Department for Energy Security & Net Zero

Evaluation of the reformed Renewable Heat Incentive

Synthesis of findings from the evaluation of the domestic RHI

Findings report

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Executive Summary

Introduction

This report presents findings from the evaluation of the reformed domestic Renewable Heat Incentive (RHI). The evaluation was undertaken on behalf of the Department for Business, Energy and Industrial Strategy (BEIS) by CAG Consultants, in partnership with Winning Moves, Wavehill, Hatch, EREDA Consultants and UCL.

The RHI scheme aimed to encourage the installation and use of renewable heat technologies (RHTs) and support the development of a sustainable market for renewable heat that was less dependent on subsidy. The scheme was originally designed to meet the requirements of the European Union (EU) Renewables Directive (2009/28/EC), but the focus shifted to decarbonisation following EU exit. The domestic RHI scheme was open to applications from 9 April 2014 to 31 March 2022. It supported accredited domestic installations of ground and air source heat pumps, solar thermal panels and biomass boilers and pellet stoves in England, Scotland and Wales, providing payments for the renewable heat produced over a 7-year period at a pre-specified tariff. BEIS expected the scheme primarily to support retrofitting of RHTs to existing domestic properties that were off the mains gas grid: new homes were not eligible unless they were 'self-build'[1].

Budgetary safeguards were built into the design of the scheme with the aim of ensuring that RHI payments provided value for money. An overall budget cap was set for the RHI, and mechanisms were put in place for RHI tariffs for new applications to be degressed (i.e. reduced) to reflect cost reductions for specific technologies, as indicated by increased take-up of those technologies. A series of reforms were introduced to the domestic RHI scheme in stages between September 2017 and June 2018 to help the scheme better meet its objectives and to improve its cost-effectiveness. The effectiveness of these reforms was the primary focus of this evaluation. The reforms included:

- the introduction of **higher tariffs** for air source heat pumps (ASHP) and biomass installations, which aimed to further stimulate take up
- the introduction of **heat demand limits (HDLs)**, capping the gross heat demand on which domestic RHI could be claimed, which aimed to improve value for money on large domestic installations and encourage more focus on smaller properties
- the introduction of a requirement that all domestic heat pumps should have separate **electricity metering**, which aimed to improve value for money by enabling heat pump users to monitor their heat pump's electricity consumption
- reform of payment arrangements for an optional **Metering and Monitoring Service Package** that could be taken up alongside the RHT
- the introduction of '**assignment of rights**' (AoR) to allow the development of third-party financing arrangements, which aimed to help householders overcome the barrier of the initial capital cost of an RHT, thereby improving access to the scheme for consumers less able to pay

[1] A new home commissioned by the potential user of the home, rather than by a third-party developer.

The aims of the evaluation were to 1) **assess the impact of the scheme** and 2) provide **strategic learning** to inform heat policy development[2], focusing on the RHI reforms.

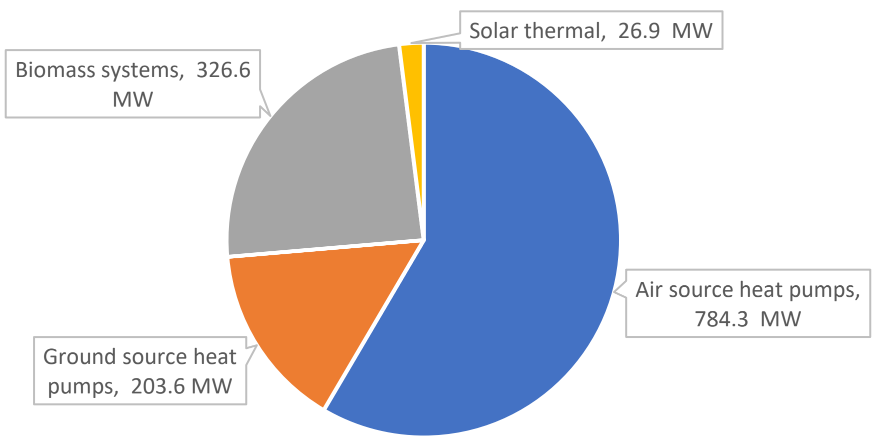
The evaluation adopted a theory-based evaluation approach, seeking to develop, test and refine realist theories about the reformed domestic RHI throughout its lifetime[3]. This synthesis report draws on findings from multiple research activities, undertaken between 2017 and 2022. These include analysis of domestic RHI administrative data, applicant monitoring surveys, qualitative research with applicants and the renewable heat supply chain, and a range of other analytical exercises designed to understand market development and value for money (including a Sustainable Markets Assessment, Subsidy Cost-Effectiveness Assessment (SCEA), and Competition and Trade Assessment). Details of the methodology are set out in the main report and then in greater depth in the Technical Annex.

Key findings

What happened under the reformed domestic RHI scheme?

The domestic RHI scheme as a whole supported 113,046 accredited installations of renewable heat technologies in domestic properties up to end July 2022. More than two thirds (68%) of these installations were Air Source Heat Pumps (ASHP), with 13% being Ground Source Heat Pumps (GSHP), 11% being biomass systems and 8% solar thermal. In total 1,341 MW of renewable heat capacity had been installed and accredited with support from the domestic RHI up to the end of July 2022. Figure 1 shows the split of installed capacity by technology.

Figure 1: Renewable heat capacity accredited under domestic RHI to end July 2022



Source: RHI deployment data to end June 2022, published by BEIS; application database for July 2022.

Biomass installations were relatively high during 2014 and 2015 but fell off after the RHI tariff degressed from 14.22p/kWh in April 2014 to 7.38 p/kWh in October 2015, despite a small rebasing of the tariff as part of the reform package in 2017[4]. There were slight degressions in heat pump tariffs during 2015 and 2016 but higher heat pump tariffs were introduced by the

[2] To address these aims, a set of detailed evaluation questions were developed, which are described in the main body of the report.
[3] BEIS Non Domestic RHI Synthesis Report (2023) is available on https://www.gov.uk/government/publications/reforms-to-the-non-domestic-renewable-heat-incentive-evaluation
[4] Tariffs stated in 2021/22 prices. Source: Ofgem Domestic RHI tariffs table (2021/22).

reforms in 2017. Heat pump installations generally showed a rising trend, apart from a post-reform hiatus in 2018 and another hiatus during the 2020 Covid pandemic. Overall scheme-supported RHT installation levels increased during the RHI but the scale of the increase was lower than was anticipated[5].

Being a subsidy that was paid back over seven years, the scheme was more accessible to customers who could afford the upfront cost of installing RHTs. Official scheme application data showed that most (76%) of accredited applicants were owner occupiers, followed by social landlords (21%) and the remainder being private landlords (3%). Scheme data highlighted that domestic RHI installations were greater in areas that did not have access to the gas grid, because renewable heat technologies offered an alternative to electric storage heating, solid fuel, oil or LPG-based heating systems.

Consumers generally reported high levels of satisfaction, with 83% of applicant survey respondents being ‘satisfied’ or ‘very satisfied’ with their technologies. A follow-up survey with applicants who had used their heat pumps for two winters found higher levels of satisfaction (92% ‘satisfied’ or ‘very satisfied’). Qualitative research with heat pump users suggested that this was because users could take time to get used to the slow, steady heat provided by heat pump systems, which contrasted with more responsive heating provided by biomass or gas boiler systems.

How much carbon has been abated to date?

To the end of March 2022, evaluation evidence indicates that the domestic RHI had saved an estimated 1,301 kilo-tonnes of CO2 equivalent[6]. Over half (58%) of estimated carbon reduction was attributable to heat pumps, while 42% was attributable to biomass boilers with under 1% being attributable to solar thermal installations. Each technology’s contribution to carbon savings depends on the total capacity installed, the length of time for which installations have been operating, the intensity of their use and the heating technology they were replacing. Overall, the scheme’s contribution to carbon abatement will increase over time, as installations supported by the domestic RHI continue to generate heat that would otherwise have been generated from non-renewable sources. The relative contribution made by different technologies will change over time: more of the biomass installations were installed earlier in the scheme and more of the heat pumps were later, so heat pumps will tend to play a greater role in the scheme’s contribution to carbon savings as time goes on.

Has the reformed domestic RHI improved value for money?

Subsidy cost-effectiveness analysis focused on the relative value for money of the different tariffs for each technology under the domestic RHI. Subsidy cost-effectiveness indicators for installations to date[7] show that the mean annual subsidy cost for the domestic RHI (both pre and post-reform) was £234 per kW of installed capacity. In terms of subsidy cost per kW, the analysis found that solar thermal appeared to provide the best value at £176 per kW, while the

[5] In practice there were 11,586 accredited installations across all technologies in 2020/21, compared to 20,300 installations in ‘illustrative projections’ in the reformed RHI Impact Assessment (see main report for further details).

[6] Carbon abatement was calculated as part of the SCEA.

