



Department
of Energy &
Climate Change

Qualitative research with Owner-Occupier applicants to the Domestic RHI

A research project commissioned as part of the
Evaluation of the Renewable Heat Incentive

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Executive summary

Introduction

This report presents the key findings of research with owner-occupier applicants to the Domestic Renewable Heat Incentive (RHI). The project was carried out as part of an independent evaluation of the RHI. The evaluation was commissioned by the Department of Energy and Climate Change (DECC) and undertaken by NatCen Social Research (NatCen), Eunomia Research and Consulting, and the Centre for Sustainable Energy (CSE).

Policy context

The RHI is the world's first long-term financial support programme for renewable heat. The scheme is designed to bridge the gap between the cost of fossil fuel heat sources and renewable heat alternatives, through financial support for owners of participating installations. The RHI was first introduced for non-domestic applicants (commercial, industrial, public sector, not for profit and systems heating multiple domestic dwellings) in November 2011 and was expanded to include domestic households in April 2014.

Scheme participants are paid a tariff per kilowatt hour of heat generated, with payments made quarterly for either seven years (domestic) or 20 years (non-domestic). Renewable heating technologies eligible for the scheme include biomass boilers, heat pumps and solar thermal systems. The non-domestic scheme also includes biogas, combined heat and power (CHP), and biomethane injection to grid.

The principal high level objectives of the RHI to date have been to:

- support the UK in meeting the 2020 renewable energy target;
- contribute to meeting carbon budgets as renewable heating systems deliver carbon savings compared to fossil fuel alternatives; and
- support the longer term 2050 decarbonisation target by building sustainable supply chains.

Research aims and approach

This report focuses entirely on the Domestic RHI scheme and specifically on the views and experiences of owner-occupier RHI applicants. The aim of this strand of the research was to better understand applicants' motivations for, and experiences of, installing a renewable heat technology and applying to the RHI scheme. The research involved three key groups of applicants: those with 'larger' homes (over 200 square metres); those who used personal finance to install renewable heating technologies, and those who had small to medium heat energy systems (those that generate 12-16 KW of heat output). Only 'new' Domestic RHI customers were included, that is, those who had installed renewable heating technologies after 8th April 2014 and so in response to the RHI programme.

The research involved 46 in-depth telephone interviews with a purposively selected sample of applicants to the Domestic RHI.

The outputs from the evaluation (available at <https://www.gov.uk/government/rgrgt/collections/renewable-renewable-heat-incentive-evaluation>) will help DECC to understand and assess how the

Domestic RHI is delivering relative to its objectives and to support development of the scheme. This evaluation will also help ensure that DECC is conforming to principles of accountability, transparency and openness to scrutiny in policy-making.

Key findings

Deployment of renewable technologies

- Key sources of information about renewable heat technologies and the Domestic RHI included installers and suppliers of renewable heat systems. Other sources of information included articles in newspapers or magazines, government and other websites, and recommendations from family and friends. There was a particularly high level of trust in the information provided by installers, and a group of participants relied solely on this source. Other participants gave weight to the views and experiences of independent ‘experts’, such as government sources, and existing users of renewable technology who could validate information from other sources.
- Interviews with applicants to the Domestic RHI suggest the RHI may have helped improve awareness of renewable technologies among some groups, including those who had not previously considered changing their heating system before they became aware of the RHI from installers, friends or family.
- Among participants, the decision to install a renewable heat technology was driven by one or more factors. Those who were driven by a single factor were either motivated exclusively by financial factors, such as anticipated lower running costs of renewable fuel, or were immersed in the environmental field and driven by ‘green’ considerations. Among participants who were driven by multiple factors, financial and practical considerations were key as participants needed to be confident the system would deliver sufficient heat output as well as be affordable to install and operate. Environmental and lifestyle considerations were additional incentives for choosing a renewable technology among this group.
- The table below illustrates the characteristics of those who were most and least influenced by the RHI:

Table A: The influence of the RHI

Most influenced by RHI	Least influenced by RHI
<ul style="list-style-type: none"> • Finance: Finance was a key barrier to deployment • Commitment: Lacked commitment to renewable heat technology over conventional options • Number of technologies: Installed multiple technologies 	<ul style="list-style-type: none"> • Financial case: Considered there to be a strong financial case for installing renewable heat technology irrespective of the RHI • Driven by non-financial motivations: E.g. environmental considerations • Confidence in the RHI: Lacked confidence in the stability of the RHI

- As financial considerations were important drivers of uptake of renewable technology, the financial return offered by the RHI was valued across participants. The RHI appeared most influential where finance was a key barrier to deployment and/or among those who did not prioritise environmental considerations when choosing a heating system or where multiple technologies were installed. Those for whom the RHI was reported to have been less influential included those who considered the financial case to be strong irrespective of the RHI, were driven by non-financial motivations and/or lacked confidence in the stability of

the RHI.

- Participants who could afford to self-fund installations used their savings to pay for installations unless there was a financially prudent reason for using credit. For example, there were participants who were advised by a financial expert to take advantage of a low interest loan, rather than using savings, because the RHI payments would cover the cost of borrowing.
- A key driver of the decision to self-fund was an aversion to being in debt. Those who took a loan were encouraged by factors including low interest rates and the financial return from the RHI. When choosing financial products, trust in the lender, convenience of the loan application and appropriateness of the financial product (that is, whether the loan had a favourable interest rate and repayment period) were key considerations influencing decision-making.

Applicants' experiences of the Domestic RHI

- Providing that the participant had gathered all the required information beforehand and/or had access to appropriate support, experiences of applying for the RHI were positive in general. Participants appreciated that the process was quicker and easier online. However, those who were less digitally literate, encountered technical issues, or received incorrect, insufficient or delayed information from installers found the application process particularly challenging.
- Satisfaction with the RHI payment process hinged on whether payments were timely and in line with expectations. Payment amounts had been overestimated by participants in cases where they had not fully read or understood information on the scheme, the installer had provided incorrect estimates, or delays to the installation date had led to the participant being on a lower RHI tariff than expected (due to depression).

Installing renewable technologies

- The qualities and skills of installers were critical to the successful installation of renewable heat technologies. At the pre-installation stage specific issues included whether participants were given sufficient and accurate information on what to expect from the installation and technology, while experiences of installation hinged on issues such as whether the installer carried out a professional installation and the level of disruption experienced.
- The responsiveness of the installer in resolving any issues that arose post-installation was also a critical factor underpinning customer satisfaction.

Satisfaction with technologies

- Among participants, overall satisfaction with renewable heat technologies was influenced by how favourably the technology compared with the previous system.
- Higher satisfaction with renewable technologies was driven by the technology providing: the same or higher heat output at a similar or lower running cost as the previous system, reliability (particularly in colder weather), and to some degree, adequate levels of heat control.

Use of technologies

- The likelihood of behaviour change depended on the extent to which the renewable heating technology heated the home differently to the previous heating system. For example, those who experienced increased heat output that was spread evenly across the home were more likely to use more rooms in their home. Additionally, because the house was warmer, they reported inviting friends round more often and not using supplementary heating sources such as electric heaters.

- Conversely, those whose renewable heat technologies did not heat their home any more or any differently than their previous system were least likely to change their behaviour.

