REPORT

WARMTH IN A CHANGING CLIMATE

HOW SHOULD THE GOVERNMENT ENCOURAGE HOUSEHOLDS TO USE RENEWABLE HEAT?

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ABOUT IPPR

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CONTENTS

SUMMARY

Meeting the targets for emissions reduction set in the Climate Change Act 2008 will require significant changes in the technology used by households to provide heat. This briefing considers the options for decarbonising household heat, examines the barriers policymakers face and reflects on the findings from four focus groups with consumers.

The government is planning a second phase of its Renewable Heat Incentive (RHI) to focus on household heating. The assumption, based on detailed modelling work commissioned by the Department of Energy and Climate Change, is that a tariff will be paid to householders who invest in renewable heat technology to make the heat they produce more cost-effective. The model suggests that the cost of reducing emissions in this way will be lower than some other sectors, such as offshore wind, but that the total costs of the policy will be high.

However, IPPR's research, including focus groups with consumers, shows that, for household heat, major uncertainties exist concerning the suitability of Great Britain's housing stock, the efficiency in situ of some of the key technologies, consumers' willingness to become early adopters and the heating industry's readiness to market alternatives. Together, these uncertainties mean that costs across the economy could be higher than anticipated or that take-up may be low. In some cases, technologies may simply not provide enough heat to meet consumers' expectations or to heat homes to a safe level.

Confidence in the technology – especially in heat pumps which, combined with electricity grid decarbonisation, offer the greatest future carbon saving opportunities – will be important if the complicated and diffuse household heat sector is to contribute towards the UK's ambitions on climate change. We therefore conclude that, except in certain circumstances, a tariff-based incentive may not currently be the best policy to grow the market for renewable heat and ready households for the 2020s when decarbonisation must scale up.

Exceptions to this include in existing and new-build properties where thermal efficiency of the building fabric is known to be high and off gas grid households suitable for biomass boilers or ground source heat pumps. To develop the market for renewable heat technologies – and especially heat pumps – beyond these types of housing, we argue that government should:

- integrate renewable heating incentives with its forthcoming Green Deal for energy efficiency, enabling people to secure warmth rather than produce heat
- assist householders to overcome the barrier of high upfront costs by enabling them to have access to low-cost lending with government guarantees, and by integrating heat and energy-efficiency policies into one package
- restrict incentives for heat to properties with a recommended level of thermal efficiency and ensure other households are offered opportunities to improve insulation
- target a proportion of the RHI funding at research and development with the aim of lowering technology costs by improving efficiency, especially of heat pumps
- learn more about the performance of heat pumps across the housing stock through much more extensive trials
- push for innovation in solid-wall insulation as the non-cost barriers, as well as high costs, make current methods highly unattractive to homeowners.

Perhaps the most striking features of IPPR's research, summarised below, emerge from the consumer focus groups, the first on the subject of renewable heat. None of the participants – drawn from households with moderate incomes both on and off the gas grid – were prepared to invest in the current crop of renewable heat technologies. The most significant barrier identified by participants was the upfront cost of installing the technology, but many were also sceptical about its efficacy, turned off by its aesthetics and not attracted by the offer of a tariff-based incentive.

Decarbonising household heat is essential. But to do this by providing a feed-in-style tariff for heat production, rather than by offering a package of measures aimed at providing warmth, risks undermining consumer confidence in heat technology. A tariff-based incentive will also fail to address the high capital costs, identified as the key barrier in IPPR's consumer workshops.

INTRODUCTION

Phase two of the Coalition government's RHI will aim to encourage householders to install a range of low or lower carbon heating technologies. Until 2015, the costs of the policy will be met out of general taxation as opposed to being levied as a de facto tax on energy consumers through bills.

But with increasing pressure on climate change policy costs, IPPR set out to study renewable heat technology and its route to market and to explore whether householders might be willing to invest in cutting their heating-related emissions with the promise of 20 years of tariff payments in return.

IPPR's research aims to:

- examine the efficacy of the technologies that might assist with decarbonising household space heating
- look at the barriers inherent in the current structure of the heating industry and the route to market for the technologies
- test the technologies, costs and attitudes to renewable heat and the proposed policy, among consumers both on and off the gas grid.

The research involved three distinct activities:

- Desktop research to review the literature concerning the technologies and their cost and their route to market
- Stakeholder interviews across the heating industry and with other experts
- Focus groups with consumers.

The discussions with consumers were conducted using a pre-determined guide and took place in late May and early June 2011 in the following locations in England:

	Off gas grid/rural	On gas grid/urban
Medium-high income	Newbury	London, Barnes
Low-medium income	Norfolk	Manchester, Levenshulme

1. DECARBONISING HOUSEHOLD HEATING

Decarbonising household space heating is not a trivial matter[1].

Twenty-three per cent of total UK emissions are from its housing stock and more than half of this occurs as a result of people heating their homes (CCC 2010). The housing sector has a very important role to play in achieving the UK's carbon targets. This framing provides the essential background to the government's RHI plans.

However, the RHI in its current form is also driven by the UK's renewable energy targets. As part of the EU's target of deriving 20 per cent of its energy from renewables by 2020, the UK must develop an energy mix that includes a 15 per cent share. As part of this initiative, the Renewable Energy Strategy (DECC 2009) sets a target of 12 per cent for the heating sector as a whole, including heat used in commercial and industrial sectors. Currently, heating in the UK is less than one per cent derived from renewable sources. The Committee on Climate Change estimates a 12 per cent penetration of renewables in the heat sector by 2020 could result in 17 $MtCO_2$ reduction in emissions (CCC, 2010).