[7] Assuming that technology usage levels are broadly unchanged, the subsidy cost-effectiveness indicators should not change over time or be affected by whether installations of specific technologies occurred earlier or later within the scheme. Where the indicators are ratios of cumulative subsidy costs to cumulative benefits (e.g. renewable heat generated, tonnes of CO2e abated), the cumulative subsidy cost for each technology will rise in proportion to the cumulative benefits from that technology. Where the indicator is the ratio of annual subsidy costs to overall capacity, the annual subsidy cost will rise with inflation but otherwise remain broadly unchanged, with overall capacity also being constant. The indicators are presented in real terms, taking account of inflation.

subsidy cost per kW was higher for biomass (£223 per kW) and heat pumps (£235 per kW)[8]. However, heat pumps and biomass were more cost-effective than solar thermal in terms of subsidy cost per MWh of renewable heat generated (£134 per MWh and £166 per MWh respectively, compared to £344 per MWh for solar thermal). Heat pumps and biomass were also more cost-effective than solar thermal in terms of subsidy cost per tonne of carbon abated (£592/tonne CO2e and £590/tonne CO2e respectively, compared to £2,085 per tonne CO2e for solar thermal). This reflects higher average installed capacity and higher usage rates for heat pumps and biomass installations compared to smaller solar thermal installations.

The SCEA compared pre-reform and post-reform outcomes (based on 80% of applications)[9], and found that subsidy cost-effectiveness per kW of capacity installed was lower in the post-reform period than the pre-reform period. This was partly because additionality was lower in the post-reform period (i.e. more applicants said that they would have installed RHTs anyway, probably reflecting growing awareness and acceptance of RHTs)[10], and partly because subsidy rates for ASHP were higher post-reform. However, the SCEA found that the cost-effectiveness of carbon abatement and air quality savings improved in the post-reform period. This was partly because of a different mix of counterfactual technologies being reported by the applicant survey during the post-reform period, and partly because of improvements to cost effectiveness of RHI subsidies arising from the introduction of HDLs, which limited the heat subsidies that could be claimed for large properties.

What impact has the domestic RHI had on the supply chain?

The number of MCS-accredited installers for all technologies rose, possibly in anticipation of the RHPP[11] scheme that preceded the RHI, with the number of solar thermal installers peaking in 2012, prior to the start of the domestic RHI scheme in 2014. The number of biomass installers peaked in 2015, declining after significant degressions in the biomass tariff during 2014 and 2015. Qualitative evidence suggests that other factors may have contributed to the rise and fall decline in installer numbers for renewable heat, including tariff degressions in the non-domestic RHI scheme, as well as changes in other Government subsidies for renewable energy (e.g. the Feed-in-Tariff for renewable electricity).

Although there were no significant degressions in heat pump tariffs during the scheme, the number of accredited heat pump installers also declined between 2015 and 2019. Qualitative evidence suggests that there may be two reasons for this. On the one hand, interviews with installers just after the reforms suggested that many installers diversified or went out of business after the biomass degressions: with many installers covering multiple technologies, this may have had knock-on effects on the number of heat pump installers. On the other hand, interviews with installers suggest that some ‘MCS umbrella schemes’ were operating in 2019 and 2020. This might have allowed installers to discontinue their MCS accreditation while continuing to install heat pumps, with final accreditation being obtained via an MCS-accredited installer or manufacturer, although the evaluation did not find evidence of this behaviour.

The number of heat pump installers recovered towards the end of the domestic RHI Scheme, showing considerable growth from 2020 to 2022, stimulated by higher tariff rates and other factors such as increasing installer confidence in future consumer demand for heat pumps,

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[8] The methodology used to calculate these figures is set out in Appendix B of the Technical Annex.
[9] The SCEA compares subsidy cost and output achievements for the respective indicators, and therefore omits installations/applications for which incomplete data was available on both costs and benefits. Further details are given in Appendix B of the Technical Annex.
[10] Additionality rates were based on applicant survey data.
[11] The domestic RHI scheme was preceded by the Renewable Heat Premium Payment (RHPP) scheme, which provided one-off payments to help householders buy RHTs and was available between 2011 and 2014.

supported by the Green Homes Grant - Vouchers (GHG-V) and upcoming Boiler Upgrade Scheme (BUS). The increasing use of 'MCS umbrella schemes'[12], suggests that installer capacity may have grown faster than indicated by the number of MCS accreditations.

Whilst the proportion of RHI applicants reporting difficulty with finding an installer has remained broadly stable in recent years (see Figure 11 in the main report), supply chain stakeholders reported recent signs that the heat pumps supply chain is growing, partly stimulated by UK heat pump manufacturing capacity. Developments included market constituents increasing investment and expanding production in the UK, alongside existing gas boiler manufacturers entering the heat pump market.

How did the RHI contribute to observed outcomes?

Analysis of applicant monitoring survey data found that over half (59%) of domestic RHI supported installations were additional to what would have otherwise occurred (i.e. applicants reported that they would not have occurred without the RHI subsidy). This suggests that the scheme was necessary to help support observed market development. However, it also suggests that considerable further support is needed to further progress towards sustainable markets for RHTs.

Qualitative evidence from both installers and consumers suggested that the RHI was perceived to have not been well publicised, and this was seen by installers to be a crucial factor in limiting its take up. The most common route for finding out about the RHI was via installers. Qualitative insights suggested that the main way in which the scheme supported the roll out of RHTs was by improving customers' rates of return on RHT projects, helping to move customers from being aware of RHTs to actually committing to invest in an RHT. Other consumer contexts identified as necessary to take-up of the RHI included: existing awareness and access to trusted information; a trusted installer/adviser; acceptable capital and running costs (after taking RHI revenue into consideration)[13]. These contexts likely limited take-up to a relatively small selection of householders. A common challenge for consumers was accessing independent and trusted knowledge and advice to help inform them about RHTs.

For social landlords, the RHI helped ASHPs to become their preferred solution for off-gas grid properties. ASHPs provided landlords with a number of benefits, including helping to meet energy efficiency standards for social housing and switching tenants away from older, less controllable, expensive electric heating systems. The RHI helped landlords to justify the upfront capital costs of installing RHTs and they were a key customer for AoR, as third-party finance reduced upfront costs and thereby helped them to increase the scale of their installations.

What difference did the reforms make?

Tariff changes

The introduction of higher tariffs for ASHP and biomass aimed to stimulate further take-up of these technologies. Heat pump installations, and particularly ASHP installations, increased steadily after a post-reform hiatus in 2018. Heat pump installers tended to attribute rising ASHP installations to a range of factors, including environmental motivations of customers and raised awareness of heat pumps stimulated by the GHG-V scheme as well as RHI tariff increases, which they recognised had played a role. No increase in demand was observed in

[12] https://mcscertified.com/findings-of-the-umbrella-scheme-consultation/

[13] Other helpful contexts included having an off-gas grid property, being environmentally motivated and technically minded.

biomass applications post-reform. Installers perceived that biomass tariff rebasing was too limited to reverse the negative impact of earlier degressions on the market.

Quasi-Experimental Impact Analysis (QEIA) examined the impact of ASHP tariff increases by analysing ASHP applications that were unaffected by HDLs, comparing the characteristics of applications and applicants in the 'pre-announcement' and 'post-reform' periods[14]. The QEIA analysis found that the ASHP tariff increases were associated with a 13% increase in the size of properties (albeit for properties below the HDL threshold), and with increasing likelihood of receiving applications for detached and semi-detached houses relative to those from flats, maisonettes and terraced houses. Post-reform ASHP applications also showed a 17% increase in annual generation intensity[15] compared to pre-announcement applications. In summary, the evaluation evidence showed that the increase in ASHP tariffs achieved its objective of stimulating take-up of ASHP. However, there was no evidence that the rise in biomass tariffs increased biomass take-up, seemingly because it did not sufficiently reverse the effect of earlier degressions.

Heat demand limits

The introduction of heat demand limits (HDLs) capped the gross heat demand on which domestic RHI could be claimed, aiming to improve value for money on large domestic installations and encourage more focus on smaller properties, without adversely affecting the overall market for RHTs. Deployment statistics show spikes in heat pump installations linked to HDL announcements. Application database analysis suggests that HDL reforms did influence heat pump and biomass installation behaviour, encouraging those applicants with large properties that would be affected by HDLs to bring forward applications to avoid the introduction of the cap on RHI payments in September 2017.

QEIA results show that, across biomass and GSHP installations at all scales, gross heat demand declined after implementation of the reforms. This is consistent with the intention of HDLs. More complex results were found for ASHP installations where the effect of HDLs was combined with significant tariff increases (whereas biomass and GSHP tariffs changed relatively little). Amongst properties above the HDL limit, there was a 9% decrease in the size of properties for post-reform applications, and the likelihood of applications from detached and semi-detached houses fell slightly relative to applications in flats, maisonettes and terraces. But there was no change in gross heat demand for this group because annual generation intensity increased by 17%. However, there was a shift away from high income households relative to households in the lowest income band (i.e. up to £31,200). And cluster analysis undertaken as a separate part of the QEIA research found that the HDL reforms delivered a reduction in typical heat demand across all three technologies (biomass, GSHPs and ASHPs).

As noted in the value for money section, the SCEA analysis found that HDLs played a role in improving the cost-effectiveness of RHI subsidies in the post-reform period, compared to pre-reform, in terms of carbon abatement and air quality.

In summary, the introduction of HDLs encouraged a focus on smaller properties and reduced gross heat demand for biomass and GSHP, in line with reform objectives. Findings for ASHPs were mixed because of the combined influence of HDLs and higher tariffs, but HDLs helped to improve the value for money of RHI subsidies overall. Given the strong growth in heat pump

[14] The QEIA analysis of tariff changes defined the pre-reform period as the 180 days prior to the launch of the consultation on the tariff reforms on 3 March 2016, with the post-reform period being defined as January 2017 to 31 March 2022. The analysis omitted the 'interim' period between the consultation in March 2016 and the introduction of higher tariffs for new applicants in December 2016.