1. Introduction

The Renewable Heat Incentive (RHI)

The Renewable Heat Incentive (RHI) is the world's first long-term financial support programme for renewable heat. The scheme is designed to bridge the gap between the cost of fossil fuel heat sources and renewable heat alternatives, through financial support for owners of participating installations. The RHI was first introduced for non-domestic applicants (commercial, industrial, public sector, not for profit and systems heating multiple domestic dwellings) in November 2011 and was expanded to include domestic households in April 2014.

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The principal high level objectives of the RHI to date have been to:

- support the UK in meeting the 2020 renewable energy target;
- contribute to meeting carbon budgets as renewable heating systems deliver carbon savings compared to fossil fuel alternatives; and
- support the longer term 2050 decarbonisation target by building sustainable supply chains.

Research aims

The evaluation of the Domestic RHI scheme included qualitative research with owner-occupier RHI accredited participants. This research aimed to explore the customer journey of participants to the Domestic RHI by examining:

- The decision-making process related to installing renewable heating technologies and applying for RHI, including motivators, facilitators and barriers;
- Experiences of applying for the RHI including what worked well and less well about the process;
- Experiences of using renewable heating technology eligible under the Domestic RHI and the influence of renewable heating technologies on energy behaviour and consumption; and
- Mapping the range of customer journeys for different types of participant and identifying the conditions in which specific technologies are most appropriate.

The research involved three key groups of applicants: those with 'larger' homes (over 200 square metres); those who used personal finance to install renewable heating technologies, and those who had small to medium heat energy systems (those that generate 12-16 KW of heat output). Only 'new' Domestic RHI customers were included, that is, those who had installed renewable heating technologies after 8th April 2014 and so in response to the RHI programme.

Methodology

For this research, individual in-depth qualitative interviews were completed with 46 owner-occupier participants to the Domestic RHI. A sample of participants was drawn from a census of

owner-occupier RHI participants undertaken as part of this evaluation (June to December 2014). Telephone interviews were carried out between January and March 2015. Interviews lasted around one hour, and were audio recorded and transcribed verbatim for analysis purposes. The qualitative data were managed and analysed using Framework, a case and theme-based approach to qualitative analysis. More detail can be found in the technical annex published alongside this report.

Limitations

All research has limitations and it is important these are acknowledged so readers can appraise the extent to which findings can be generalised and replicated. There were two key limitations to this study:

- **Sample composition:** A sample of participants was drawn from a census of owner-occupier Domestic RHI applicants undertaken as part of this evaluation (June 2014 to December 2014). For ethical reasons, only those who had agreed to be re-contacted for future studies when completing the census were invited to participate in this project. This means that all participants in this study had a) chosen to install a renewable heat technology and b) successfully applied to the RHI scheme. As such, this research is unable to comment on motivators and barriers to installing renewable heat technologies among owner-occupiers who chose to install conventional heating systems, or on the views and experiences of owner-occupiers who have installed a renewable heating system that is not accredited to the RHI scheme. Additionally, this research may not fully reflect the views and experiences of Domestic RHI applicants who did not give permission to be contacted for future research.
- **Timing of study:** Participants in this study had limited experience of the RHI payment system due to the timing of fieldwork. This limits the ability of this research to fully describe applicants' views and experiences of receiving payments from the scheme.

How to interpret qualitative data

This report shows the range and diversity of views and experiences among those interviewed. As this is qualitative research, we have not reported the number of people who hold a particular view as it bears no indication of the extent to which these views are held in the wider population. Any numerical inference would be misleading or inaccurate as the sample was not designed for this purpose.

Interview quotations and case illustrations have been used where appropriate. Quotations have been attributed to participants using descriptive categories relevant to this research. Additional descriptive information has been included where this might help illuminate a finding and does not breach anonymity. All case illustrations use pseudonyms to safeguard anonymity.

2. Hearing about renewable heat technologies and the RHI

Awareness of renewable heat technologies and the RHI

This section explores how participants first became aware of renewable heat technologies and the RHI. It examines the sources of information that were used and views on the quality of information sources.

Sources of information on renewable heat technologies and the RHI

Sources of information through which participants became aware of renewable heat technologies and the RHI were similar and are described below:

- Installers, suppliers or surveyors made participants aware of renewable heat technology and/or the RHI through strategies such as 'cold calling'. Participants also met installers at trade shows or contacted installers by phone to discuss changing their heating systems. In some instances, the installer then visited the participant's home in order to discuss the technology and provide information on running costs, efficiency and system sizing.

“ We got a telephone call...this guy just sort of called - a cold call. And he was talking about air to water...And he said he'd been to Scandinavia, and they use it a lot over there...he says, 'Would you like me to come and see it and talk to you about it?' So he came, and we found everything really, really good. [We] said, 'we'd like to think about it,' and he left all the details... ” (Participant who installed ASHP)

- Word of mouth, whereby participants became aware of renewable heat technology and/or the RHI through discussions with friends, family, colleagues or associates who either had some knowledge of the technology through their professional background or used renewable heat technology in their own homes. These individuals could explain how the technology worked and in some instances influence participants' decisions to choose a particular type of renewable technology.

“ [The participant's friend said] 'Why don't you ring my friend up and ask him about [their biomass boiler]?' And so that's what we did...we [had] a look round this man's house... and we sat for a couple of hours and talked about biomass and we went from there really. ” (Participant who installed biomass)

- Online research carried out by participants included consulting the websites of the Energy Savings Trust, Ofgem, Microgeneration Certification Scheme (MCS), DECC, Which?, and YouGen plus other sites that had relevant case studies and forums.
- Articles in national and local newspapers or magazines or media advertisements.
- The professional background of participants (who worked as engineers for example) gave them awareness and knowledge of renewable heat technology.

Participants' views on the quality of information

Online information was generally considered useful and informative. Websites were viewed favourably where they provided clear and comprehensive information on renewable heat technologies in general and on particular technologies, or provided insight into the views and experiences of home-owners who had installed non-conventional heat systems. A key limitation of some online sources was that there was too much text to read, which made it difficult to engage with the information, navigate to that which was relevant to the reader and understand its meaning. This could result in misunderstanding of aspects of the scheme such as how the RHI payment system operates.

Installers were highly trusted sources of information who could provide quotes for installation as well as answer any questions the participant had about the technology. This encouraged a group of participants to install renewable heat technology without using any other sources of information.

Witnessing renewable heat technology systems in action and speaking to current users was important in helping participants trust the technology. It also helped participants feel confident that the technology could work for them, as it did for their friends or family.

While there were those who used a single source of information, other participants found multiple sources of information to be more reliable than relying on just one source. Word of mouth was important in validating information gained from other sources. For example, participants would have discussions with people who were knowledgeable about renewable technologies, such as trade persons, or hear about other users' experiences of operating the system. This made them feel more confident that information provided by an installer could be trusted.

“ I spoke to probably three installers, and I also...spoke to three of their clients...and I went round to their houses to look at it, and quiz them about it, and I got quite a good sense of how good it is. ” (Participant who installed biomass)

When deciding which renewable heat technology to install, participants would read information online or in the press then speak to users of the technology to learn from their experiences.

