which causes specific distortions in ratings between properties that use different fuels.

This is a particular problem for off-gas grid properties where all fuel options (heating oil, electricity, solid fuel or LPG) are more expensive than natural gas. Off-grid properties are

instantly disadvantaged as their location dictates their fuel options which automatically results in lower EPC ratings.

To achieve meaningful energy efficiency improvements and performance standards both on and off the grid, EPC's should be calculated to encourage investment in building fabric and energy efficiency measures irrespective of a property's input fuel.

We maintain that there should be no cost element in the methodology if Government's key and long-term aims are to cut harmful emissions and drive improvements in energy efficiency.

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

Any future regulation has to be well consulted and proportional. The Boiler Plus regulation was a good example of this.

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?

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?

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

Heat Pumps require some form of hot water storage in order to provide hot water. Therefore new homes should be mandated to include hot water storage. In that way any future retrofit of a heat pump will not have to include the cost of a new storage cylinder, and more importantly space will already have been made for the cylinder.

In the last ten years sales of domestic hot water cylinders has fallen by over 50%. "Over the last two decades, the use of combination boilers for central heating have increased. Such boilers provide hot water from the central heating without a separate tank and have increased dramatically from 12% in 1996 to 52% in 2014. This has meant that fewer homes have a hot water tanks, down from 63% to 38%."[16].

The government wants to reduce energy use in the home. As we reduce the amount of energy needed for space heating the proportion of energy used to generate hot water will stay at similar levels to today. If we also move to lower temperature heating devices, such as heat pumps, then the energy use needed to generate hot water will increase. Heat pumps need a hot water store, they cannot generate hot water on demand.

Therefore the current policy framework needs to look to encourage the retention of hot water stores. It also needs to encourage new homes to be built with hot water storage to make them renewable ready. If they are not then they will need to be retrofitted at a later date which will be more expensive to the householder.

A common hot water cylinder of approximately 180 litres can store around 800 kWh of electricity which is converted into hot water. This is approximately an average homes daily use. We believe that more research is needed into the potential use of hot water storage for demand side management. Close to 40% of homes have a store and so the park of available appliances is already in situ unlike with expensive 'battery' technology.

Nearly all hot water cylinders have an electrical immersion heater inputted into the store to provide a secondary source of heat. This is the primary source for homes with no natural gas or oil connection. These immersion heaters could be 'smart' enabled to be used by national

[16] English Housing Survey Energy Report, 2014

grid to manage demand by transferring electricity to the stores when needed. This energy will then be used by the household in terms of hot water.

One of the biggest problem for the installation of hot water cylinders in new build is that the value of floor space is too high in many cases to justify using that space for a cylinder. Developers will attempt to use that space for a functional item such as a spare toilet or in some cases an en-suite.

BEIS could look to regulate to mandate that house developers include a storage cylinder to tackle this market deficiency.

We would also like BEIS to review storage options for new build as we believe there are benefits to be achieved from linking solar PV to a storage cylinder using a solar diverter in order to maximise a householder's return on investment having installed solar photovoltaic (PV) panels. This can help encourage homes to install PV panels and help them to maximise their return on investment.

The savings have been calculated using a bespoke model that calculates how much a typical household would pay for hot water, before using solar PV generation data to estimate how much of this cost could be offset by using "spare" electricity from their solar PV array.