The introduction of the RHI represents over £850m of investment over the current spending review period, which comes from general taxation. Cumulative gross resource costs of the RHI tariffs are estimated at £11.5bn, over the lifetime of the policy (30 years). Estimated subsidy costs of the policy over the same period are estimated at £22bn (DECC 2010b). The estimated costs beyond the current spending review period are highly contingent upon a variety of factors, some of which, such as fossil fuel prices, are highly uncertain.

Renewable heat technologies are, in most cases, more costly to purchase than incumbent technologies, such as gas-fired condensing boilers. They may be cheaper to run, but because capital costs are often significantly higher, the payback period may be long. Logic therefore dictates that, if the objective is to grow the market for renewable heat technologies, a subsidy will help make them more attractive to householders by reducing the length of the payback period.

Incumbency is less of a problem in properties that are not connected to the gas grid and purchase fuels in bulk or rely on costly electric heaters.

- Heating oil: 1.5m households
- LPG: 150,000 households
- Electricity: 1.73m households (including urban flats)
- Biomass: 35,000 households

In phase one of the RHI, the government set out plans to incentivise industry and commerce to achieve 11 of the 12 percentage points required in heat by 2020 (DECC 2011[2]). The final percentage point for the achievement of heat's share of the renewables target is to be found in the domestic sector.

1 As distinct from heating water, although space and water are often heated using the same energy source or fuel.

2 Phase one also includes 'Premium Payments' to householders; lump sums paid to assist with the capital costs of installing renewable heat technologies. These payments are being administered by the Energy Savings Trust and the total budget is £15 million. See http://www.energysavingtrust.org.uk/Generate-your-own-energy/Sell-your-own-energy/Renewable-Heat-Premium-Payment#WhatistheRenewableHeatPremiumPayment for more details.

While this appears a modest ambition, it requires the decarbonisation of 11TwH of heat demand in 2020; some 700,000 households [3]. It is, however, important to draw a clear distinction between the task of increasing the share of renewable energy in the UK's economy by 2020 and the wider and longer-term task of decarbonisation. Beyond 2020, most household heating will have to be decarbonised. Developing and deploying the right technologies and putting in place a policy to support this goal are, therefore, important.

Three other – perhaps mitigating – factors are also worth noting. The first is that while, for the majority of the population, long spells of very cold weather are rare in the UK, many households require high grade heating to maintain comfort during 'spikes' of cold weather when bursts of heat are required.

Figure 1 below shows that because of this, heat demand is concentrated into a relatively small number of days per year (20 per cent in 31 days in 2010, for instance). With increased thermal efficiency in the UK's buildings (see 'Heat 2050' curve) the demand peak flattens but a high proportion of heat demand is still concentrated in relatively few days.

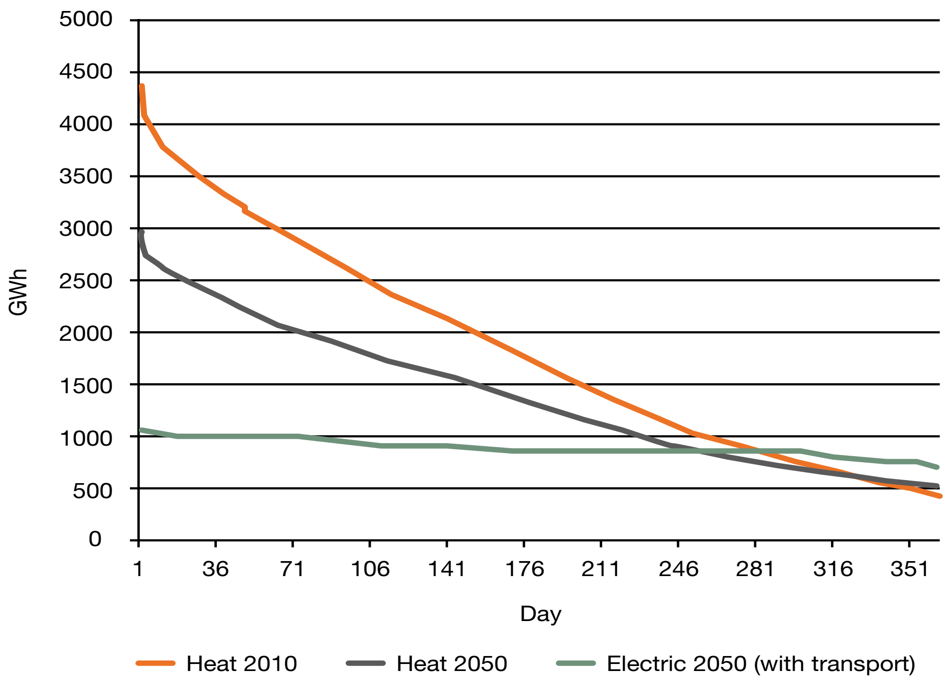

Figure 1 Source: National Grid

3 DECC's RHI Impact Assessment (2010) states that total heat demand in 2020 is modelled as 68TWh from which 57TWh is to be met from RHI Phase1 (that is, commercial, industrial, public sector and premium payment household). This leaves 11TWh to be covered by Phase 2. If the average heat demand for a household in the UK is 15,500KWh, this suggests that around 709,000 households will need to have decarbonised their heating by 2020.

The second is that, unlike other forms of energy use, heating goes hand-in-hand with health. An inability to heat one's home, due to low income or because a property is very poorly insulated, is correlated with illness in vulnerable groups and can be associated with increased rates of mortality, although the causal link is not straightforward [4].