“ I always read The Sunday Times Home Magazine and there [were] articles in there about the pros and cons of air source and ground source...The local builder that we used... I had a chat with him about alternatives. And he had installed in his own home an air source heat pump system and he was very pleased with it. So...I thought, well, sounds as though it would suit our needs... ” (Participant who installed GSHP)

Influence of the RHI on awareness of renewable heat technology

This research suggests the RHI has had a direct role in raising awareness of renewable heat technologies among some groups. Participants who first heard about the RHI before becoming aware of renewable technologies fell into two groups:

- Those who carried out a standalone installation of a new heating system after hearing about the RHI from friends or family. This group included home-owners who said they had not considered changing their heating system prior to becoming aware of the scheme.

- Those who became aware of the RHI first through searching for information online to help inform decision-making related to wider property renovations.

In other cases, the RHI appears to have been less influential in first making people aware of these technologies as participants either said they were aware of renewable technologies before the RHI or heard about the RHI and renewable technologies around the same time.

3. Enablers and barriers to uptake of renewable heat technologies

Factors affecting uptake of renewable heating technologies

What factors influenced participants to change their system and select renewable heating technologies?

Similar sets of factors influenced participants' decisions to both replace a heating system and to install renewable rather than non-renewable technologies. These factors are outlined below.



Property led factors. These factors influenced a change in the heating system where this was done as part of a wider project of renovations to improve the property. Three types of participant whose decision-making was influenced by property led factors were:

- The 'new builds' – those who were building a new property installed a renewable heating system due to its lower running costs or greater heat output.

“ The plumber who we employed [for the self-build] was a renewable energy specialist and, when he did the first fix we hadn't completely decided what we were going to do, but when it came to the point of putting in the boiler and the heat, we went for ground source... We've always had oil boilers and the marked difference is the cost. It's a lot cheaper to run [GSHP] on a monthly basis. ”
(Participant who installed GSHP)

- The 'new arrivers' – those who had recently moved into a new property and were in the process of changing it to meet their needs. Replacement of the heating system was part of the wider set of 'nesting' decisions that were hastened by the breakdown of the old systems in some instances.

“ We bought an old cottage that needed a bit of work doing to it. It already had existing double glazing which we will replace in time. But we took the opportunity, because we had to strip back the rest of the cottage, the only service that we had up here was oil, and electricity obviously, and we didn't want to continue with the oil, so that's why we changed. ” (Participant who installed biomass)

- The 'renovators' – those who had been living in their property for some time and were modifying it to meet their needs, such as the need to have more space and/or to have a more energy efficient home that is cheaper to run. Changes to the heating system could take place alongside other property changes, such as an extension.

“ We done a lot of building work and it was part of the same building project ... it was extension and renovation, so we decided we were gonna completely revise how we heated our home as part of the same project... [the existing system] was old, it was oil-fired...we had reason to believe that we had some cracked pipes and leaks in the solid concrete floor. When we got the floor up, we found there wasn't a damp-proof membrane underneath it, so...obviously it's all done to a, to a good standard now... The idea was always to bring it up to date and install some very energy efficient infrastructure...to spend money on the place while we're earning it and then, hopefully, make it fairly cheap to run thereafter. ”
(Participant who installed GSHP)

Particular characteristics of participants' properties also meant that they had to consider alternative heating systems to those that used non-renewable fuels. For example, properties that lived off-grid could not access gas, while building regulations on new build houses discouraged oil heating systems. In addition, there were views that renewable heat technology, particularly biomass, had an aesthetic that was more in keeping with the property and local area than the previous system.



System led factors. Changes to the existing heating system were influenced by whether there were actual or anticipated problems with the system. Participants varied in terms of how reactive they were to these problems. The 'reactors' were prompted to take immediate action due to events such as the heating system breaking down. In contrast, the 'planners' were driven by issues that they anticipated, such as an old heating system that was likely to break down or rising fuel prices.

“ [The new system] replaces an oil burner. And, because of the expense of oil I was, I guess, fairly frugal with running it. And because we were fairly frugal with running it, a fairly low temperature house, I would say that some of the walls were getting a little bit damp and a bit of mould and things like that. ” (Participant who installed ASHP)

In terms of selecting renewable technologies, a key system led factor was whether participants trusted that the renewable heat technology would effectively serve its purpose. Therefore confidence that it would provide sufficient heat output encouraged take up and was underpinned by several factors including knowledge of how the technology works; that it was well-established; and that existing users had positive experiences of the technology. For example, learning that biomass fuel technology was popular in European countries, reading positive user reviews online or receiving recommendations from trusted sources such as friends who were users all enhanced participants' confidence that the technology was effective.

“ ...because we'd lived in [North Eastern Europe] for a while, we knew that biomass boilers were used extensively in Scandinavia and generally they tend to get things right...so we were...convinced that was a good way to go. ” (Participant who installed biomass)

Those who were less confident that the heat output of renewable heat technology would be sufficient included those who lived in larger homes or in areas of the UK that had colder winters such as Scotland and East Anglia. In particular, it was questioned whether an ASHP system would be able to generate enough heat or do so cost-effectively when the air outside their homes becomes very cold.



Financial factors. Replacements to existing heating systems were influenced by the desire to reduce fuel costs by installing a more efficient system, and having access to finance that made a replacement system more affordable, such as the RHI or a windfall such as a family inheritance. ‘Planners’ who were unable to self-fund renewable heat technologies delayed changing their system until they had access to suitable finance or became aware of the RHI, which, although did not help with installation costs, made the new system more affordable through the long term financial payback and/or savings in fuel costs. However, given that this study only interviewed Domestic RHI applicants, it must be acknowledged that there may be others who did not overcome financial barriers to installing renewable heat technologies.

The perception that renewable heat technology would bring financial benefits was also a key financial ‘pull’ factor in the decision to install. The lower cost of renewable fuel meant that running costs were expected to be cheaper, and in the context of anticipated rises in the cost of non-renewable fuels this benefit was expected to increase in the future. Further, an expectation among some participants that council tax for homes using renewable heat technology would be reduced in the future, and that renewable heat technology increased a property’s value were additional anticipated benefits. Affordability of installation was a key facilitator of uptake, as it was perceived to be more expensive to install renewable heat technology than to replace existing, non-renewable technology like-for-like. Consequently, access to finance and awareness of the RHI (discussed further below) were key to overcoming the barrier of installation costs among those who would otherwise have lacked the financial means to install renewable heat technologies.

“ Because of the RHI it makes it very attractive if you [install renewable heat technology] because you get a return on it. It saves money on the heating, and then you get the paybacks as well. It’s also a quite good selling point for the house when you come to sell the house in the future. ” (Participant who installed biomass)



Person led factors. Prompted participants to decide to replace their existing system through other people making them aware of a better alternative. Friends, family or colleagues recommended renewable heat technology systems, explaining the benefits or showing the participant renewable heat technology functioning in their home. Such discussions were in some instances prompted by participants talking about their desire to change their heating system due to various problems, such as a ‘messy’ or ‘dirty’ oil system and the rising costs of oil fuel.