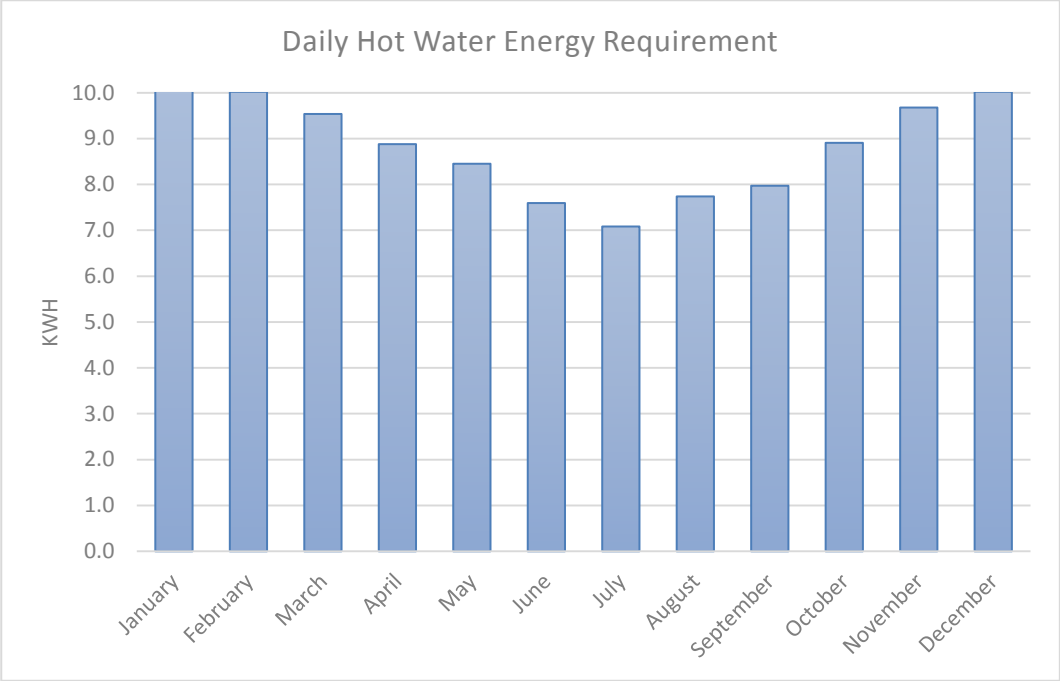
Daily hot water energy requirements were estimated using the Building Research Establishment's Domestic Energy Model (BREDEM) 2012 methodology. For a given number of occupants, this methodology uses an estimate of the number of showers and baths taken each day to calculate how much hot water would need to be produced to satisfy the needs of these occupants. For the purposes of this calculation, it is assumed that the property is home to 2.4 occupants.

By taking into account the temperature of incoming water[17] and the temperature to which it is heated, the energy content of the heated water can be calculated for each day of a representative year. In addition to this, water heating system losses (in the form of

[17] BREDEM assumes the temperature of incoming water is higher in summer which explains the drop in energy demand for hot water at that time of year. Most new cylinders installed will be mains pressure and therefore the water feed at more constant (and lower) ground temperature. This may mean there are greater savings to be made with unvented systems.

distribution, storage and primary pipework losses) impose a further energy requirement upon the hot water system. It is assumed that the property has a 180L hot water storage cylinder.

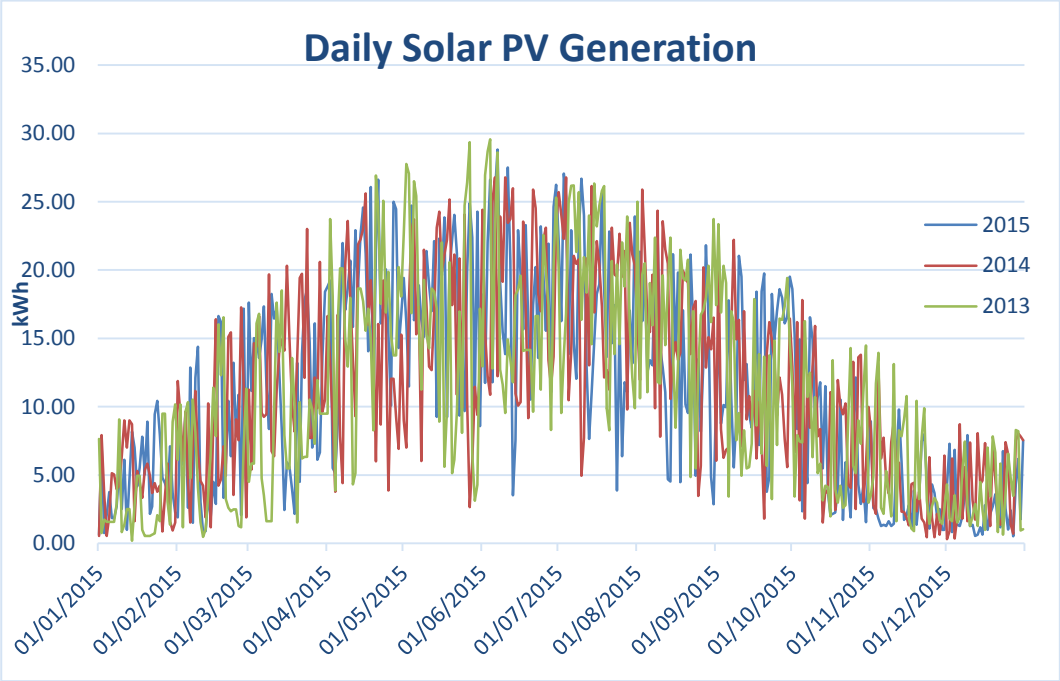
Adding the above together provides the following estimate of daily energy requirements for hot water in each month:



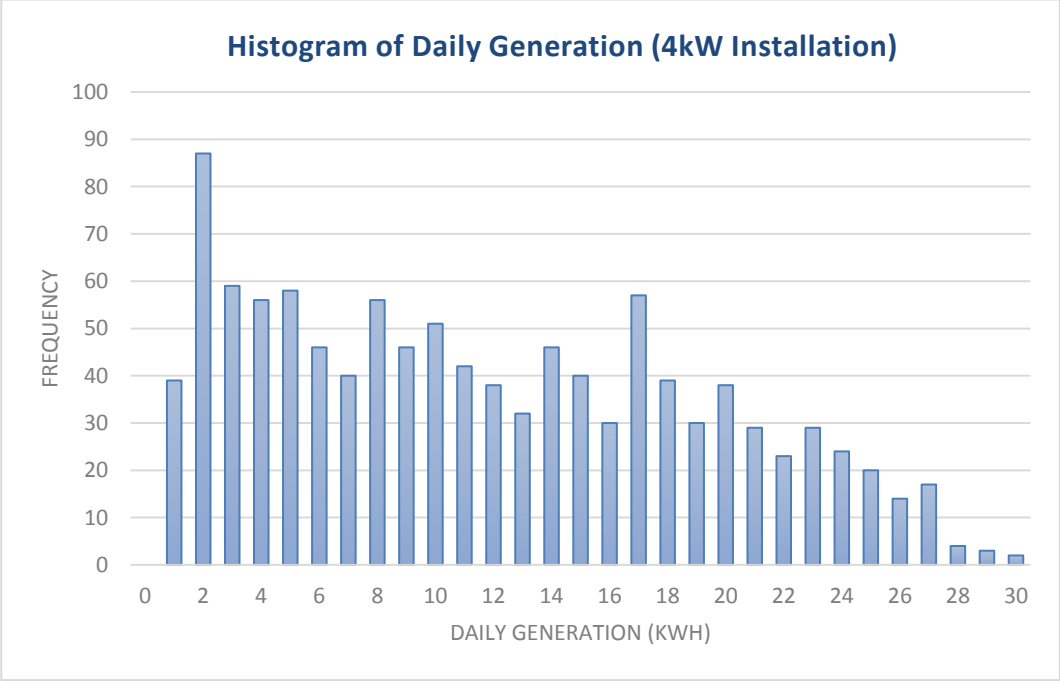
Generation data for a UK solar PV installation was provided to by Viridian Solar. The data related to the 44.5 kWp installation on Viridian's factory roof[18] and detailed the amount of electricity generated from this installation on each day between 1st January 2013 and 31st December 2015. A 44.5 kWp installation is far larger than the typical domestic PV installation, so these generation data were scaled to indicate the output from a 4kWp installation.

The following line graph demonstrates how daily solar generation varies from day-to-day throughout the year. As would be expected, a highly seasonal pattern emerges:

[18] Sout-West facing, tilt angle 35 degrees, shading – none or very little.