The third is that heat production per se is not what is required by householders but rather warmth. In the consultation that preceded the publication of phase one of the RHI, a number of submissions (for instance UKERC 2010 and Green Alliance 2010) argued that, to achieve climate targets without compromising warmth and threatening wellbeing, priority should be given to improving the thermal efficiency of buildings and reducing the demand for heat, renewable or otherwise.

1.1 Assessing renewable heat technology

The Department of Energy and Climate Change's (DECC) assumptions for paying incentives to installers of renewable heat are based on modelling work by NERA Economic Consulting and AEA Consulting (NERA/AEA 2009). The model used is complex and takes into account a wide range of factors including projections of total heat demand, the cost, efficiency and heat load of renewable technologies, future prices for oil, biomass and carbon emissions and the location, type and condition of the UK's housing stock.

The heat supply cost curves produced by the models suggest that between 45TWh and 66TWh of heat demand could be decarbonised by 2020 at a cost of less that £100 per MWh. To achieve the upper end of the range, the market share of renewable technology would need to grow by 30-50 per cent between 2015 and 2020; this is the maximum rate of transformation that has been observed in other countries where renewable heat technologies are already more widely used.

The NERA/AEA model suggests that the lowest-cost opportunities for the use of renewable heat exist in large-scale biomass boilers, primarily in industry but also in the public sector, along with air-source heat pumps to heat commercial or public buildings, and to some extent also domestic biomass boilers in locations off the gas grid. DECC appears to have pursued this logic to a high degree in phase one of the RHI by seeking to achieve 11 of the 12 percentage points of deployment in the commercial and industrial sector (save for the £15 million of domestic premium payments, which will pay for relatively few installations[5]).

In comparison with renewable technologies in other sectors – and in theory – renewable heat technologies are on average relatively low cost. The RHI impact assessment (DECC 2010: 20) gives a lifetime cost effectiveness (to 2045) of £57/tCO_2 in the traded sector and £75/tCO_2 in the non-traded sector. This compares with the £101/tCO_2 abatement cost of the Renewables Obligation in 2008-2009 (Ofgem 2009) and appears favourable.

However, the RHI impact assessment also notes that '…in actuality cost effectiveness will depend on the exact pattern of renewable uptake and fuels displaced, which is likely to differ to some extent in reality from the modelling results presented here' (DECC 2010: 20). Other important uncertainties also exist and are not adequately captured in the models.

4 Winter death rates in 2009/10 were 30 per cent lower than in the previous year even though winter temperatures were colder. This is likely to be due to a number of factors, such as a low level on influenza, although colder weather is likely to exacerbate existing conditions. See ONS, 2010, *Excess winter mortality in England and Wales*, 2009/10 at http://www.statistics.gov.uk/hsq

5 For instance, DECC will pay £850 per installation for an air source heat pump and £950 for a biomass boiler. If each had an equal share of the premium payments funding pot, some 16,600 installations would be possible during the current spending review period.

In the case of biomass, the price, availability and efficacy of the supply of fuel are important variables that could change the economics and diminish emissions reductions (thus reducing carbon cost effectiveness). With all heating technology, but with heat pumps in particular, performance is very profoundly affected by the thermal efficiency of the property into which it is installed. In addition, heat pump performance is also significantly affected by the heat distribution system to which it is connected and external temperature.

The liability for any additional cost as a result of this uncertainty will fall on the shoulders of householders (and, if carbon efficiency falls short of expectations, the environment) as the heat requirement of a property is likely to be estimated or 'deemed' in advance and incentive payments capped at this level. The volume of 'deemed' heat will be based on an assessment of how a technology should perform in a property of a particular type and size that is insulated to a given standard (although the minimum thermal efficiency standard is still a matter of conjecture).

If a renewable heat technology performs with lower-than-expected efficiency, perhaps because the heating system to which it is fitted is inefficient or if the property is not adequately insulated, then the householder will experience lower-than-expected rates of return and thus a longer payback period. The taxpayer will not have to pay more.

Without deeming, and in the absence of an affordable means of metering heat, householders would be incentivised to produce as much heat as possible and would be rewarded for using heat inefficiently; this is the fundamental problem with offering incentives for heat production. But, unless technologies can return predictable levels of efficiency with a high level of certainty, then with deeming householders are likely to feel short-changed and perhaps even become disillusioned with renewable heat technology. The evidence presented in the sections below suggests that the technologies included in the RHI, especially ground and air source heat pumps, cannot offer such guarantees in substantial proportions of the UK housing stock.

1.2 The challenge posed by the UK's housing stock

The UK's housing stock is among the oldest (see figure 2 below) and most inefficient in Europe. While there will be many new, and likely more efficient, properties built during the period covered by the UK's current carbon emissions reduction targets, many older properties will remain in occupation and, in the case of Victorian housing in major cities, highly desirable in relation to the housing market.

Age	%
Pre 1919	21.5
1919-44	16.5
1945-64	20.2
1965-80	20.7
1981-90	8.9
Post 1990	12.2

More than 4.5 million dwellings. Hard to heat and treat. (← Pre 1919)

More than 2.5 million dwellings. More suitable for renewable heat. (← Post 1990)

Figure 2 Source: English House Condition Survey

As part of their Extended Ambition Scenario[6], the CCC suggest that new policies should address barriers and deliver significant energy-efficiency improvements in the UK housing stock by 2020, including:

- the insulation of 90 per cent of lofts and cavity walls
- the insulation of 2 million solid walls (from a total of nearly 8 million)

The CCC also assume that 13 million boilers will be replaced with new efficient boilers, and that substantial increases in appliance efficiency are achieved. In total, without any renewable heat technology, this could result in a 2020 emissions reduction of 17 $MtCO_2$ in the residential sector (CCC 2010, p199). This is, interestingly, as much as the RHI is assumed to deliver through 12 per cent penetration of renewable heat.