Case Study

Aaron lives with his wife and children and had a biomass boiler installed to replace an oil heating system. They had been thinking about replacing their ageing oil boiler for a few years and had friends who told them about renewable energy systems that they had installed and how positive their experiences had been. Although hearing about the experiences of their friends was encouraging, it would have been cheaper to replace the oil boiler with a gas boiler. It was not until Aaron received a financial windfall and was looking for something to invest the money in that they chose to install a renewable heating system. When doing research into renewable heating technology, he heard about the RHI, which acted as a second trigger to replacing their existing system because it made it even more affordable.



Multiple factors. Multiple factors could work together to prompt the decision to change a heating system. For example, the need to improve a property through home renovations and the need to replace an ageing system worked together to provide changes to both the heating system and the home, or access to finance could prompt participants to carry out home renovations, including replacing an ageing and inefficient heating system.

The decision to install a heating system that used renewable rather than non-renewable technology was also driven by either a single dominant factor or multiple factors working together. Participants who were driven by a single factor were split between those who were motivated exclusively by finance related reasons and those who had strong environmental interests. The distinction between these two groups was that the latter group were immersed in the environmental field, that is, they worked in a related profession, had been involved in environmental issues or had installed other renewable technologies in the past.

Among participants who were influenced by multiple factors to install renewable heat technology, financial and practical considerations carried the most influence, as participants needed to be confident that the new system would work effectively and would be affordable to install and operate. Environmental and lifestyle considerations, although influential in decision-making, were of secondary importance to this group.



I'm quite into green technology...But finance will always outweigh that in my point of view...But when you put this together, you've got the [RHI], you've got the cost of it being cheaper than oil, the fact that we're gaining space, when you put it together as a package then it becomes very, very viable. ” (Participant who installed solar thermal)

There were also three factors which were specifically relevant to the decision to install renewable heat technology. These included:

Practical benefits

Perceived practical benefits of renewable heat technology that encouraged take up included:

- It requiring fewer fuel storage facilities in comparison with a heating system such as an oil tank. This was discussed in relation to ASHPs and GSHPs. Biomass boilers were also seen to require less storage facilities than previous oil based systems in some cases and were considered to be cleaner and less 'messy' to operate.
- Technologies such as ASHPs were favoured because they did not present the supply issues experienced with a previous system, such as difficulty having oil delivered to the home in bad weather; and
- It was perceived to be safer compared to gas, which raised concerns around carbon monoxide poisoning. Further, renewable fuel stores, particularly ASHP and GSHP, were considered more secure by participants whose oil fuel stores had been stolen in the past.

Environmental benefits

The desire to have a more environmentally friendly system was a secondary motivation for participants. The exception to this was participants who had particularly strong environmental interests, including those who had already adopted other 'green' technologies in the home and those who worked in the environmental sector.

Personal lifestyle choice

There were participants whose personal interest in new technologies had encouraged them to install renewable heat technology. In addition, the idea of being more self-sufficient and not dependent on carbon fuels appealed as a lifestyle choice, as did the idea of a cleaner environment compared to a more 'messy', 'smelly' and 'dirty' oil system.

What factors influence the uptake of particular technologies among participants?

Motivations for selecting one particular renewable heat technology over another mirrored the factors discussed above. Participants were more easily able to identify reasons why they did not choose a particular technology over another, which are summarised in table 1 below.

Table 1: Reasons why people who installed renewable heating systems chose not to install other particular renewable technologies

Factor	ASHP	Biomass	GSHP	Solar thermal
Financial	-	Running costs: Reluctance to being tied to fluctuations in fuel pellet costs or to ongoing fuel costs	Installation costs: Perceived as higher than other technologies due to groundwork	-
Technical	Heat output: Mixed views on whether it would be a sufficient temperature	Maintenance: Perception that constant monitoring is required; particularly off-putting for those regularly away from home Heat output: Mixed views on whether it would be a sufficient temperature	Installation complexity: Lack of trust in installers to carry out such extensive work on property Heat output: Mixed views on whether it would be a sufficient temperature	Heat output: Mixed views on whether it would be a sufficient temperature
Practical	Durability: System not perceived to last as long as other technologies	Storage: Lack of space to house the boiler and/or hopper Supply: Aversion to being tied to fuel deliveries	-	-
Environmental	-	Fuel pellets: Not considered a sufficiently 'renewable' technology	-	-
Property	Aesthetic: Concerns that technology would look 'unsightly', make noise and neighbours would react negatively	-	Installation: Concerns around having insufficient or inappropriate type of land for installation	Slanting land: Not suitable for solar thermal system

Cells contain '-' where participants did not identify particular reasons for not choosing a particular technology

The influence of the RHI on the decision to install a renewable heating system

The RHI was welcomed by participants because it provided the security of regular payments for a fixed period of time. It removed potential barriers to uptake by, at least partly, offsetting installation and running costs. Further, it increased confidence in borrowing money or using savings to pay for renewable technologies.

Exploring the influence of the RHI in more detail shows that participants fell into one of three categories detailed below according to the strength of influence of the RHI on their decision-making. Participants in each category varied in terms of their key characteristics, such as the type of property they owned, their demographic details (such as age and gender) and the type of renewable technology they had deployed.

Group 1: Those where the RHI had limited influence

Participants in this group would have installed renewable heat technology even in the absence of the RHI for one or more of the following reasons:

- The running-cost savings of their renewable heat technology made it economically viable, regardless of the RHI. This was particularly the case for properties that were not already connected to a gas supply.

“ The Renewable Heat Incentive didn't play a big part. It was obviously an attraction, but I think we would have put the system in anyway, simply because...I was just astounded at the cost of how much I was spending on oil...there isn't a gas supply up here, so our only choice was either going to be oil or look for something different and, as we see this as our long-term property, I was quite keen to look for something different. ” (Participant who installed ASHP)

- Participants were concerned that the RHI scheme would not operate as advertised (that they would receive regular payments for seven years).
- The participants planned to change their heating system anyway as part of wider renovations to their property, because their existing system was ageing or unwanted (for example an oil system was considered too expensive to run), or because they were building a new build house.
- Environmental considerations were a key motivation for installing renewable heating technology and the participant had the financial means to afford it.

“ ...the [installer] said 'Oh yeah, yeah you'll get this heat incentive and you'll have no problem'. I was a bit cynical about that and I said to my wife 'We need to put this in assuming we're not going to get this heat incentive'...You know I just had this feeling in my mind that something would happen, so... even if it wasn't there I still would have put the heat pump in, because I was just sold on the whole aspect of a renewable energy source and the technology interested us both... ” (Participant who installed GSHP)

Group 2: Those where the RHI provided a ‘nudge’

The RHI was one of a number of other factors that prompted participants in this group to install renewable heat technology, including environmental benefits and cheaper running costs. Those who were ‘nudged’ by the RHI were ‘planners’ who were considering replacing their previous system with a renewable heat source. The RHI hastened the decision to replace a heating system by, for example, lowering the risks associated with borrowing money to pay for the installation.

“ I think we probably would have [installed the biomass boiler without the RHI] because obviously, like the saving, I’ve halved my heating bills, so, yeah, I probably would have still gone ahead with it...It was definitely the RHI [that triggered us to switch from oil to biomass]. We’d had a couple of people round sort of telling us about the payback, but it just so happened that we had a bit of money anyway, so we just did it. ” (Participant who installed biomass)

Group 3: Those where the RHI was a decisive factor

Participants who would have struggled to afford installation costs without the RHI and/or who were not driven by environmental considerations would have chosen to replace their existing system like-for-like if the RHI had not been available.