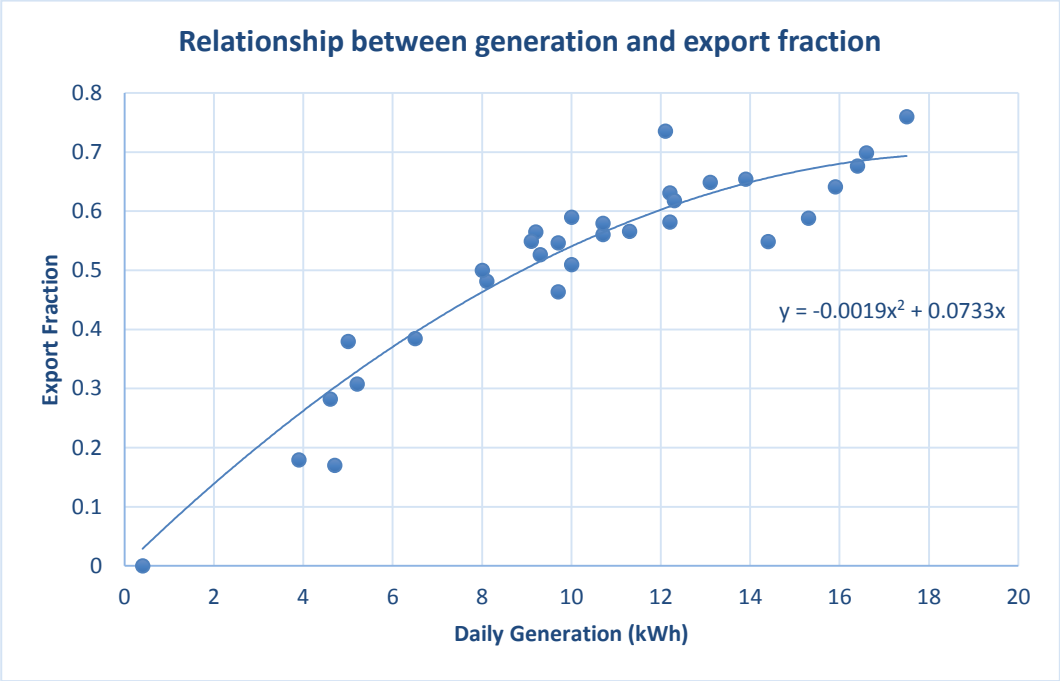


The following histogram shows the frequency of different levels of daily generation.



Although Feed-in Tariff (FiT) export payments are currently paid on the basis that 50% of generated electricity is exported, this is unlikely to be true in reality. It stands to reason that a higher level of generation should result in a higher export fraction, since household electricity consumption is largely intransigent to solar irradiation (this may not be true in hotter countries where domestic air conditioning is more prevalent).

A second data set supplied by Viridian Solar provided information from real household solar installations on the level of solar generation and the percentage that is exported. Using these it was possible to construct a model that allowed the estimation of the export fraction for a given level of generation. The graph below shows the relationship between generation and the export fraction.



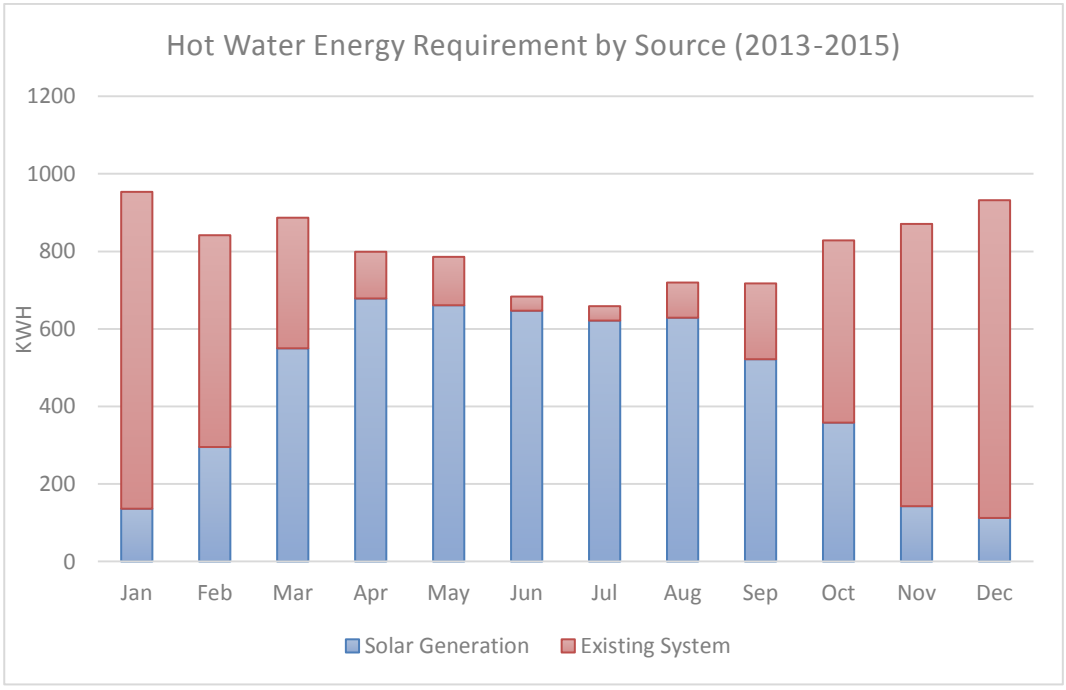
A quadratic line of best fit was then fitted to these data (with the intercept set to zero). Using the formula associated with the line of best fit, it is possible to estimate the export fraction for any given level of generation. This is demonstrated in the table below:

Generation (kWh)	Export Fraction
0	0.00%
2	13.90%
4	26.28%
6	37.14%
8	46.48%

10	54.30%
12	60.60%
14	65.38%
16	68.64%
18	70.38%
20	70.60%

Using a solar diverter, it is assumed that any electricity that would have been exported is used to instead meet the household's hot water demand.