[15] Annual generation intensity is the annual heat generated per kW of installed capacity.

installations beyond 2018, the introduction of HDLs does not appear to have noticeably constrained heat pump market growth in the longer term, although some installers suggested it contributed to the biomass market decline. On balance, the HDL reform met its objectives.

Metering requirements

The reforms introduced a requirement that all domestic heat pumps should have separate electricity metering, enabling heat pump users to monitor their heat pump's electricity consumption. The applicant survey found that, at the time of their application to the RHI, 40% of ASHP respondents and 45% of GSHP respondents were aware of the requirement for all new heat pumps to have electricity monitoring, but only 5% of heat pump respondents reported that it influenced their installation decision[16]. Installers had mixed views about the requirement for electricity meters, with some viewing them as unnecessary but others reporting that they helped customers to pick up on problems with heat pump performance.

The reforms also changed payment arrangements for the optional MMSP[17] package, aiming to increase take-up of this monitoring package by offering partial payment upfront. Installers reported that take-up of the MMSP continued to be fairly low because of low returns for consumers and the package's purpose being unclear, despite the change in payment arrangements. However, Ofgem data showed an increase in MMSP take-up post-reform, from 302 households at end May 2018, when this reform was introduced, to 3,228 households at end April 2022.[18] In summary, the payment reform appears to have aided in stimulating take-up of MMSP, but there was mixed evidence about the introduction of the electricity metering requirement. The impacts of metering reforms were not researched in depth by the evaluation.

Assignment of Rights

The AoR reforms allowed the development of third-party financing arrangements, aiming to help householders overcome the barrier of the initial capital cost of an RHT, thereby improve access to the scheme for consumers less able to pay. There were 1,319 accredited AoR applications[19] by the end of July 2022[20], nearly all of which were for ASHPs (1,302[21]). Just over half of accredited AoR applications were for owner occupiers (666), a little under half were for social landlord properties (593) and 60 were for private landlord homes. Nearly three quarters (918) of AoR applications were for off-grid properties, while 398 were for on-grid homes. BEIS and wider stakeholders felt that the number of AoR applications was significantly lower than they had expected prior to the AoR option coming into force. This view was supported by investors, who commonly reported selling far fewer AoR packages than they had expected to. Key reasons for the low take-up cited by investors were COVID (which severely hampered marketing and installation activity, stunting growth in the AoR market), the GHG-V scheme (which had the effect of diverting consumer attention away from the AoR option), and barriers in relation to AoR processes (including delays in the investor registration process and

[16] These statistics relate to post-reform applicants (from September 2017 onwards). Note that applicants surveyed are likely to have already installed their RHTs at the time of the survey, so being made aware of electricity monitoring requirements via the survey would not influence their installation decision.
[17] The optional Metering and Monitoring Service Package provided a fuller performance monitoring package including heat meters, electricity meters and temperature sensors. The cost of installing this package was offset by an additional financial incentive, with performance data being accessible to the user and installer (and potentially shared with Ofgem for performance-related research).
[18] https://www.ofgem.gov.uk/environmental-and-social-schemes/domestic-renewable-heat-incentive-domestic-rhi/contacts-guidance-and-resources
[19] RHI application data (end July 2022), supplied by BEIS in September 2022.
[20] Note that a small number of applications were either 'pending' or 'under review', so the final number of accredited AoR applications may change. Historic accreditation figures may also change slightly because Ofgem withdraws old accreditations when properties change hands and provides new accreditations to new owners.
[21] 16 applications were for GSHPs and one for biomass.

perceived AoR contract-related barriers). A lack of government promotion of the AoR option was another of the barriers highlighted. In summary, the evaluation found that the contribution of the AoR reforms to improving access to the RHI for consumers who were less able to pay was significantly less than intended by BEIS.

Lessons for Future Renewable Heat Policy and Programmes

What did the domestic RHI scheme do well?

The domestic RHI was one of the first policies in the world to provide subsidies for the generation of renewable heat. Evidence presented in this report demonstrates that the policy was successful in stimulating take-up of renewable heat technologies. Qualitative research with applicants and supply chain stakeholders confirmed that long timeframes and policy certainty were important in supporting major investments in renewable heat. The domestic RHI was principally successful in encouraging applicants who were considering, and could afford, RHT to actually make the investment and supported the ongoing transition towards the normalisation of RHTs. The requirement for equipment, installers and installations to be MCS accredited was an integral part of the domestic RHI, so the scheme introduced mandatory product and installation quality standards where industry standards had previously been voluntary. Applicant experiences of scheme application and administrative processes were broadly positive. The scheme reforms positively influenced the take-up of heat pumps, in particular ASHPs, alongside other influences such as increases in consumer environmental awareness, and latterly the GHG–V and upcoming BUS schemes. The combination of HDLs and tariff uplifts increased applications from smaller properties and lower incomes. Furthermore, there was evidence to show that the introduction of HDLs improved cost effectiveness.

What did the domestic RHI scheme do less well?

Whilst the scheme was successful in stimulating take-up of RHTs, there is evidence to suggest that RHTs still need considerable further support to achieve sustainable market growth. Qualitative evidence from installers found that MCS requirements were regarded as burdensome by some installers, although the emergence of MCS umbrella schemes may have reduced this burden. The scheme's design did not help with capital costs, which limited scheme participation to those who were better able to afford to install RHTs. The scheme was not well publicised and heat pumps, despite awareness of them growing during the domestic RHI, remain relatively unfamiliar to consumers, and more complex to understand than fossil fuel alternatives. For example, in the BEIS Public Attitudes Tracker survey for Winter 2021, 29% of respondents were unaware of ASHP, 51% knew a little or hardly anything about them while 20% knew a lot or a fair amount. Awareness of GSHP was slightly lower. In qualitative research, installers reported that more recent upfront grants such as the GHG–V and upcoming BUS schemes had been more influential in raising awareness of RHTs. A common challenge for householders was finding independent, trusted information and advice on heat pumps and other renewable heating options.

Perceived market barriers and enabling factors

The evidence suggests that some progress towards a sustainable market for domestic RHTs has been made. As intended in the design of the RHI, the RHI made most progress in areas that were off the gas grid, including:

- owner-occupied, often off-grid larger households, with larger incomes

- social housing schemes with off-gas grid properties (or properties unsuitable for gas heating), where ASHPs have become the preferred solution

The synthesis of evaluation evidence indicates that other areas of the domestic RHI space have shown less progress towards a sustainable market. The main perceived barriers to further use of RHTs include:

- RHTs with high capital costs; particularly for GSHPs which are expensive compared to fossil fuel alternatives
- cost and hassle of retrofitting buildings with suitable levels of insulation to improve the operating efficiency of heat pumps
- lack of familiarity with heat pumps

Glossary

Accreditation	A system that has submitted an application and has gone through full checks by Ofgem to make sure that it complies with the relevant conditions.
Additionality	The extent to which observed outcomes are attributable to the intervention and would not have occurred in its absence.
Application effective date	The date from which an applicant can claim RHI payments for the renewable heat generated by their system.
Biomass	Refers to any fuel derived from organic matter generally wood, but also includes straw, grass and organic waste.
Capacity	The capacity of the system is the maximum power output. It depends on the installations size and technical capability.
Combined heat and power (CHP)	A system which generates electricity whilst also capturing usable heat generated in the process.
Counterfactual	The outcomes which would have been anticipated if an intervention had not been implemented.
Date of approval	The date on which Ofgem approved the eligibility of the application and accredited the installation.
Date of first submission	When the application was first registered with Ofgem.
Deeming (deemed payments)	A process which was applied to most properties under the domestic RHI in which RHI payments were made on the basis of deemed (or estimated) rather than metered usage. The Energy Performance Certificate (EPC) was used to calculate a space and water heating demand, based on the characteristics of the building. That value of heat was then paid for by Ofgem (with various regulations in place, e.g. for maximum demand and minimum energy efficiency levels).
Full application	A completed application submitted to Ofgem with a relevant system already installed.
Heat pumps	A heat pump is a device that transfers thermal energy from a heat source to a heat sink (e.g. the ground to a house). There are many varieties of heat pump but for the purposes of the policies they fall into 3 categories: air, ground and water source heat pumps. The first word in the title refers to the heat source from which the pump draws heat. The pumps run on electricity, however less energy is required for their operation than they generate in heat, hence their status as a renewable technology.
LPG	Liquefied petroleum gas is a fuel source used for heating homes. It is a mixture of flammable hydrocarbons compressed to liquid form and stored in canisters.
MCS umbrella scheme	This is a contractual arrangement whereby an MCS-certified contractor (either an installer or manufacturer) appoints a network of subcontractors, each of which undertakes specified work for the MCS contractor without being certified themselves. The scope of work undertaken by the subcontractors varies but typically includes site survey, sales activity, installation and sometimes commissioning of RHTs, with design work usually undertaken by the MCS contractor.