“ It would have been cheaper to put in [a new gas boiler], the initial cost, obviously, than putting in a biomass boiler, but once it was explained to us that we could get the RHI, we decided that the green option was better, a nice thing to do...I think it was an important trigger... if it hadn’t been for the RHI, we probably would have put a gas boiler in. ” (Participant who installed biomass)

Participants in this group who self-funded installations felt more confident about paying for renewable technologies with savings because they would receive regular payments from the RHI so that the overall projected spend on the system would be much less.

“ In terms of the installation costs of the heat pump versus an oil boiler I think it was another eight or £9000 which at the time was, you know a bit of a difficult one for me and my wife to swallow. But actually, as I say, with the heat incentive...I mean that was just going to offset it within a matter of years, so no, delighted that we did it. ” (Participant who installed GSHP)

In addition, those who installed multiple renewable heat technology systems in their home had higher installation costs, so the financial support of the RHI was more influential in reducing costs over the seven year period.

Financing renewable heat technologies

Sources of finance used by participants

Participants received funding for renewable heat technology from the following sources:

- Self-funding, including savings, pensions, windfall money or income from selling investments;
- Grants from community organisations;
- Informal borrowing from family members; and
- Formal borrowing from organised lending institutions such as a bank overdraft, mortgage or re-mortgage, or a Scottish government loan scheme.

A key driver of the decision to self-fund was an aversion to being in debt, which was particularly, although not exclusively, relevant to older participants (those aged 50 and above) for whom being in debt was against their values.

“ I wouldn't have [taken out a loan] because of the interest payments...since I retired I won't touch loans with a bargepole. I don't believe in paying interest on anything if I can find the money...when we retired we were able to pay off our, the last bit of the mortgage, so that was us free of any - what do they call it, incumbencies. ” (Participant who installed ASHP)

Younger participants (those under the age of 40) also expressed anxieties around owing money, particularly those who had no previous experience of debt. Those who had sufficient savings to afford renewable heat technology saw it as a prudent investment as cheaper energy costs would offset any interest that could otherwise have been earned on savings and the RHI payments meant that eventually the money spent on installation would be returned to them.

“ We didn't have a particular use for that savings pot, so it seemed like a good opportunity to invest it. So obviously hopefully we should basically replace that pot over seven years, which means we can spend the money again. ” (Participant who installed ASHP)

However, there was a lack of awareness among self-funding participants that financial products such as loans were available specifically for renewable heat technology. Therefore it was assumed that they would have to use savings to finance a new system. Older participants in particular doubted that finance would be available to them in retirement.

Drivers of the decision to borrow money included not having sufficient savings to cover the cost of installation. Other drivers included the opportunity to take a low or no-interest loan from family, or the anticipation of a windfall such as an inheritance, that they could use to pay off the loan in the near future.

“ We were fortunate in being able to...borrow some money... to fund the installation...and we will hope to be able to repay [the loan] at some stage in the future from a [windfall] that we should be receiving soon. ” (Participant who installed biomass)

Those who were aware of the RHI when installing their renewable heat technology realised that regular payments would cover or even exceed loan repayments. This encouraged some participants who had savings to pay for their heat system using a low-interest loan instead, as the RHI payments would cover interest payments and allow them to keep their savings. As such, the RHI lowered barriers to borrowing money to pay for renewable heat technologies, which encouraged uptake among those who were not convinced of the financial viability of renewable heat technology in the absence of the RHI.

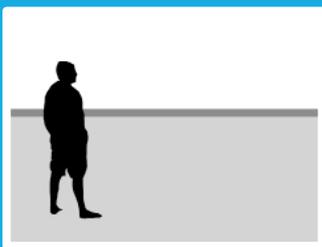
Awareness of third party finance from installers or other lenders was low among those interviewed. Where there was awareness, there was a lack of trust in these lenders due to a lack of familiarity with this type of borrowing and a perception that information on lending rates was inconsistent.

When choosing a lender, trust, convenience and appropriateness of the financial product were the key considerations that influenced decision-making. A loan was considered 'appropriate' if it had favourable conditions attached, such as a low interest rate and a repayment period that suited the borrower. Banks, particularly those that participants had borrowed from before or held a current account with, were trusted more than installers as a lender, because of the existing relationship. Taking out a loan was considered more convenient if the application process was short and not too intrusive (for example, without burdensome credit checks), or if it was part of an existing borrowing arrangement, such as a business account overdraft or a loan that had already been taken to fund wider renovations. Low interest rates and favourable loan periods were also sought from a potential lender.

Typology of participants who sought finance to fund their renewable heat technology

The approach taken to choosing a lender varied according to whether renewable heat technology was part of wider changes to the property, and how affordable the new system was felt to be. This can be summarised using the following typology:

Fig 1. Typology of participants who sought finance



Shore watchers used a known lender. They included participants who installed renewable heat technology as part of wider changes to the property or when building a new home. As such, these participants appeared to choose the most convenient source of finance for the larger project on their home and this would cover the cost of installation. Consequently, 'shore watchers' could lack knowledge of financial products that were specific to renewable heat technology.

Case Study – 'Shore watcher'

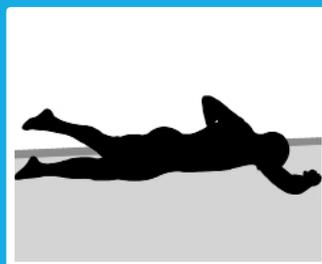
Ian installed GSHP and solar thermal heating systems in a new build property. He chose to take out a single loan covering the total costs of the project for reasons of convenience. Specifically, Ian wanted to avoid having to select and manage multiple financial products.



Toe dippers explored different sources of funding to a limited degree. They included participants who had standalone renewable heat technology installations, which meant they were more inclined to look for finance specifically for renewable heat technology. However, their exploration of alternative sources of funding was generally limited to conversations with installers about third party finance, and their decisions were based primarily on convenience and trust.

Case Study – 'Toe dipper'

Jimmy was in his 80s. He replaced his oil boiler with a biomass because it was getting older. Jimmy chose to pay for the installation by taking out a loan rather than using his savings as he felt this was financially prudent. While Jimmy briefly explored third party finance options with the installer, he decided to use a bank loan because he trusted the lender and because the application process was considered to be quick and easy.



Swimmers explored multiple sources of funding and were keen to identify the most competitive financial product. Affordability of renewable heat technology was a key concern for this group so the RHI was a decisive factor in their decision to install a renewable heat technology system.

Case Study – 'Swimmer'

Frank lived with his partner. He chose to replace his older oil boiler with biomass. Frank did not have sufficient savings to cover the installation costs and so prioritised finding a loan that was affordable. He identified a number of potential sources of funding through conversations with colleagues and friends. Frank chose a loan that offered zero percent interest.

4. Participants' experiences of the Domestic RHI

Applying for the RHI

The experience of the Domestic RHI can be split into three different stages: the pre-application stage where the applicant had to meet the scheme requirements; the application stage; and the post-application stage when applicants received the payments.