Progress towards these targets is currently variable. Driven in part by the recent scrappage scheme (EST 2011) boiler replacement is running ahead of target with 1.3 million having been replaced by 2010, when 1 million were required by the CCC's targets. Loft insulation is also running ahead of target, although cavity wall insulation is behind and installation rates for both were lower in 2010 than they were in 2009. Installation rates for solid wall insulation are low with only 13,200 being installed in 2010 under the Carbon Emissions Reduction Target (CERT). In a recent report, IPPR argued that further technological innovation in solid wall insulation would be required if there was to be any significant increase in installations rates (IPPR 2011).

The thermal efficiency of buildings matters intrinsically to heat production. Table 1 below, taken from a forthcoming dissertation by Kate Gilmartin of the Graduate School of the Environment at the Centre for Alternative Technology, shows dramatically the (modelled) results of the effects on heat demand of three levels of insulation on four housing types in two locations. While the need for technological change to decarbonise heat is ultimately unavoidable, an improvement in the thermal efficiency of homes will help reduce carbon emissions in the immediate term and energy costs going forward.

6 Measures which would cost more 'per tonne' than the projected carbon price in the current budget, but which are important stepping stones on the path to 2050.

INSULATION	Terrace		Semi-detached		Bungalow		Detached	
	Annual Space Heating demand		Annual Space Heating demand		Annual Space Heating demand		Annual Space Heating demand	
	Total kWh	kWh/m²	Total kWh	kWh/m²	Total kWh	kWh/m²	Total kWh	kWh/m²
London AD								
Standard	19194.1	138.9	11368.8	89.1	8083.7	86.9	17541.5	100.6
Extra	13994.7	101.3	7949.3	62.3	4670.3	50.2	13965.2	80.1
Super	9133.7	66.13	4438.7	34.8	1384.5	14.8	10181.2	58.4
Edinburgh AD								
Standard	23884.5	172.9	15162.0	118.8	11050.3	118.8	23168.5	132.9
Extra	17407.6	126.0	10895.4	85.4	6767.1	72.7	18713.9	107.3
Super	11341.6	82.1	6458.2	50.6	2421.6	26.0	13983.1	80.2

Table 1 Source: Centre for Alternative Technology – forthcoming

Heat pumps, the primary technology that will be used to decarbonise heat in many – especially urban – properties, rely heavily on a high level of thermal efficiency. We explore the efficacy of the technology in greater detail below, but buildings that are poorly insulated are unlikely to be suitable sites for heat pumps; in the worst case, a heat pump fitted to a property with poor thermal efficiency (that is, a low EPC rating) will not provide sufficient heat during 'spikes' of cold weather. The combination of the UK's ageing and thermally inefficient housing and the requirements of heat pump technology could prove an unhappy one.

Gilmartin (2011, forthcoming) goes on to assess the CO_2 emissions performance of air source heat pumps in the four UK properties and concludes that they should only be incentivised in properties that meet PartL1b designated U values for thermal insulation. This requires properties with solid walls of 220mm to have insulation using one of the following methods:

- Directly applied internal wall insulation using 60mm of phenolic insulation
- Directly applied internal wall insulation using 80mm of extruded polystyrene
- Studwork internal wall insulation using 100mm of mineral wool slabs[7]

7 See The Building Regulations 2000, PartL1b, Conservation of Fuel and Power http://www.planningportal.gov.uk/uploads/br/BR_PDF_ADL1B_2010.pdf

1.3 Renewable heat technology

There are four key domestic renewable heating technologies that are likely to receive some form of subsidy through phase two of the RHI:

1. Air source heat pumps (ASHP)
2. Ground source heat pumps (GSHP)
3. Biomass boilers
4. Solar thermal water heaters

These same four are already receiving support through the premium payments in phase one.

Household heating fuel use, and therefore emissions, are already falling due mostly to the mandating of highly efficient gas condensing boilers. In 2000, domestic space heating in the UK consumed 28.7 million tonnes of oil equivalent. In 2008, this had fallen to 26.5 million tonnes (ONS 2011). There is also still considerable scope for further improvement as almost one-third boilers in all types of housing (in England) pre-date condensing and even combination technology. The CCC assumes that 13 million further efficient condensing boilers will be installed by 2020.

However, while increasing the market penetration of condensing boilers – in combination with increased thermal efficiency – may make sense now, in the 2020s, if carbon targets are to be hit, a large number of homes will need to switch to electric powered heat pumps or biomass fuelled boilers. According to the NERA/AEA heat model, a high carbon abatement scenario in 2030 could see savings of more than 45MtCO_2 but that this would require 42 per cent of all heat to be generated from renewable sources (CCC 2010).

The RHI is, therefore, conceived as a means to drive this transition and explicitly to develop markets for the technologies that will be important in the 2020s. However, the variables discussed above, plus other factors, such as whether properties have suitable outbuilding or utility space to store fuel for biomass boilers, or gardens under which ground source heat pump elements can be sunk, significantly affect whether this is currently a realistic and affordable ambition.