MW	MW stands for megawatt. A watt is a unit of power and a megawatt is a million watts.
MWh	MWh stands for a megawatt hour and is a unit of energy. It is equal to the amount of energy a system will generate in an hour whilst running at a megawatt power output.
Ofgem (Office of the Gas and Electricity Markets)	Ofgem is the regulator of the gas and electricity industries in Great Britain. Ofgem Delivery and Schemes (formerly known as E-serve) is Ofgem's delivery arm that administers the RHI scheme.
Realist evaluation	A type of theory-based evaluation which involves exploring 'what works, for whom and in what circumstances' (or 'contexts').
Renewable heat	Heat energy that comes from a natural source.
Renewable heat technology (RHT)	A system which produces renewable heat.
Seasonal performance factor (SPF)	A seasonal performance factor (SPF) is a seasonally adjusted coefficient of performance (COP). A COP is a measure of efficiency based on the proportion of useful energy given out compared with the amount taken to run the system. Therefore a system with a COP of 2 will produce twice the amount of thermal energy than electrical energy that it takes to run. Because the COP is calculated under laboratory conditions, seasonal adjustments are made to give its average performance across all times of the year to give us the SPF.
Self-build home	A new home commissioned by the potential user of the home, rather than by a third-party developer. The self-builder's input might vary from doing the actual building work to contracting the work to an architect or building company.
Shared ground loop (SGL)	This technology involves a large underground or underwater loop providing low-grade (low temperature) heat to multiple heat pumps in individual properties. Although SGLs often serve domestic properties, applications were made under the non-domestic RHI because this technology serves multiple properties.
Solar thermal	Panels which convert solar energy to thermal energy.
Tariff band	The different rates paid per kWh of heat produced depending on the size and type of installation.
Tariff degressions	The means of controlling the budget for the domestic RHI. The tariffs which can be paid to new applicants are lowered as more renewable heating systems are installed.
Theory-based evaluation	An approach to evaluation which involves systematically testing and refining the assumed connections (i.e. the theory) between an intervention and the anticipated impacts.
Under review	An application that is currently being considered for accreditation.

Contents

Introduction

This report presents findings from the evaluation of the reformed Renewable Heat Incentive (RHI). It synthesises the evaluation's findings in relation to the domestic RHI, which closed to new applicants on 31 March 2022.

The evaluation was undertaken for the Department for Business, Energy and Industrial Strategy (BEIS) by CAG Consultants, in partnership with Winning Moves, Wavehill, Hatch, EREDA Consultants and UCL. It aimed to provide **a) an assessment of the impact of the scheme**, and **b) strategic learning to inform heat policy development focusing on the reforms**.

A separate report on the evaluation findings regarding the non-domestic RHI has been published separately[22].

Policy Context

Domestic RHI overview

The domestic RHI scheme was designed to incentivise households to install renewable heating technologies. Covering England, Scotland and Wales, the scheme launched on 9 April 2014. It was targeted primarily at off-gas grid households[23], and allowed applicants to apply for financial support for renewable heat installations. The scheme primarily aimed to support retrofitting of RHTs to existing domestic properties: new homes were not eligible unless they were 'self-build'[24].

The scheme was originally designed to meet the requirements of the European Union (EU) Renewables Directive (2009/28/EC) – which influenced the original scheme design – but the focus shifted to decarbonisation following EU exit.

To receive support through the scheme, households needed to install an eligible technology to heat their home. There were four eligible technologies: biomass boilers and pellet stoves, air source and ground source heat pumps, and solar thermal panels. The technologies were required to be fitted by a qualified installer and certified by the Microgeneration Certification Scheme (MCS) which helps protect consumers by ensuring the installations met certain product standards, and were fitted properly.

Each technology has a set level of financial support, known as a 'tariff'. The tariff is the amount of support a household receives in respect of each unit of heating supplied by the system towards their heating needs[25].

The payments a household receives depend on the applicable technology tariff and the annual heating requirement of the property. For most scheme participants, the property's heating

[22] BEIS Non Domestic RHI Synthesis Report
[23] Department for Energy and Climate Change (2013*),* Domestic Renewable Heat Incentive: The first step to transforming the way we heat our homes, 12 July 2013. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/212089/Domestic_RHI_policy_statement.pdf [accessed: 27 January 2023].
[24] A new home commissioned by the potential user of the home, rather than by a third-party developer.
[25] The domestic RHI tariffs are listed in the technical annex to this report.

requirement is taken from the property's Energy Performance Certificate (EPC). This is referred to as 'deeming' the heat requirement of the property. The only exceptions to this are where the installation is solar thermal (whereby payments are based on the Estimated Annual Heat Generation found on the respective MCS certificate), or where heat meters are required to determine the exact amount of heat being supplied by the system (for example in second homes).

The heating requirement ((whether measured using heat meters or taken from the EPC) is multiplied by the tariff to determine the payment. Ofgem administers the scheme and makes payments to accredited applicants[26] based on heating requirement and the relevant tariff[27].

Accredited RHI applicants receive quarterly payments for a period of seven years, provided they continue to satisfy the eligibility criteria and ongoing obligations. Where meters are used, the participant has to submit a meter reading each quarter to determine the payment level.

The scheme closed to new applicants on 31 March 2022, with a final cut-off date for payments being end of March 2029.

Budget management

The scheme had two main mechanisms to manage spending levels:

- an RHI budget cap mechanism was introduced in April 2016 — it allowed the Government to close the scheme if there was a risk of overspending
- reductions to the tariffs available (referred to as tariff 'degressions') occurred when spending reached pre-set levels — tariff degressions were designed to control spending on each technology, ensuring individual technologies did not dominate scheme spending, by reducing support levels as installation numbers grew and technologies began to take off

No action was taken under either of these two budget control mechanisms during the reformed domestic RHI scheme.

Scheme reforms

The Government announced reforms to the non-domestic RHI in December 2016[28]. The reforms were designed to ensure the scheme:

- focused on **long-term decarbonisation**: promoting deployment of the 'right technologies for the right uses', while ensuring the RHI contributes to both the UK's decarbonisation and renewable energy targets
- offered **better value for money and protected consumers** by: improving how costs were controlled, giving consumers more confidence in the performance of particular

[26] An 'accredited applicant' is defined as an applicant to the domestic RHI who had had their application approved by Ofgem and was therefore eligible for RHI payments.
[27] See 'Ofgem (2022), Domestic Renewable Heat Incentive: Essential Guide, March 2022' for more detail on how tariffs are calculated. Available at: https://www.ofgem.gov.uk/publications/domestic-rhi-essential-guide [accessed: 27 January 2023].
[28] Department for Business, Energy and Industrial Strategy (2016), The Renewable Heat Incentive: A reformed scheme – Government response to consultation, 16 December 2016. Available at: https://www.gov.uk/government/consultations/the-renewable-heat-incentive-a-reformed-and-refocused-scheme [accessed: 24 May 2018].

technologies, addressing potential loopholes in the scheme, and significantly improving the scheme's subsidy cost-effectiveness

- supported **supply chain growth** and challenged the market to deliver: the reforms were designed to drive cost reductions and innovation to help build growing markets that provided quality to consumers and were sustainable without Government support in future

The principal reforms to the domestic RHI, introduced between September 2017 and June 2018, were:

- the introduction of heat demand limits (HDLs) to limit the level of annual heat demand in respect of which any household can receive support, which aimed to improve value for money on large domestic installations and encourage more focus on smaller properties — the HDLs were set at 20,000kWh for ASHPs, 25,000kWh for biomass boilers and stoves and 30,000kWh for GSHPs (there was no HDL for solar thermal)
- the introduction of higher tariffs for certain technologies, particularly ASHP and biomass, intended to stimulate take-up of ASHPs, which were seen as important for long-term decarbonisation, and to 'reset' the biomass tariff in order to reverse previous degressions, increasing the tariff to the level available between October and December 2015 (adjusted inflation)
- a reform allowing 'assignment of rights' was introduced during 2018 whereby registered investors could provide credit to cover some or all of the up-front cost of an applicant's renewable heat installation, in exchange for the rights to the applicant's future RHI payment — this aimed to help householders overcome the barrier of the initial capital cost of an RHT, thereby improving access to the scheme for consumers less able to pay
- the introduction of a requirement that all new ASHPs and GSHPs applying for support under the scheme to have separate electrical metering to monitor their heating system, which aimed to improve value for money by enabling heat pump users to monitor their heat pump's electricity consumption
- a restructuring of additional payments made to applicants installing 'Metering and Monitoring Service Packages' (MMSP) in order to increase uptake[29]

Evaluation Background and Aims

The evaluation of the reformed domestic RHI scheme began in February 2017 with the purpose of assessing the effectiveness of the reforms.

Aims

The aims of the evaluation were to:

A1: Provide an assessment of the impact of the scheme.

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[29] Applicants could opt to install a MMSP which worked like a service contract and was a way for households to check how well the heating system is performing. Applicant who successfully registered an agreement for MMSP receive additional financial support for installing the package and sticking to the agreement. The reforms restructured the payment, with 50% of the total payment being made with the first payment, with the remaining 50% being paid over the remaining payment lifetime.

1. Assess the extent to which the RHI's expected aims have been achieved (including renewable heat generation, carbon abatement and development of a sustainable market).
2. Assess the extent to which the reform objectives have been met (including improving value for money).
3. Demonstrate the causal mechanisms through which the reformed RHI scheme has led to the achievement of the scheme objectives and how these differ between different consumers and in different contexts.

A2: Provide strategic learning to inform heat policy development.

4. Identify the factors that are important in increasing the installation of renewable heat technologies and the generation of renewable heat and how these differ across customer groups and/or technologies.
5. Identify the factors that are important in supporting the development of a sustainable market for renewable heat and how these differ across customer groups and/or technologies.