Pre-application stage: meeting the scheme requirements

The pre-application stage consisted of meeting the RHI eligibility criteria and collecting the necessary documents to evidence this, including the Green Deal Assessment (GDA), Energy Performance Certificate (EPC) and the Microgeneration Certification Scheme (MCS) certificate. There were both positive and negative experiences at this stage, and the table below illustrates the key factors that underpinned experiences.

Table 2: Enablers and barriers at the pre-application stage

Aspect of pre-application process	Enablers	Barriers
Understanding the process	<ul style="list-style-type: none"> Installers, friends and family supported participants in understanding eligibility criteria, information required and the accreditation process 	<ul style="list-style-type: none"> Eligibility criteria were considered unclear, particularly where they related to cavity wall insulation
Meeting eligibility requirements	<ul style="list-style-type: none"> Installers and surveyors explained to participants whether they met the requirements and took action to ensure they did, such as overseeing the installation of insulation 	<ul style="list-style-type: none"> Property-related factors made it difficult to meet eligibility criteria, for example if their house was older
Gathering information in a timely manner	<ul style="list-style-type: none"> Installers helped participants to gather information or supplied it quickly themselves 	<ul style="list-style-type: none"> Delays were experienced in obtaining all the relevant paperwork from installers, surveyors or inspectors
Organising GDA, EPC and MCS	<ul style="list-style-type: none"> Installers and Ofgem helped participants organise assessments, or installers carried out assessments themselves or organised for someone else to GDA assessor was found easily online 	<ul style="list-style-type: none"> Difficulties identifying a GDA assessor or estimating the cost of the GDA. When GDA found there to be insufficient insulation, its value was questioned Incorrect information entered on certificates by installer EPC considered unnecessary in a new, well insulated house

Application stage: completing and submitting the online form

Once participants had gathered all the information that they needed to supply, they went online to complete and submit the application. The experience of completing the application form was influenced by the following factors:



Preparedness

Gathering all the required information beforehand was key to ensuring that completing the application was easy and quick. It was also considered important to read the application guidelines before starting the application.



Accessibility and clarity of the form

On the whole, the application form was found to be simple, logical and written in clear and accessible language. However, there were specific examples of questions that were deemed inflexible, and not allowing the participant to provide a sufficient explanation of their circumstances.



The only thing I would say about [the RHI application form] was that it didn't give you any little boxes to explain... so there were questions like: 'how long have you lived in the property for?' And we did own it, but we didn't live in it. So I found that the questions weren't very flexible. They weren't difficult, but I would have liked a little [box to write in comments for] a couple of the questions. ” (Participant who installed ASHP)



Mode

Applying online was considered to be more convenient, straightforward and timely than a paper method. The application website was deemed to be well-constructed and easy to navigate. The exception to this was participants who were less confident using the internet and who therefore found it challenging to complete the application online.



Access to correct and timely guidance and support

Key sources of support taken up by participants at the application stage included:

- Installers and suppliers providing information that participants needed to complete the form such as technical information, calculations and supporting paperwork, and completing sections of or the whole application on the participant's behalf. Those who did not use the help of an installer and completed the application on their own or with the help of a family member reported struggling with the application. However, there were also negative experiences of installers who had provided incorrect or insufficient information or had taken too long to supply information.
- Ofgem providing information on its website and through its telephone advisors, who explained the meaning of questions that participants did not understand and the steps they needed to take to submit the application.
- Friends or family who helped by completing the application form for the participant in some instances.



Unfortunately [I'm inexperienced] where the computer is concerned and my niece is an IT expert. So she came down, brought my computer - she got the form and asked me the questions and we filled the answers. I did need the assistance on that. (Participant who installed biomass) ”



Technical issues

On the whole, participants found it easy to upload supporting information and submit the application, and were pleased that they received an acknowledgement of the submission within a few hours. Nevertheless, some participants over the age of 50 experienced technical problems with submitting the application, saving the application form and uploading supporting information.



Time taken to complete the application

Where delays were experienced, they were generally due to errors made in completing the application. This was because of either incorrect information having been provided by the installer, or the participant having misunderstood the meaning of the question.



Whether the application was accepted or returned

Applications were returned by Ofgem if information was incorrect or missing. Participants were generally disappointed if this happened because it resulted in delays in joining the scheme. Despite facing challenges, participants chose to re-apply to the scheme after first asking for clarification on why their application had been initially rejected.

Post-application stage: receiving RHI payments

Once the RHI had successfully been awarded, the applicant began to receive payments. At the time of the interview, participants had limited experience of RHI payments, with those who had received any payments having only received one or two so far.

Factors that had a core influence on satisfaction were:

The amount received and how that fitted with expectations

Expectations of the RHI payment amount were based on information provided by installers or research undertaken by participants. Payments could be lower than expected for one or more of the following reasons:

- Information provided by installers was inaccurate;
- Participants made their own miscalculations, in some instances by having misunderstood information on the RHI website such as the formula used to calculate payments, or not having read all the information on payments, including caveats;
- Delays in the installation process had led to degression, that is, the applicant was on a lower RHI tariff than expected; and
- Metered participants were uncertain what their RHI payment would be as it depended on their meter reading that they were yet to submit.

Timeliness of payments

Causes of delay included issues experienced at the installation stage that delayed installation and hence RHI payments. It was reported that RHI payments took up to five days to be processed and cleared by banks and there was a view that this was too long.

In addition to these core factors, there were others that had a peripheral or secondary influence on satisfaction with RHI payments. These were:

- Authority of the body overseeing the payment process: there was a general appreciation that the government was a reliable body to oversee the process.

“ I think mainly because it's government funded, we trusted it a little bit more...it's like a safety thing...It made us feel like it wasn't just a random company who said, 'Here you go, we'll give you payment back every three months.' ” (Participant who installed biomass)