An incentive is paid in order to help reduce the period in which the capital costs of technologies are repaid and become cost-saving. In the meantime, because fuel costs are theoretically lower, the technologies are cheaper to operate, which further reduces the payback period. However, IPPR's analysis of a range of literature both from industry and non-commercial sources suggests that, unless good conditions for heat pumps and biomass can be guaranteed (for example, high levels of thermal efficiency in buildings) then lower running costs cannot be guaranteed (see Table 2 below).

Fuel	Annual cost	p/kWh
Gas	£437- £635	2.82 - 4.1
LPG	£853 - £1,539	5.5 - 10.26
Direct electricity	£1,641- £2,015	10.5 - 13
Heating oil	£620 - £868	4 - 5.6
Wood chips	£403 - £465	2.6 - 3
Wood pellets	£605 - £852	3.9 - 5.5
Heat pump	£410 - £504 (COP 4) £547 - £672 (COP 3) £820 - £1,008 (COP 2)	10.5 - 13

Table 2 Sources: IPPR calculations based on KENSA Heat Pumps, Biomass energy centre, E4Tech, Centre for Alternative Technology

Perhaps the most important of all is the heat pump. At its heart is a mature technology used in heating and cooling worldwide and heat pumps are widely and successfully used in many other European countries with installation rates of more than 100,000 per year in France and Germany (CCC 2010).

The measure of a heat pump's efficiency is the Coefficient of Performance (COP) which is the ratio of the electrical energy required to operate the heat pump to the quantity of heat it produces. In factory conditions and in ideal field circumstances where thermal efficiency is high and equipment is fitted to a suitable heating system[8], heat pumps can achieve a COP of '3' or above (that is, the heat produced is three times greater than the electricity required to power the pump).

The NERA/AEA modelling for the RHI assumes the following COPs for heat pumps:

- ASHP: 2.5-2.7
- GSHP: 3.15 (pre 1990 property) - 3.85 (post 1990 property)

Manufacturers also publish COPs for their products, for instance:

- Mitsubishi Ecodan ASHP 'at least' 3
- KENSA GSHP 3-4 (depending on insulation and heating system)

Trials of heat pumps in the UK have so far been limited, but the results underperform both manufacturers' expectations and modelling assumptions.

- Cockcroft and Kelly (2011) 'Westfield trials' in Scotland, ASHPs in social housing annual COP 2.7

8 In 'wet' heating systems that are the norm in the UK, gas boilers heat the water to a temperature in excess of 60°C. Heat pumps operate at a much lower temperature, typically 30-35°C, and therefore require a much larger radiative area and to operate constantly to raise the temperature of the building fabric in order to provide sufficient heat. See Fawcett (2010).

- Energy Saving Trust (EST 2010) ongoing field trials have so far achieved a mid-range COP of 2.2 (ASHPs) and a range of 2.3 - 2.5 (GSHPs)
- JRF (2010) Elm Tree Mews zero carbon housing (new build) GSHPs achieved a COP of 2.7

These are disappointing results that suggest, at least in the case of Cockcroft and Kelly and EST, that retrofitting heat pumps into properties that have a less-than-ideal level of thermal efficiency (and may not have under-floor heating or oversized radiators) appears to reduce their efficiency. This is significant because lower efficiency would lead to higher running costs and a higher electricity load and, in turn, higher carbon emissions. In extreme circumstances, householders may experience insufficient heat which will have significant satisfaction and possible health implications.

At current grid intensities, heat pumps achieving COPs of 4 may not achieve carbon emissions reductions compared to condensing gas boilers, although with ambitious grid decarbonisation planned, this should change significantly [9]. Heat pumps may be more cost- and carbon-effective in properties not connected to the gas grid and particularly where electric storage or convection heaters are currently used, although even this is not straightforward (see Figure 3 below).

30-year installation cost and CO_2 emmissions of optimal systems applied to a solid wall property

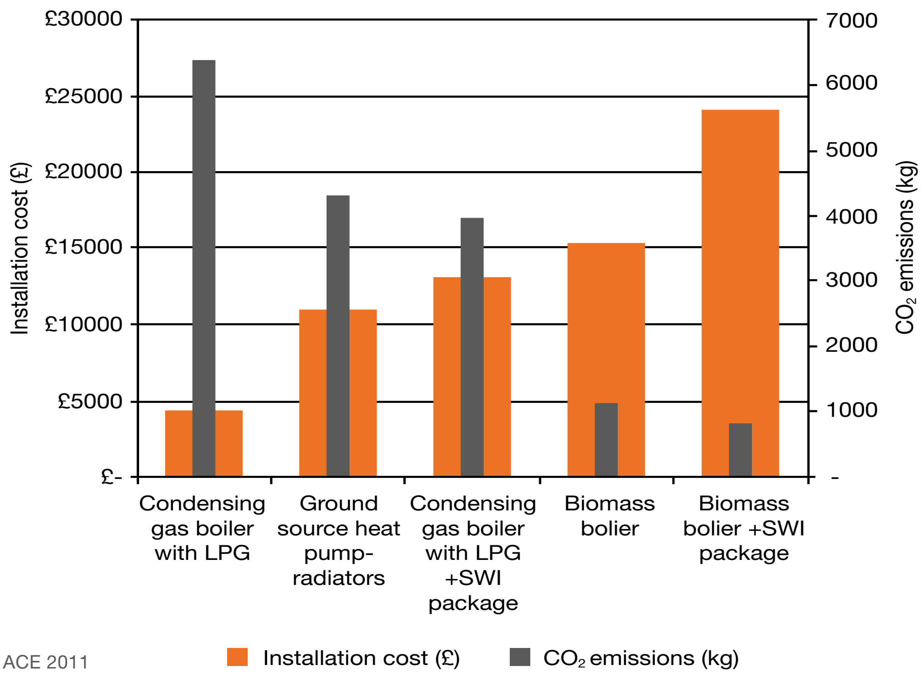

Figure 3 Source: ACE 2011

9 For instance see http://carbonlimited.org/2009/08/11/heat-pumps-emit-more-carbon-than-gas-boilers-so-why-will-they-get-the-renewable-heat-incentive/