Evaluation questions

To address the aims above, a set of detailed evaluation questions (EQs) were developed. Five main EQs were agreed with BEIS:

1. How far have the renewable heat outcomes sought by the reformed RHI been achieved (for whom and in what contexts) and how has the reformed RHI contributed to these? (links to Aims A1.1 and A1.4)
2. How has design and implementation of the reformed RHI influenced these outcomes, in what respects and for whom? (links to Aims A1.4 and A2.5)
3. To what extent have the RHI reforms improved the cost-effectiveness of the RHI scheme, in terms of offering value for money to taxpayers and to different beneficiaries? (links to Aim A1.2)
4. How far has the reformed RHI contributed to the development of sustainable markets for renewable heat, and how does this differ across market segments or technologies? (links to Aim A2.5)
5. What lessons can be drawn by BEIS from the evaluation of the RHI regarding future renewable heat policy? (links to Aim A2)

A detailed set of sub-questions for each main EQ was also developed. These are set out in Appendix A in the Technical Annex. Further detail on evaluation design and methods is set out in chapter 2 and in Appendix B of the Technical Annex.

Report Structure

This report opens with a methodology chapter and then presents the findings, split into three main chapters, as set out in the table below.

Table 1: Report structure

Report chapter	Description	EQ addressed
Methodology	An overview of the methodology used to undertake the evaluation.	n/a
What happened?	A presentation of key scheme outcomes as they relate to: decarbonisation, better subsidy cost-effectiveness, and supply chain development.	Parts of EQ1, EQ3 & EQ4
How did the RHI contribute to observed outcomes?	An exploration of the domestic RHI's role in supporting the installation of renewable heating technologies, focusing in particular on the impact of the scheme's reforms.	All of EQ2 Parts of EQ1, EQ3 and EQ4
Future lessons for policies and programmes on renewable heat	A summary of learning from the scheme for future policies and programmes on renewable heat.	EQ5

In addition, the Technical Annex, set out in a separate document, contains the following appendices:

- Appendix A: Evaluation questions – the full set of evaluation questions and sub-questions
- Appendix B: Technical methodology – an overview of the key methods employed for each of the evaluation workstreams that informed this synthesis report
- Appendix C: Tariff levels – a detailed table setting out the tariff levels for the different technologies in the scheme over time
- Appendix D: Data tables – setting out the data tables for figures cited in the report, where they are not already publicly available
- Appendix E: Theoretical framework – a summary of the theoretical framework for the evaluation

Methodology

This chapter sets out the methodological approach for the evaluation as a whole and for the research underpinning this synthesis report. It also outlines the process employed to synthesise the research findings from multiple evaluation workstreams.

Evaluation Design

The evaluation was theory-based and informed by the principles of realist evaluation[30]. This involved developing, testing, and refining 'realist' theory about the reformed RHI as the scheme proceeds[31]. This approach was selected as a robust means of assessing the contribution of the reformed domestic RHI scheme to observed outcomes in the absence of a meaningful control group. This approach also had the advantage of creating an evaluation design that sought to understand why, how and in what circumstances the RHI reforms did or did not work (which an experimental approach would not do).

A theoretical framework was developed to guide the research. The framework consisted of four 'layers' of theory, to allow an examination of the impact of the scheme at different levels. It was continually tested and refined throughout the lifetime of the evaluation, reviewing the theory against emerging evidence, and building up evidence to help the evaluation team to understand 'what works, for whom, in what circumstances, in what respects and why'. This happened both at a micro level – conducting detailed realist analysis to understand the impact of the key reforms to the domestic RHI - and at a macro level – organising evaluation evidence into tables to support systematic synthesis of evidence in relation to the higher-level theories and evaluation questions.

Note that use of theory-based and realist evaluation terms has been avoided in the findings sections of this report to make it more readable for a general audience. Appendix F in the Technical Annex presents the theoretical framework in detail.

Evidence Sources

Evidence was collected across multiple workstreams, undertaken between 2017 and 2022, as set out in Table 2. Further detail on the methods for each workstream are set out in Appendix B of the Technical Annex.

[30] R Pawson, R, and Tilley, N. (1997) *Realistic Evaluation*. London: SAGE Publications Ltd; and Pawson, R. (2006) *Evidence-Based Policy*. London: SAGE Publications Ltd.
[31] Realist Evaluation explicitly focuses on causal conjunctions rather than causal chains and relies on formal logic of causal mechanisms that are embedded in different contexts forming regular patterns or 'configurations' of context/mechanism/outcomes. Because realist approaches assume that the same mechanisms work differently in different contexts it is an approach well-suited to answer the question: 'what works for whom in different circumstances?' (referred to in EQs 1 & 2).

Table 2: Summary of evidence sources used for the domestic synthesis

Workstream	Purpose	Method	Timing of work
Analysis of RHI administrative data	To provide evidence of scheme-wide application and outcomes data.	Desk-based analysis of lifetime domestic RHI administrative data (November 2011 – July 2022). Included analysis of lifetime application data over time, application data by technology, installed capacity data and other key variables to understand key scheme outcomes and outputs, insofar that these can be assessed within the timescale for this evaluation.	September-November 2022
Detailed applicant monitoring	To provide evidence on a range of areas including applicant demographics, reasons for installing a renewable heat technology, experiences of installation and using their technology, and fuels and feedstock details.	Detailed applicant monitoring comprising collection and analysis of RHI application data from BEIS, supplemented by an online survey of applicants. The survey tracked a series of indicators including additionality, influence of RHI reforms, satisfaction with the technology, sources of information about renewable heat and technology-specific questions. Across all waves[32] during this evaluation contract, the response rate was 25%. The total number of responses during this evaluation contract was 13,710[33][34].	A retrospective survey, covering applications that had gained accreditation status between 1 April 2016 and 31 August 2018, was completed in November 2018. It was followed by a survey wave of new successful applicants every six months until the end of the scheme[35].

[32] Waves are repeated measures of data collection; in this instance, the survey was repeated every six months for all applicants that had successfully applied in the previous six months.
[33] This excludes survey responses from before 1 April 2016 which were collected under the previous evaluation contract.
[34] The survey was originally intended to be a census of all accredited applications; it was sent to all applicants with at least one accredited application, provided that they had not been sent the survey in a previous wave. This is so that respondents were only able to complete this survey once. However, as c. 25% of applicants responded to the survey, it ended up being closer to an opportunity sample than a census.
[35] Data from previous monitoring surveys, undertaken under the previous evaluation contract, which ran up to December 2014, were also used as evidence where appropriate.

Workstream	Purpose	Method	Timing of work
Consumer heat pump satisfaction analysis	To provide additional insight to the usage experiences of domestic RHI participants who had installed ASHPs and GSHPs	Analysis of the ongoing detailed applicant monitoring isolating those participants with an ASHP or a GSHP, to explore satisfaction with their heat pump at an early stage in their user journey. An online follow-up survey issued to participants that had an ASHP or a GSHP in place for at least two winters, the purpose of which was to explore participants' heat pump satisfaction, and reasons for satisfaction / dissatisfaction, at a more mature stage in their user journey.	Fieldwork and analysis conducted in 2020.
Qualitative research	This workstream was designed to understand and identify the causal effects of the scheme reforms.	This included concentrated qualitative fieldwork (i.e. interviews) on: • 'interim applicants' (2017-18) • heat pump 'evaluators'[36] (2018-19) • shared ground loop applicants and installers (2019-20) • domestic heat pump applicants and installers (2020) • Assignment of Rights applicants and investors (2022)	Fieldwork conducted between 2017 and 2022 (see previous column).
Sustainable Markets Assessment (SMA)	To track progress towards a more sustainable market (defined as a market able to operate	This workstream tracked a set of indicators over time covering the key factors expected to indicate progress towards a more sustainable market. Many of	Conducted every six months throughout the evaluation's lifetime, from

[36] Consumers who had actively investigated installing a heat pump but had decided not to go ahead with the installation.

Workstream	Purpose	Method	Timing of work
	without – or with less – public subsidy, with the market growing to the size needed for deployment to meet Government decarbonisation targets for 2050).	these indicators measured interim outcomes, such as cost reductions, increased demand and increased supply for particular markets and technologies. Much of the data used by this workstream was collected in other workstreams, however some additional data was collected from engagement with external stakeholders, reviews of industry data and wider sources such as Public Attitudes Tracker data.	winter 2017 through to summer 2022.
Subsidy Cost-Effectiveness Assessment (SCEA)	To provide insight into how the reforms have affected subsidy cost-effectiveness in key areas. This analysis examined the relationship between subsidy costs and outcomes in the overall policy map (detailed in the theoretical framework – see Appendix F of the Technical Annex).	This workstream used a mix of quantitative and qualitative evidence. The analysis presented an overall narrative on changes in relative cost-effectiveness of the scheme before and after the introduction of reforms, using the evidence that is available for each technology. A full cost-benefit analysis was not conducted for this evaluation, as full costs and benefits will not be known until programme financial closure in March 2029.	Conducted in two waves, the first in 2019, the second in 2022.
Competition and Trade Assessment (CTA)	To assess the extent to which the reformed RHI impacted competition in renewable heating related goods and services. This tested for potential ‘perverse effects’ in the overall policy map	This workstream used a mix of quantitative and qualitative evidence to test the original assumptions around tariff setting and whether these held in practice, considering any implications of this for over or under compensation of applicants.	Conducted in two waves, the first in 2019, the second in 2022.
Quasi-Experimental Impact	To assess the impact of two policy changes (increased	The approach involved grouping the most similar participants based on a number of variables	Conducted in two waves, the first in

Workstream	Purpose	Method	Timing of work
Assessment (QEIA)	tariffs and HDLs) on the socio-demographic characteristics of the applicants and the characteristics of the properties where installations took place.	of interest (cluster analysis), and an econometric model following the logic of the Regression Discontinuity Design, to assess the impacts of the reforms.	2018-19, the second in 2022.