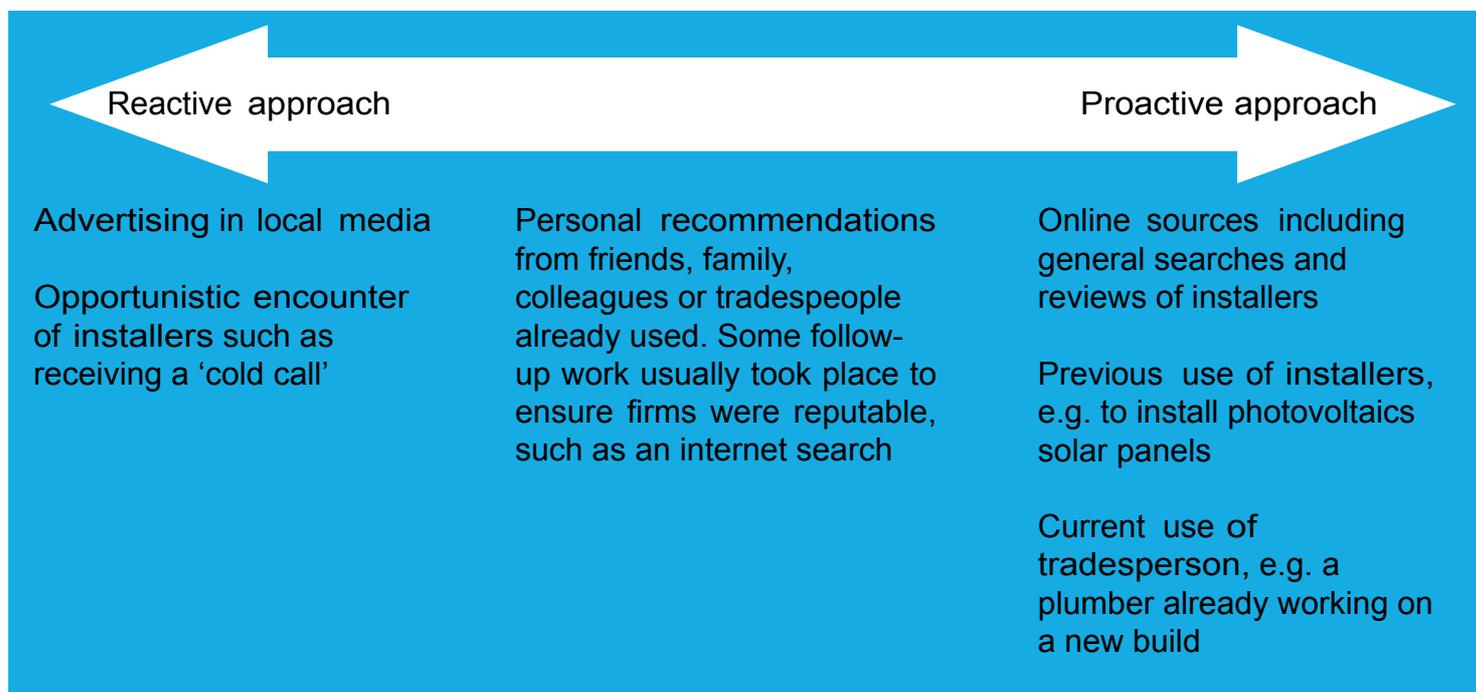
- Mode of delivery: convenience was a key consideration. It was appreciated that payments were delivered straight into bank accounts, multiple RHI payments were made at the same time, and it took the form of monetary payments rather than discounts.
- Payment period: while there were participants who had no issues with quarterly payments, others felt that more frequent, monthly payments would be more helpful, possibly to synchronise with loan repayment schedules.

5. Experiences of installing and operating renewable heat technologies

Installation of renewable heat technologies

Participants varied in terms of how proactive they were in identifying a suitable installer. Proactive participants carried out more extensive searches and used a number of different information sources, while 'reactive' participants relied on a single source of information such as adverts or 'cold calls' from installers. The diagram below illustrates the range of ways in which participants identified an installer.

Fig 2. Approach to identifying a suitable installer



Participants described taking into account three factors when selecting an installer:

- The price of installation – whether the installation was affordable and offered value for money.
- The quality of installation – participants were confident they would receive a good service if they had previous positive experience of using the installer, or the installer had been recommended by a friend or family member. Participants also valued when installers took the time to explain the installation process and address any queries, were transparent about costs and any anticipated disruption and demonstrated they were knowledgeable about the technology.

- The post-installation support offered – when assessing the likely quality of post-installation support participants considered whether the firm was established and so likely to be reliable, and whether the installer was local and so able to respond more quickly to call-outs.

“ They were a local firm; if anything went wrong they would come to the house the same day...I've heard of some folk that's had biomass installed and their installer's 100 miles away so any problems you've got to wait weeks and weeks to get fixed. ”
(Participant who installed multiple renewable heat technologies)

Problems encountered with identifying an installer included a lack of accredited installers in the local area, participants having limited knowledge of local tradespersons, and wide variation in quoted costs from different installers, which led to confusion around why costs varied.

Experiences of installation varied across participants.

One factor influencing overall satisfaction with the installation process appeared to be how proactive participants had been in sourcing information, with more proactive approaches contributing to more positive installation experiences. This may be because proactive participants were more successful in identifying an installer who could meet their specific needs. Other key factors influencing satisfaction included:

Pre-installation

At the pre-installation stage satisfaction depended on whether participants were given sufficient and accurate information on what to expect from the installation and from their chosen renewable heat technology. This included information on the cost of installation, the nature and scale of disruption, and likely running costs and fuel usage of the new system.

Installation

At the installation stage, factors impacting on satisfaction related to the quality of work carried out, level of disruption experienced and how the experience compared to expectations. They included:

- Installer-related factors. Participants reflected favourably on their experience where the installer was reliable by turning up when promised; carried out the installation safely and professionally (such as by lagging and fitting pipes properly); and was approachable, polite, flexible; and kept the participant informed.
- Level of disruption experienced. Unexpected disruption had a particularly negative impact on experiences of installation. Types of disruption experienced by participants included: damage to the property and many tradespeople being there at one time. Participants also reported waiting too long for the new heating system to be up and running, the impact of which was felt more acutely in winter.
- Property-related factors. Certain aspects of the property were reported to have made the installation more complex and problematic than expected, making the overall experience more negative for the participant. Examples included more preparatory work than expected for the installation of a GSHP due to ground conditions, and difficulties installing underfloor heating because the floor was uneven.

Post-installation

How well the installer responded to any issues that arose impacted upon customer satisfaction. Satisfaction was reduced if installers left long-term damage to the property or unfinished work, such as unwanted trenches or exposed pipes, or did not acknowledge, accurately diagnose or fix problems quickly. There were also complaints that renewable heat technology system manufacturers had not provided user instructions in English.

Case study

Bob and Anita decided to replace their old gas boiler with an ASHP. Prior to the installation, the installer reassured them that everything would be done to time and budget. However, the installer hired sub-contractors who appeared to have limited knowledge of the technology. The installation was supposed to take around five days but it took over 10 days and since installation the ASHP has broken down multiple times. Bob found it difficult to get in touch with the installer, and when he did finally manage to get the installer to have a look at the system, he did not diagnose the problem correctly. Eventually, the installer issued an apology and is now fixing their system.

Operating renewable heat technologies

This section explores participants' experiences of living with and operating renewable heat technology.

Overall satisfaction with renewable heat technologies was influenced by how favourably the technology compared with the previous heat system. For example, participants who reported little difference between their old and new systems were neither particularly satisfied nor dissatisfied with their renewable technology. This included participants who moved from a gas to a biomass boiler and found that both systems were similar in terms of key qualities such as heat output and control.

Factors that influenced satisfaction with renewable heat technology can be grouped into those that had a core role in shaping experiences and those that had a more peripheral role, as discussed below.

Factors that had a core influence on satisfaction included:

Cost: The perceived value for money of a renewable heat technology had a key influence on overall satisfaction. A renewable heat technology was considered by participants to provide value for money if it gave the same or a higher level of heat output than the previous system at a lower running cost. Perceptions of value for money were also influenced by participants' expectations, so that where running costs were higher than anticipated, satisfaction levels were lower. Similarly, participants' satisfaction decreased where the cost of fossil fuels, such as oil prices, had not risen as high as expected or participants had concerns that the price of renewable fuels would increase more than they had anticipated.

Heat output: Satisfaction was driven by whether the system heated the home and hot water at the required temperature and did not result in 'cold spots' or sudden bursts of heat. Participants who had trouble heating their homes using their old system were particularly satisfied with their renewable heat technology if the technology (combined with the additional energy efficiency measures implemented in the course of installing their system) provided adequate warmth.