On some days, excess solar electricity is sufficient to meet all of the energy requirements for hot water. On others, the existing heating system has to meet some of the additional energy requirements. The graph below shows the average proportion of the hot water energy requirement that could have been met by each energy source in each month over the three years for which the solar generation data were available.



In the first instance, the cost of meeting hot water demand using a gas boiler or an electric heating system (boiler or immersion heater) is calculated. For a household using a gas boiler the following assumptions are made:

- Hot water efficiency of 80%
- Gas price of 4.18 p/kWh

For a household using electric heating, the following assumptions are made:

- Efficiency of 100%
- Electricity price of 13.86 p/kWh[19]

In the second instance, the cost of meeting hot water demand using a solar PV array and power diverter alongside the existing heating system is calculated. The table below demonstrates the costs of each situation and the resulting savings:

		2015	**2014**	**2013**
Gas	**Original cost**	156.53	156.53	156.53
	Cost with PV and Diverter	67.63	65.61	71.33
	Savings	**88.91**	**90.93**	**85.21**
Electricity	**Original cost**	415.22	415.22	415.22
	Cost with PV and Diverter	179.38	174.03	189.20
	Savings	**235.84**	**241.19**	**226.02**

[19] This could be reduced to 7.21p if using economy seven, however this is not representative of the majority of UK households.

For households using gas to heat their hot water, a saving of approximately £90 could have been made in each of the last three years. For those using electricity, the saving would have been between £220 and £240.

This study only considers the benefits to the homeowner, but it would be remiss to conclude without mentioning some of the wider benefits of hot water cylinders in a future of widespread renewables. The unpredictable nature of renewables means that the challenge of balancing the grid will become more difficult as renewables play a larger role in the electricity mix. Finding economic methods of storing this electricity will be a key component of managing the new electricity system.

This study suggests that the use of a solar diverter alongside an existing hot water storage cylinder has the potential to produce significant savings. Given the relatively low initial cost of a diverter (~£200-£300), payback could be achieved in under three years.

The Electric Heating Company and Delta EE also completion trials of their EHC Solar PV Ready Radiator secondary heating solution ("the EHC solution")[20].

The nationwide Trials of the EHC Solution involved 27 properties in total and covered a 12 month period. The final report prepared by Delta EE analysed the performance of the EHC Solution and found:

- The EHC Solution increased PV self-consumption on average by 42%.
- Average estimated annual Bill Savings of £42.44 for properties with Gas Central Heating and carbon savings of 199kg.
- Average estimated annual Bill Savings of £185.87 for properties with all Electric Heating and carbon savings of 868kg.

[20] https://www.electric-heatingcompany.co.uk/solar-pv-secondary-heating-success-final-trial-results-now-available/

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 future-proofing measures.

There are a diverse range of pathways which include technologies that have low carbon emissions available within the heating industry such as:

- Direct Electrification
- Heat pumps (Air Source)
- New Gas Boilers

Through undertaking a simple in house cost analysis we can determine which technology possesses the lowest cost per tonne of carbon saved which gives a good indication of cost-effectiveness and affordability.

Within our cost analysis we compare the two means of heating through electrification if they were to be installed in an off grid new build setting. As suggested within the call for evidence, latest figures show that there are 154,220 new build properties, of this total 28% or approximately 43,182 properties are found to be off the mains gas grid. Given this total we consider the cost effectiveness and carbons savings if we were to install all 43,182 off grid new build properties with either a storage heater or a heat pump.