Sampling

Qualitative research

The sampling approach was purposive, led by the specific research questions which framed each wave of fieldwork. Details of the approach applied for each wave of fieldwork are set out in the Technical Annex. The fieldwork waves involved interviews with the following:

- interim applicant fieldwork: 7 ASHP applicants, 3 GSHP applicants, and 5 heat pump installers
- heat pump 'evaluator' fieldwork: 29 consumers who had actively investigated installing either a GSHP, an ASHP, or both, but had decided not to go ahead with the installation
- shared ground loop fieldwork: 11 shared ground loop applicants, 2 communal GSHP applicants , 9 applicants who had installed multiple ASHPs in neighbouring properties rather than shared ground loops or communal GSHPs, and 6 shared ground loop installers
- domestic heat pump fieldwork: 7 GSHP applicants, 28 ASHP applicants, and 19 heat pump installers
- Assignment of Rights fieldwork: 9 Assignment of Rights applicants, 5 stakeholders, 10 investors and 1 potential investor

RHI detailed applicant monitoring

The detailed applicant monitoring survey aimed to cover all applications who had been accredited to the scheme. Where applicants had more than one application to the scheme, the application sampled for the survey was chosen at random. Applicants who had already been sent the survey in previous waves for a different application were excluded from the sample to reduce the research burden on applicants. Aside from successful application status and an eligible date range, there were no other criteria for inclusion of the applicant / application in the monitoring survey.

Each survey wave covered applications from the previous six months and was conducted twice per year. The majority of the detailed applicant monitoring was conducted through an online survey, with a link to the survey being sent to all successful applicants whose application had gained accreditation status in the six-months period covered by each survey wave. In some waves, a telephone top-up survey was also conducted to boost representation of certain categories of applicants.

Further detail on the methods for each workstream is set out in Appendix B in the Technical Annex.

Synthesis Approach and Process

The synthesis process was led by CAG Consultants, with inputs from Winning Moves and Wavehill.

Key steps in the realist synthesis process were:

- step 1 — relevant data from across the seven workstreams was mapped against the evaluation questions and key elements of theoretical framework. This mapping took place iteratively throughout the evaluation, with the evidence gathered used to populate the map against the theory and research questions. Evidence was collected purposively, with fieldwork directed to help answer specific areas of interest. Before the formal synthesis process began, a matrix was created, setting out the evidence from the workstreams against the theory and research questions
- step 2 — internal review — the consortium of CAG, Wavehill and Winning Moves conducted a workshop to review the matrix, identify evidence gaps and purposively explore additional analytical opportunities to be addressed through further analysis
- step 3 — following this review process, additional analysis was conducted of the applicant survey data by Winning Moves; data from the SMA, SCEA, CTA by Wavehill; and RHI application and administrative data by CAG Consultants
- step 4 — assessment of evidence — the evaluation evidence was assessed by the evaluation team to establish the extent to which it supported the existence of the hypotheses in the theory, with a particular focus on the scheme reforms. The assessment combined both the empirical evidence and emerging theoretical thinking to provide explanations of how the scheme worked, in what contexts and for whom
- step 5 — refinement of theory — the assessment was then used by CAG to confirm, refine or revise the hypotheses in the theory and derive a synthesised assessment of evidence in relation to the key evaluation questions

Limitations

A more detailed consideration of the limitations for each individual workstream forms part of the detailed technical methodology appendix (Appendix B) in the Technical Annex. The limitations detailed in this section are the most important which pertain to the evaluation overall and should be noted when reading this report.

Lack of a control group

A key task in understanding causes is to compare the observed results to those you would expect if the intervention had not been implemented (the 'counterfactual''). This is often done through use of a control group. As the domestic RHI was open to all households, however, an experimental design with a control group was not feasible. In any case, the theory-based design of the evaluation meant that a control group was not necessary to assess the contribution of the reformed non-domestic RHI scheme to observed outcomes.

Analysis not based on whole-scheme data due to some applications still being processed

An analysis of whole-scheme data was not possible at the time of analysis (September-November 2022). While the scheme closed to new applications at the end of March 2022, not all applications had completed the accreditation process by this point, meaning final application figures were not known.

Furthermore, payments for the domestic RHI will continue for up to seven years after scheme closure. This means that certain figures included within the report (such as renewable heat generated and carbon abatement) are not final and should not be read as such. It also means that a full value-for-money assessment was not possible at the time of writing. Instead, the focus of subsidy cost-effectiveness analysis was limited to actual spend to date. Figures should therefore be interpreted by readers for comparative purposes, rather than taken as absolute.

Self-reported additionality statistics

The detailed applicant monitoring survey included questions that asked applicants what they would have done if the RHI scheme had not been in place. These questions were included to get an insight into the impact the scheme had on each applicant’s decision to install a renewable heating system and the potential counterfactual actions. Self-reporting of additionality, however, is subject to biases resulting from respondent recall and distortions in perception. Consequently, the basic or ‘core’ additionality figures were more valuable in assessing the changes in motivations or counterfactual installations over time, or between groups, rather than providing an absolute assessment of the impact of the scheme on each applicant. Given the importance of additionality statistics within the SCEA, ‘high’ and ‘low’ estimates of additionality were constructed around the ‘core’ additionality assessment. This was done by cross-checking applicant responses to the survey question on additionality with their responses to other specific questions in the applicant survey. The final additionality statistics used were the average (mean) of the ‘high’ and ‘low’ additionality estimates. This process is explained further in the SCEA section of Appendix B.

Some analysis undertaken in nominal terms

The SCEA was undertaken in real terms, taking account of inflation, to provide an accurate comparison of cost-effectiveness pre- and post-reform. The CTA assessments were undertaken at 2016 prices. However, the CTA assessments of costs were based on nominal figures, meaning they were not adjusted for inflation. Although inflation was low during the domestic RHI period, this may in some cases lead to slight under-estimation of the risk of over-compensation from the domestic RHI in the post-reform period.

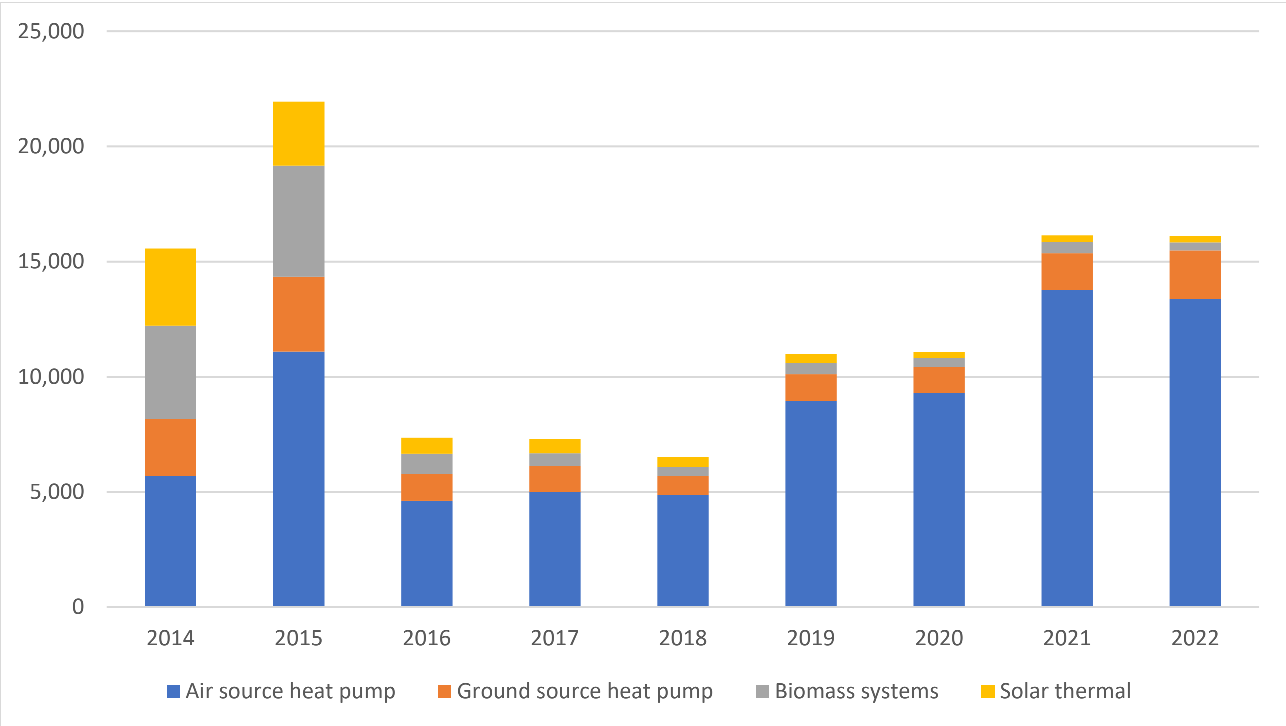
What happened?

A summary of key scheme outcomes as they relate to the overall scheme objectives in relation to deployment, decarbonisation, better value for money, consumer satisfaction and supply chain development. More detail about how and why these outcomes happened, including the influence of the domestic RHI, is presented in the next chapter.