Reliability: Although minor teething issues were generally tolerated, participants reported low levels of satisfaction where they experienced repeated system breakdowns, particularly if the installer had been unable to resolve the problem within good time. In contrast, those who previously experienced problems with fuel supplies, such as deliveries of oil during the winter, considered their new renewable heating system to be more reliable and this enhanced satisfaction.

Views were divided on whether the ability to control heating had a core or peripheral influence on satisfaction levels. Those who did not feel it significantly affected their satisfaction levels explained that it was less time consuming to leave heating systems such as ASHPs on all day rather than worry about timing or zoning. Other participants placed importance on the ability to control their heating systems and were satisfied with their technologies when it allowed them to carry out the following functions:

- Zoning allowed the different rooms in their home to be heated to different temperatures;
- Transitioning enabled participants to heat their home to the required level when they entered, for example when returning from holiday;
- Monitoring energy use, allowed the applicant to use Home Energy Monitoring Systems to inform decision-making around usage;
- Easy-to-use controls that seemed to be intuitive; and
- Responsive to needs. Having their home warmer than desired or having to keep the heating on when there was no one at home when using technologies such as ASHPs reduced satisfaction.

Factors that had a more peripheral influence on satisfaction levels included:

Convenience: A certain degree of inconvenience in using the system was tolerated, providing that the core factors that influenced satisfaction were met. Convenience was considered in terms of the level of everyday interaction, such as monitoring settings and cleaning (in the case of biomass systems), that was required to maintain the system. It also included how easy it was to receive delivery of fuel sources such as biomass pellets and to store them.

Environmental considerations: Knowing that the heating system was environmentally friendly had a positive impact on satisfaction with the system. Experiences were also affected by whether the system had any impact on participants' living environment. The noise of ASHPs was reported as a minor issue for the home owner rather than their neighbours; although it is not clear whether participants had actively sought feedback about noise from neighbours.

Influence of renewable heat technologies on participants' heat behaviours

As a result of having a renewable heat technology system installed, participants reported a number of behavioural changes. These included:

- Changes in how space was used in the home – participants reported using more space in a room or more rooms in the house as a result of better heat dispersion. They also discussed having more visitors round because a warmer home removed the 'embarrassment' of inviting people to a cold home.

Case Study

Gregory is just over 70 years of age and lives with his partner in an off-grid area. Prior to installing a biomass boiler, Gregory used a wood burner system. Although Gregory felt that his previous system was more environmentally friendly than having an oil boiler, it did not heat the home up as he would have liked. Specifically, there were cold spots in the home which meant that some rooms were underused. Since installing a biomass heat system, the whole house has become warmer and there are no longer cold spots. As Gregory puts it: “[the living room has got] the same warmth as all the rest of the house...so [the biomass boiler] has enabled us to live better in the house we have”.

- Changes in heating and hot water use: the running cost and efficiency of the renewable heating system influenced how long the heating was kept running during the day; whether supplementary heating sources were used; and at what point in the season the heating system was switched on or off:
 - How long the heating was kept running: heating was kept on for longer where the renewable heat technology was less expensive to run than the previous system and/or it was less responsive due to the nature of the technology. For example, participants who switched from oil boilers to ASHPs or GSHPs reported in some instances that their technology did not warm spaces as quickly as they would have liked, resulting in the participant keeping heating on for longer. Conversely, participants reported keeping the heating on for less time where the technology (and the attendant heat efficiency measures) was seen to be effective in heating spaces quickly, afforded the control to target heating of key spaces and/or there were concerns around costs.



Yeah, it's [biomass boiler] on more often [than the previous wood burner system]. It seems to heat the radiators hotter than, than the oil and because you're not worried about what it's costing you, you tend to have the timer [on with the wood burner]. And now, when it was cold you put it [biomass boiler] on to all day so it comes on at six thirty in the morning and goes off at ten o'clock at night and that makes a massive difference[to how warm the home is]. ”
(Participant who installed biomass)

- Use of supplemental heating sources: participants who were satisfied with the efficiency and control of their renewable heat reported using supplemental heating sources as portable heaters and blankets less frequently. In contrast, the use of supplementary heating sources was reported to have increased where the heat output of the new heating system did not meet the needs of participants.
- Seasonal use of heating systems: concerns around the cost of technologies such as ASHPs resulted in participants turning the heating off earlier in the year in some instances.

- Changes in level of interaction with the heating system: participants discussed the cleaning and maintenance requirements of renewable heat technologies in comparison with their old systems. For example, while biomass boilers were acknowledged to require regular cleaning, they were seen as being easier to service compared with an oil boiler.

“ The feed of the pellets I would say is, you know, is the one slightly clunky side of it... we've had two or three sort of pellet blockages, you know, it obviously doesn't feed as well or easily as oil does, or gas...so occasionally you have to go and unblock it, and it's usually at night and freezing, but that's - you know, I'm happy to pay a small price for the other benefit [running cost savings]. ” (Participant who installed biomass)

- Changes in household routines and habits: behaviour changes discussed by participants included wearing more or less clothes in the house after installing a new heating system, having showers in the morning rather than at night due to changes in the availability of hot water and opening windows due to rooms being too warm.

“ I'll tell you the difference between now [and before installing ASHP]: my wife used to go [to the lounge] about seven o'clock in the evening. With the [previous] gas boiler, she used to put a dressing gown on and get under a blanket. And what, we've had since [ASHP]...all she does is just sit in the lounge in her [normal] clothes now, and she's comfortable. ” (Participant who installed ASHP)

- Transitional and zoning behaviours: that is, ensuring the home is warm enough when participants return home through the use of online apps or a timer and keeping different rooms at different temperatures. For example, participants reported keeping bedrooms cooler than the rest of the home to help them sleep better. They also discussed keeping rooms used by young children and older family members warmer than other spaces in the home. In instances where running costs of the new system were lower than those of the previous system, it encouraged less zoning, as participants no longer had to heat fewer rooms in order to minimise costs.

“ We've got a general background heat [as result of ASHP] all the time. It's important with my parents living with me in their 80s that [their] room has to be very warm... because they don't move around that much...So they're on one zone and the rest of the house, or the majority of the rest of the house where we live in, is on one of the other zones. ” (Participant who installed ASHP)

“ ...in the old days [with their storage heater system], you would heat the room you were in, we would have the AGA on in the kitchen and that would be a warmish area. And then you would heat the sitting room that you would sit in, in the evening, and then, when you went to your bedroom, you would go with a hot water bottle and probably electric blankets...but now [after installing GSHP]...whichever room you go in, it is a very comfortable 20 degrees centigrade. ” (Participant who installed GSHP)

The extent to which behaviour was affected by renewable heat technology depended on how different the experience of the new technology was to that of the old heating system in terms of running costs, heat output, control, convenience and maintenance required. For example, in instances where a biomass boiler produced the same heat output with little difference in running costs to the previous system, these factors contributed to similar heating behaviours as before. However, for example - if the new system afforded the applicant greater control, had a higher heat output and lower running costs, it would elicit behavioural changes such as having the heat on a lower temperature for longer time periods and using more rooms in the house.