The RHI impact assessment states that, if heat pumps replace electric heating, then the overall load on the electricity grid will be similar. However, the heat load of heat pumps would be different to that of much existing electric space heating. Much of the latter takes place off peak, using electric storage heaters. However, heat pumps may not be fitted with storage and will, therefore, demand electricity load constantly, including at peak times.

In rural areas where smoke is not a concern and where there is adequate space for storage of fuel, biomass boilers will be an important alternative to those currently fired by oil or LPG. Figure 3 above suggests that, from a carbon cost perspective, biomass is a viable option, although capital costs are still high.

The RHI is most likely to be designed to reward early-adopter householders to fit ASHPs in urban areas and GSHPs and biomass boilers in suburban and rural areas. But there are a range of additional technologies that may also have a part to play. In addition to conventional condensing boilers, some manufacturers also offer condensing boilers that are capable of generating small amounts of electricity while they are in operation. These installations are known as 'micro combined heat and power systems' and can offer carbon savings of between 4 and 14 per cent as well as the opportunity for householders to benefit from the feed-in tariff for electricity generation (Carbon Trust 2011).

A further option for densely housed neighbourhoods is to fit district heat networks – an infrastructure rather than a technology. The heat source, which could be waste heat from a nearby incinerator or primary heat from a bespoke plant, would typically be linked to a number of homes and commercial and community premises by a network of pipes. While not intrinsically low-carbon, heat networks can be powered by large biomass plants or heat pumps and offer the opportunity to decarbonise a whole neighbourhood without necessarily needing to improve the thermal efficiency of properties. The disadvantage of heat networks is that the installation cost of the pipework and (if necessary) the bespoke power plant, is high.

1.4 The route to market

The RHI impact assessment states that '…the uncertainties associated with the uptake of renewable heat technologies are very high. The 12% ambition requires significant growth rates in the supply chain for renewable heat which if they fail to materialise will create bottlenecks in the uptake rates and in the contribution of renewable heat towards our 2020 target' (DECC 2010).

Consumer preferences in the heating market are primarily influenced by the existing supply chain and their drivers, which are rooted in the traditional gas boiler with a wet central heating system and delivered to consumers mainly by local, small firms of plumbers, which may be difficult to influence. A transition towards different, and at present, more expensive systems requires 'transformation' in the UK heating installer industry, according to Eyre (2011).

The current market share for renewable technologies is very small. Therefore, a large annual increase (100 per cent for ASHPs, for instance) could challenge the supply chain, particularly in respect of the availability of qualified fitters, but also from the perspective of the supply chain being partly the trigger in making that demand materialise.

In interviews with stakeholders, however, manufacturers dismissed supply capacity constraints that were also highlighted as a major uncertainty in the NERA/AEA supply curve. Individual manufacturers referred in stakeholder interviews to training schemes where 'thousands' of installers have been trained for fitting heat pumps in the UK.

Furthermore, manufacturers are optimistic about the Microgeneration Certification Scheme (MCS) delivering required standards and building consumer confidence in new technologies and quality of installation. EST (2010) suggests this is important in helping improve observed COPs for heat pumps.

It should be noted that the liberal market approach to the supply chain from the manufacturer to the consumer in the UK is different from the approach for example, in Sweden, where installers work for certain manufacturers only. Interestingly, the EST field trials concluded that 'responsibility for the installation should be with one company, and ideally be contractually guaranteed to ensure consistency in after-sales service'. Therefore, the area of trust and responsibility in the supply chain emerges as a key issue in the UK.

2. SUMMARY OF FINDINGS FROM CONSUMER WORKSHOPS

IPPR conducted four consumer workshops in England – two with consumers off the gas grid and two whose participants all had gas connections. All four groups were led by the same IPPR qualitative analyst and conducted to a strict set of guidelines, with minimal intervention in each discussion. In the segment of each workshop focusing on renewable heat technologies, participants were given factsheets with pictures, basic details and cost ranges.

The following key findings emerged:

2.1 Attitudes to heat

- Participants in all workshops had a high awareness of heat as an issue, primarily due to increased costs; there was a tendency to blame energy companies for this.
- Off gas grid participants tended to focus on the problems of the supply of oil (most had oil-fired heating systems) and the escalating costs, whereas, for participants on the gas grid, one key concern was boiler maintenance.
- For all participants there was a very strong correlation between heat and comfort.
- But comfort was evidently being compromised to compensate for rising costs. Most participants off gas grid reported using less heat in the past two years: 'I wouldn't say I have my temperature at the comfort level. I have to have it at the temperature I can afford.' (Norfolk)

2.2 Attitudes to energy efficiency

- Participants were, perhaps surprisingly, aware of and interested in measures to reduce heat demand and insulate their homes.
- Most understood the basic interventions, although there was a degree of uncertainty in many cases as to precisely what level of insulation – for instance in lofts – they already had.
- Solid wall insulation received a hostile reception in most cases, especially among the participants in the Barnes workshop: 'I think the beauty of Victorian houses [is] the red bricks. You wouldn't want to be covering the front of the house because it would take the character away.' (Barnes)
- Participants were surprised at the likely cost of solid wall insulation and most said they would be unwilling to undergo the level of disruption required to install it.