Deployment Outcomes

The domestic RHI scheme supported 113,046 accredited installations of renewable heat technologies in domestic properties up to end July 2022[37]. More than two thirds (68%) of these installations were ASHPs, with 13% being GSHPs, 11% being biomass systems and 8% solar thermal. Just over 20% of accredited applications were 'legacy' applications[38] relating to installations made between July 2009 and the start of the domestic RHI scheme in April 2014. Legacy applications and high biomass tariffs boosted the level of accreditations in the first two years of the scheme, as shown Figure 2 below.

Figure 2: Number of accredited applications to the domestic RHI to end July 2022, by accreditation date

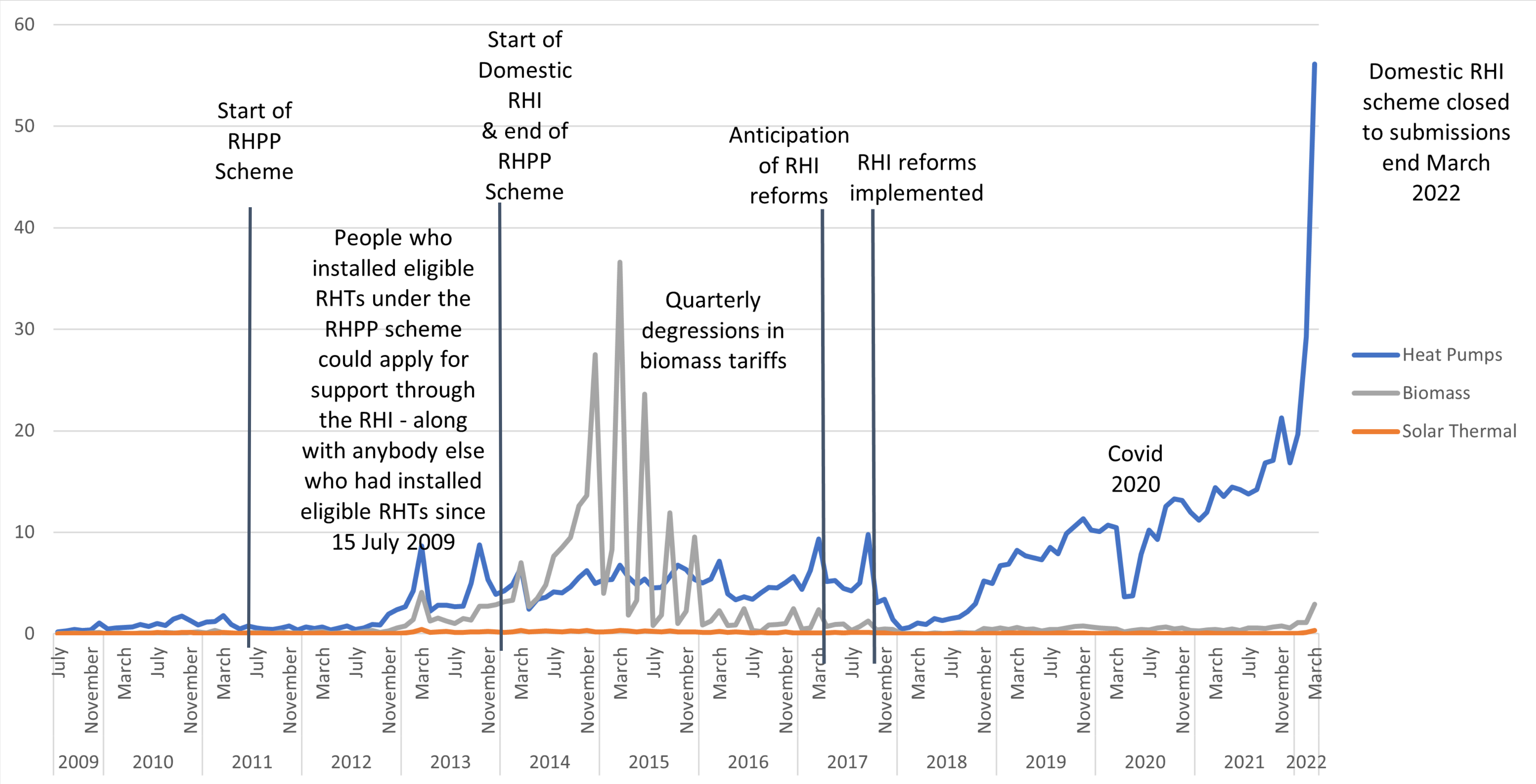


Source: RHI deployment data, published by BEIS, to end July 2022.

[37] The figures for end July 2022 were taken from RHI deployment data published by BEIS in September 2022. Historic accreditation figures may change slightly over time because of changes in ownership of installations.
[38] People who installed eligible RHTs under the Renewable Heat Premium Payment (RHPP) scheme (August 2011 until 31 March 2014) could apply for support through the RHI provided they met the eligibility criteria of the scheme - along with anybody else who had installed eligible equipment since 15 July 2009.

Figure 3 presents the capacity of installations by installation date, rather than accreditation date, showing legacy applications installed pre-2014. Some ‘legacy’ installations received one-off payments from the pre-RHI Renewable Heat Premium Payment (RHPP) scheme which operated as a stop-gap until the full domestic RHI scheme was launched.

Figure 3: Accredited capacity installed (MW), by installation date up to the last submission date for domestic RHI scheme (end March 2022)



Source: RHI application database. 'Installation date' is the earlier of the commissioning date and RHI application submission date. Figures are month-by-month, not cumulative.

Biomass installations are prominent in Figure 3 because they tended to have higher capacity: the median capacity of biomass applications was 25 kW compared to 12 kW for GSHPs, 8.5 kW for ASHPs and 2.7 kW for solar thermal[39]. Spikes occurred around deadlines in both the RHPP and domestic RHI Schemes, with quarterly spikes in biomass applications during 2014/2015 in anticipation of tariff degressions. Heat pump installations spiked during 2017 in anticipation of RHI reforms (see next chapter). All technologies showed a strong rise in installations before the end of the scheme, with applicants taking advantage of the last opportunity to obtain domestic RHI subsidies.

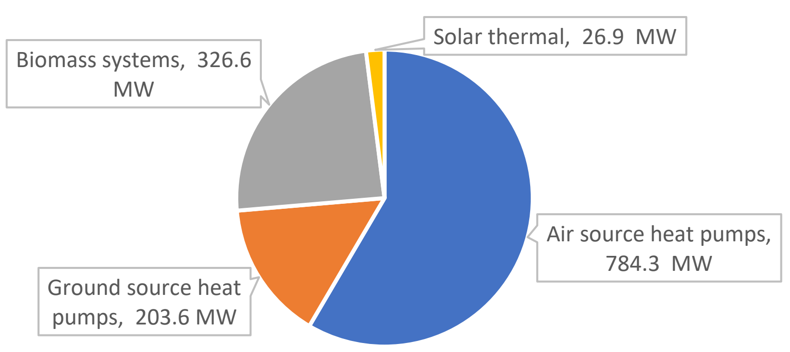
Biomass installations were relatively high during 2014 and 2015 but fell off after the RHI tariff degressed from 14.22 p/kWh in April 2014 to 7.38 p/kWh in October 2015, despite a small rebasing of the tariff as part of the reform package in 2017[40]. There were slight degressions in heat pump tariffs during 2015 and 2016 but higher heat pump tariffs were introduced by the reforms in 2017 (see next chapter). Heat pump installations generally show a rising trend, apart from a post-reform hiatus in 2018 and another hiatus during the 2020 Covid pandemic.

RHI-supported installation levels at the end of the domestic RHI were higher than the period 2009 to early 2014 (when RHPP was introduced) but lower than projected in the Impact Assessment for the reformed RHI. In practice, there were 11,586 accredited installations across all technologies in 2020/21[41], compared to 20,300 installations in 'illustrative projections' in the Impact Assessment[42].

What was installed under the domestic RHI?

In total 1,341 MW of renewable heat capacity had been installed and accredited with support from the domestic RHI up to end July 2022. As shown in Figure 4, this comprised 784 MW of ASHP, together with nearly 327 MW of biomass systems, 204 MW of GSHP and 27 MW of solar thermal. While installations were only eligible for domestic RHI if installed before the end of the scheme in March 2022, accreditation numbers rose in the months following the end of the scheme because the final wave of applications were still being processed by Ofgem. The accredited capacity figures may rise slightly beyond the end of July 2022.