Storage heaters are heating systems with thermal storage. For modelling purposes we assume the cost of storage heaters to be approximately £4,500. Given this we calculate the total cost of installing all the off grid new build properties (43,182) to be approximately £194,317,220

In terms of carbon savings Ofgem report that a new more efficient storage heater on average requires 6682 kWh a year for space heating purposes. This coupled with the carbon intensity factor of electricity being 0.4 kgCo2/kWh in accordance with the Energy Savings Trust, we calculate the carbon emissions for a single modern storage heater to be approximately 2.672 tonnes. Further multiplication by 43,182 gives us the aggregate carbon emission level if all off grid new builds were installed with storage heaters to be 115,415 tonnes

Comparative calculations can also be done for heat pumps which is a heating technology that converts energy in the ground or air into heat and requires electricity to do so. For modelling purposes we take a typical air source heat pump (ASHP) to cost on average around £9,000 this is inclusive of installation costs (franckenergy,2018)[21]. Given the cost of a single ASHP, aggregate costs of installing all new builds off grid with ASHP come to approximately £388,634,400.

Once again, in terms of carbon savings, Franck Energy(2018) reports that an air source heat pump consumes 4,000 kWh per year this multiplied by the carbon intensity factor of electricity being 0.4 kgCo2/kWh, we find that the carbon emissions for a single ASHP equates to approximately 1.6 tonnes. Further multiplication by 43,182 gives us the aggregate carbon emissions level if all off grid new builds were installed with ASHP to be 69,090 tonnes.

Given the above deductions, we can see that if the government were to install all off grid new build properties with Storage Heaters it would cost them around £194.3 million. Of these Storage Heaters in situ they would in total emit 115,415 tonnes of carbon dioxide. Comparatively, if the government were to install all off grid new build properties with heat pumps it would cost them around £388.6 million and those heat pumps in situ would emit approximately 69,090 tonnes of carbon dioxide.

Differencing the total carbon emissions if both technologies were to be installed gives us the level of carbon savings of one technology over the other per year.

Aggregate Carbon Emissions of all Storage Heaters (tonnes)	**Aggregate Carbon Emissions of all ASHP (tonnes)**	**Carbon Savings (tonnes)**
115,415	**69,090**	**46,325**

In order to monetise the aggregate carbon savings from using an ASHP over a storage heater, a simple division of the carbon savings with the total cost of instalment puts the cost

[21] https://franckenergy.com/2017/06/27/what-are-the-running-costs-for-an-air-source-heat-pump/

per tonnes of carbon saved at approximately £8,389 per year. Further, discounting the cost of carbon saved across the lifetime of an ASHP which we assume to be 15 years, we determine the cost of carbon saved of a full off grid new build instalment at approximately £599 per tonne across the lifetime of the heat pump

Therefore, from the above deductions if electrification was the only option with regards to new build properties it is clear that the most cost effective way of decarbonisation would be to install heat pumps.

HHIC's belief is that when possible it is always better to connect new builds to the mains gas grid and install a gas boiler. On average gas boilers at current price cost approximately £2,000 which is £7,000 cheaper than an ASHP. Further to this, on a consumer level they are also significantly cheaper to run as according to the Energy Savings Trust, it costs 3.63 pence/kWh for gas and 14.33 pence/kWh for electricity at a standard rate. With regards to carbon intensity for each fuel, gas emits 0.185kgCo2/kWh in comparison to 0.4kgCo2/kWh for electricity which is more carbon intensive.

It has been noted in the Wales & West Utilities Freedom project that whilst the project was aimed at retrofit to existing housing stock, the combination of boiler and small heat pump whilst being a higher investment for the housebuilder inside the property, would have very substantial savings in the overall energy system. Reduced electricity grid reinforcement; reduced standby generation and reduced storage requirements in the grid would outweigh the house investment. A low carbon home, such as the SOLCER House in Wales, produces more energy than it consumes over a year, with an excess in summer and a deficit in winter – hybrid installations in these kind of low carbon homes can manage low heat demand by switching between fuel vectors and enable low cost full decarbonisation using green gas – as well as helping to get over the smaller but still important hurdles of hot water and the predominant preference for gas hobs for cooking.

In conclusion, it is clear that the utilisation of mains gas is the most cost-effective method going forward in order for the government to meets its decarbonisation targets. Coupled with smart hybrid heating it could make further cost and carbon savings, as demonstrated

by the trails carried out by WWU. This ad vocation for the use of the gas grid is further corroborated by a recent study undertaken by the National Infrastructure Commission (2018)[22]. It also allows for these homes to be connected to a potential hydrogen network.

[22] https://www.nic.org.uk/wp-content/uploads/Element-Energy-and-E4techCost-analysis-of-future-heat-infrastructure-Final.pdf