2.3 Attitudes to renewable heat technology

Participants in the two locations on the gas grid were given information about: Solar thermal, micro-combined heat and power (CHP), ASHPs, GSHPs and district heat networks with CHP. Participants in the two off gas grid and rural locations were given information that excluded district heat networks but included biomass.

- Technologies in general, and in all workshops, fared badly on first impressions except micro-CHP.
- Although most participants took a dislike to heat pumps and, off gas grid, biomass boilers due to their aesthetics, the number one barrier people felt would prevent them from considering installation was cost: 'It's a massive expense.' (Newbury)
- Most felt they would not consider any kind of new technology until their existing boiler needed replacing, and some in each workshop expressed the view that the technology would become cheaper in time and so they would be inclined to wait and let others adopt early.

- Unfamiliarity in general with renewable heat technology was a problem; heat and electricity generation was frequently confused by participants: 'Why can't I use a wind turbine or solar panel'. (Norfolk)
- The 'bling' effect of solar photovoltaic (PV) has clearly been influential, though, as people receptive to the idea of renewable energy in general frequently refer to panels.
- While off gas grid participants, like their grid-connected counterparts, were unconvinced on the renewable technologies, they had a deep dislike of their existing heat technology, especially if they used oil.
- **Solar thermal:** Participants on the whole disliked the aesthetics even though many also talked at other times in favourable terms about solar PV.
- Most participants were accustomed to using their space heating system, such as a conventional gas combination boiler, to heat hot water and were unhappy about spending money on a system that only heated hot water.
- **Micro-CHP:** This fared the best of all, perhaps because it looks very much like a conventional gas condensing boiler.
- There was a surprisingly high awareness of the feed-in-tariffs for renewable electricity and so participants responded favourably to the idea of generating electricity and receiving tariff payments.
- **Air and ground source heat pumps:** Nearly all disliked the aesthetics and size of the heat pump equipment: 'It's like an industrial air conditioner.' (Barnes)
- One participant in a solid walled end-of-terrace property in the Newbury group had installed an air source heat pump and was highly satisfied, although had not yet used it in winter conditions.
- Several participants preferred GSHPs because they liked the idea of drawing heat from the ground, but many felt space would be major issue.
- Cost in particular was felt to be an insurmountable barrier by many, even among the apparently wealthier participants in the Barnes workshop.
- **Biomass:** Surprisingly, biomass fared badly in the two off gas grid locations, principally because people already have fuel deliveries and wanted to escape from this, rather than buy new technology that locked them back into the same fuel markets.
- Space and, again, aesthetics emerged as significant barriers, as did the notion of having to feed the fuel into the cheaper boilers.
- Questions were raised by some in the Norfolk group concerning the true sustainability and renewable credentials of biomass.
- **District heat networks with CHP:** There were concerns expressed by some about the security of the heat supply delivered through a network of pipes.
- Most, however, seemed happy with the notion of buying heat rather than fuel and, in some cases, felt the sense of providing heat across a community was advantageous and desirable.
- Some questioned where the plant would be based.

2.4 Information and advice provision

- Participants were genuinely perplexed about renewable heat technologies and so were asked to think about where they would go for information and advice.
- The issue of trust was manifest in this debate, with energy companies emerging as an untrusted source of advice on which heating technology to install.
- Many suggested they would research the issue themselves, relying on the internet, government information sources, existing energy suppliers (in something of a contradictory point to the last), local installers and word-of-mouth recommendations.
- Most would have liked to have seen an impartial and trusted source of information.

2.5 Attitudes to the renewable heat incentive

- The RHI proved very difficult to explain in the context of a consumer focus group.
- Consumers were asked whether they supported paying for climate policy measures on energy bills and given the example of a £100 premium on an average dual fuel bill.
- The carbon reduction aim passed uncontested in all four workshops and several participants spoke up in support of reducing emissions.
- Many, however, said they would like the costs to be transparent, and one participant in Barnes felt it was a 'stealth tax'.
- Some – including those in Barnes – also argued that, unless they could afford the upfront costs, they would be subsidising wealthier people: 'The squeezed middle paying for everyone else'. (Norfolk)
- Participants were also asked whether they would prefer help with capital, tariff payments over a period of time or a combination of the two.
- Many felt that assistance with the upfront costs would be more helpful than an ongoing payment, although few were inclined to take up any of the three options.

CONCLUSIONS

Decarbonising household heat is not an optional extra in tackling climate change. It is essential. Committee on Climate Change projections suggest that this task will be particularly important in the 2020s, but in order to ready the market, action should begin now. The Coalition government, like its predecessor, is therefore right not to shy away from the heat challenge.

The policy framework for beginning the task of domestic heating as it is currently proposed is, however, unlikely to prove to be the right approach. This is because:

- The very poor level of thermal insulation across the UK housing stock poses a particular challenge, with the hardest to heat and treat homes also being the largest consumers of energy for household space heating. It will be important, therefore, to prioritise thermal efficiency.
- Heat pumps, which are likely to offer the greatest future opportunity to decarbonise heat both in urban and rural areas, have not performed well in properties with poor thermal insulation; new-build houses and those built after 1990 may be suitable sites already, but older properties may not be.
- The upfront cost of the technology is prohibitive. This, combined with a high level of uncertainty concerning the level of efficiency in operation and potentially higher-than-anticipated running costs, makes heat pumps an expensive option at present; the evidence from IPPR's workshops suggests this may be an insurmountable barrier for consumers.
- Householders may be left out-of-pocket or with longer-than-expected repayment periods if the amount of 'deemed' heat demand, determining the level of incentive paid, is significantly less than the heat that is required in practice due to poor house fabric or technological efficiency.
- CO_2 emissions reductions from domestic heat are theoretically possible and the NERA/AEA modelling suggests can be achieved at costs lower than other technologies. However, because of the above factors, plus the carbon intensity of the electricity grid, which is still high, significant and low-cost emissions reductions are by no means certain.

Reducing heating demand gives rise to significant CO_2 emissions reductions regardless of technology. Indeed Eyre (2011, p 1391) concludes that electrification (that is, using heat pumps) 'is only likely to contribute to a viable climate solution in the context of significantly improved efficiency and reduced heating demand. The two processes of demand reduction and electrification need to be conceptualised, planned and delivered together'.

Although households would only be paid up to a certain level to avoid the process of heat dumping, heat – unlike electricity – is not a commodity whose production should be incentivised per se. Incentives should be provided for warmth through a combination of increased thermal efficiency and low carbon heat technologies.

The route to market for heat technologies also presents a barrier. The incumbents in the household heat market, consisting predominantly of small and medium-sized enterprises, have a big influence on the choices made by homeowners. If renewable heat technologies are to take a larger share of the market, then firms of plumbers and heating engineers nationwide will need increasingly to promote them as alternatives and persuade consumers to make timely purchases, rather than wait for their old boiler to fail.

RECOMMENDATIONS

The government's principal aim in providing incentives for low carbon heat production is to develop a market for the technology. IPPR's research suggests a tariff-based incentive may not be the best approach to achieve this objective. How else then can it ensure that costs are reduced and markets for nascent heat technology readied for the 2020s?

1. A focus on innovation

Some innovation in the renewable heat market is already taking place. For instance, 'bivalent' systems are now on the market that combine heat pumps with other sources, such as an existing gas boiler or an electric heater. But, while the heat pump is considered a mature technology by its proponents, the feedback from IPPR's consumer focus groups suggests that they need to be smaller and cheaper to convince people to move away from gas condensing boilers.

But even if the heat pump market in the UK grows exponentially, it may prove too small to drive technological innovation; cost savings are likely to be found in the supply chain and by installers becoming more accustomed to fitting heat pumps. Two approaches are, therefore, of high importance. First, government investment in research and development may pay dividends and require a lot less taxpayers' money than a deployment incentive; second, action at the European level will provide a much more significant market pull.

2. Extensive heat pump trials

Greater discovery of the efficacy of heat pumps in situ is also required, with links back to the research and development process. While the trials highlighted in this report suggest that heat pump efficiency is lower in practice than in theory, they have hitherto been limited in scope. The UK, therefore, also needs a pipeline of field trials that are fully funded, independently overseen and designed to help with the process of learning about how heat pumps can be made to perform better in the UK housing stock, and their implications for electricity supply.

Recipients of a future incentive – and of the phase one premium payments – could assist with the process of discovery by being rolled automatically into trials as a condition of receiving the incentive.

3. Restrict incentives to well-insulated properties

Through the deeming process, the total sum of incentives paid to households will be restricted, but if renewable heat technology does not reach promised levels of efficiency, then the householder – and the wider economy – will be worse off. In the case of heat pumps, the drain on the electricity grid will also be higher and, until the grid reaches a higher level of decarbonisation, fewer if any additional CO_2 emissions will be abated.

Any incentives should be restricted to properties that have a recommended level of thermal insulation, especially in the case of heat pumps. Through the forthcoming Green Deal, and the issuing of certificates for properties that benefit, monitoring thermal efficiency in housing should improve.

4. Assistance with capital costs

Capital costs emerged as the biggest barrier for consumers in IPPR's workshops. To enable consumers to enter into the renewable heat market, incentives may need to be focused on assistance with the costs of purchasing and fitting renewable heat technology. Our fear otherwise is that take up of a renewable heat incentive could be very low or that taxpayers' money will flow largely to high-income households who can afford the capital costs, and for whom an incentive is not necessary.

In addition to the premium payments that are part of phase one of the RHI, one obvious way of assisting households with capital costs is by integrating heat technology with the Green Deal for energy efficiency, allowing households to borrow through participating institutions. However, through private sector borrowing, upon which the Green Deal will largely depend, consumers will pay higher rates of interest – and thus higher capital costs – than would be the case if households were able to borrow from a government-backed entity such as the Green Investment Bank.

5. The government should incentivise warmth

Through its forthcoming Green Deal, the Coalition government is seeking a step change in domestic thermal efficiency. Until details of the Green Deal are published, it will be difficult to argue whether or not it will prove successful in persuading people to install insulation measures. Many think that it will not, in part because householders may be reluctant to take on additional debt.

This research, however, suggests that the thermal efficiency of homes will determine whether or not renewable heat technology becomes acceptable to consumers, achieves operating cost and CO_2 savings and provides sufficient warmth. Therefore, heat and efficiency should go hand in hand.

In the immediate term, this suggests that renewable heat technology should become part of the Green Deal offer. But ultimately the government needs to move away from a focus on incentivising heat and towards a focus on warmth, through a combination of efficiency and appropriate heat technology. Thus the debate about changing the incentives of energy companies from sales of fuel to providing energy services must be reignited.

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