Figure 4: Renewable heat capacity accredited under domestic RHI to end July 2022



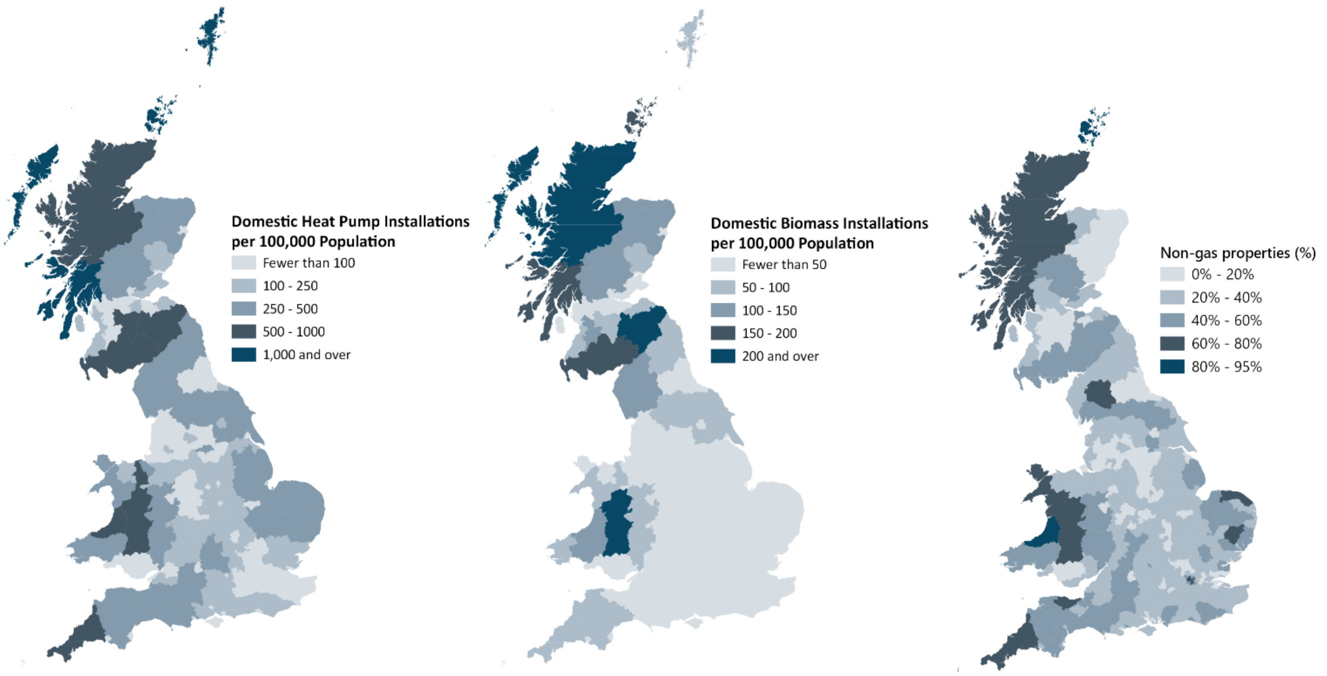
Source: RHI deployment data to end June 2022, published by BEIS; application database for July 2022.

[39] RHI deployment data, published by BEIS (September 2022)
[40] Tariffs stated in 2021/22 prices. Source: Ofgem Domestic RHI tariffs table (2021/22)
[41] Ofgem (2021) DRHI Annual Report 2020-21 Data Sheet v1.0 (Figure 1.2 – accreditations). Historic accreditation figures may change slightly over time because of changes in ownership of installations.
[42] BEIS (2018) The Renewable Heat Incentive: A reformed and refocused scheme. Impact Assessment (Table 17) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/680624/ukia_20180029_en.pdf

Where were these technologies installed?

As anticipated in the design of the domestic RHI, and shown in Figure 5 below, the density of domestic RHI installations was greater in areas that did not have access to the gas grid, because renewable heat technologies offered an alternative to electricity storage heating, solid fuel, oil or LPG-based heating technologies. The density of installations was highest in the Scottish Highlands and Islands, the Scottish Borders, central Wales and Cornwall. Conversely, the density of RHI installations was lower in areas where properties had access to the gas grid, including London and the South East. These maps do not necessarily reflect the density of GSHP installations in urban areas, such as London, because some of these schemes served multiple domestic properties and were eligible to apply for the non-domestic RHI scheme (see separate report). In absolute terms, RHI installations were dominated by England and Wales (82%) with the remaining 18% being in Scotland[43].

Figure 5: Domestic heat pump and biomass installations per 100,000 population – compared to proportion of properties off-gas grid



Source: RHI applicant database to end March 22. Population data from ONS Annual Population Survey 2020. Gas grid data from BEIS at http://nongasmap.org.uk. Prepared for Sustainable Markets Assessment, Wavehill.

Characterisation of households installing renewable heat technologies

The evaluation used application data to analyse the characteristics of households installing RHTs with RHI support, focusing on contexts that were both relevant to the realist analysis of demand for RHT and for which application data was available. The characteristics analysed below are the extent of retrofit versus self-build, access to the gas grid, type of dwelling and tenure.

The vast majority of households receiving RHI lived in existing rather than new build properties. Existing homes and self-build homes were eligible to claim RHI, but new homes constructed by developers were not eligible. As shown in Table 3, just over 5% of accredited

43 RHI deployment data, published by BEIS. (September 2022).

applications were for new self-build properties. This percentage rose to over 15% of GSHP applications, possibly because groundworks for GSHP could be undertaken as part of construction works.

Table 3: Proportion of applications from self-build properties, for those submitting accredited applications to RHI up to end July 2022[44]

	ASHP	GSHP	Biomass	Solar thermal	Total	Comparison to all households in England & Wales
Self-build	3.2%	15.7%	3.7%	9.6%	5.4%	n/a
Existing properties	96.8%	84.3%	96.3%	90.4%	94.6%	n/a
Total	100%	100%	100%	100.0%	100.0%	n/a

Source: RHI application database. Comparison data from Housing, England and Wales; Census 2021 (ONS).

The RHI was primarily designed to serve properties off the gas grid. As shown in Table 4, just over 70% of applications were in properties not served by the gas grid. This was significantly higher than the proportion of all households in England and Wales living off the gas grid (15%)[45]. There was a higher proportion of off-grid properties amongst GSHP and biomass installations and a lower proportion amongst solar thermal (which often supplemented rather than replaced an existing heating system, including gas heating systems).

Table 4: Proportion of applications living off the gas grid, for those submitting accredited applications to RHI up to end July 2022[46]

	ASHP	GSHP	Biomass	Solar thermal	Total	Comparison to all households in England & Wales
Off-gas grid	69.4%	78.1%	84.8%	45.5%	70.3%	15%
On gas grid	30.5%	21.9%	15.2%	54.5%	29.6%	85%
Total	100%	100%	100%	100.0%	100.0%	100%

Source: RHI application database. Comparison data from 'Subnational estimate of properties not connected to the gas network 2015-2021' (BEIS).

[44] Historic accreditation figures may change slightly over time because of changes in ownership of installations.
[45] Comparisons to the population as a whole should be treated with caution, because comparison statistics are only available for England and Wales whereas the RHI covered Scotland as well.
[46] Historic accreditation figures may change slightly over time because of changes in ownership of installations.

As shown in Table 5, RHI applicants were considerably more likely to live in detached houses or bungalows than typical households in England and Wales[47]. Qualitative research suggests that this was influenced by the space needs of RHTs. GSHP were most likely to be installed in detached houses or bungalows because they require significant land for installation of ground loops or boreholes.

Table 5: Proportion of applications living in detached houses and bungalows, for those submitting accredited applications to RHI up to end July 2022[48]

	ASHP	GSHP	Biomass	Solar thermal	Total	Comparison to all households in England & Wales
Detached houses and bungalows	57.7%	90.2%	74.8%	75.6%	62.3%	23%
Other housing types	42.3%	9.8%	25.2%	24.4%	37.7%	77%
Total	100%	100%	100%	100.0%	100.0%	100%

Source: RHI application database. Comparison data from Housing, England and Wales; Census 2021 (ONS).

Analysis of application data, as presented in Table 6, shows that 76% of accredited applicants were owner occupiers, with nearly 21% being social landlords and the remainder being private landlords. ASHPs were the technology most often installed by social landlords, while biomass systems were least often installed by them. Compared to the wider population in England and Wales, RHI applicants were slightly more likely to be owner occupiers or living in social housing, rather than living in private rented accommodation[49].

Table 6: Proportion of applications by tenure, for those submitting accredited applications to RHI up to end July 2022[50]

	ASHP	GSHP	Biomass	Solar thermal	Total	Comparison to all households in England & Wales
Owner occupiers	68.6%	90.0%	96.0%	89.9%	76.1%	63%
Social landlords	28.5%	6.1%	1.0%	8.4%	20.9%	17%

[47] Comparisons to the population as a whole should be treated with caution, because comparison statistics are only available for England and Wales whereas the RHI covered Scotland as well.
[48] Historic accreditation figures may change slightly over time because of changes in ownership of installations.
[49] Comparisons to the population as a whole should be treated with caution, because comparison statistics are only available for England and Wales whereas the RHI covered Scotland as well.
[50] Historic accreditation figures may change slightly over time because of changes in ownership of installations.

	ASHP	GSHP	Biomass	Solar thermal	Total	Comparison to all households in England & Wales
Private rented	3.0%	3.9%	3.0%	1.7%	3.0%	20%
Total	100%	100%	100%	100.0%	100.0%	100%

Source: RHI application database. Comparison data from Housing, England and Wales; Census 2021 (ONS).

The domestic RHI provides ongoing payments for deemed or metered heat demand over a seven-year period with the customer bearing the upfront costs of installation unless they took out a loan or other finance arrangement (see next chapter for discussion of 'Assignment of Rights'). The scheme therefore worked best for customers who could afford the upfront cost of installing RHTs. To illustrate the scale of investment required, the median total technology cost including installation ranged from £23,461 for GSHP through to £17,000 for biomass, £11,105 for ASHP down to £4,750 for solar thermal in the final 12 months of the scheme[51].

The applicant survey found that 33% of domestic RHI applicants reported household income in excess of £52,000, with 45% reporting income below £52,000, and 22% preferring not to say. Households reporting income less than £52,000 were more likely to have smaller floorspace, lower heat demand, electricity as their previous fuel and to be in Scotland, while households with income higher than £52,000 were more likely to be in South East England. The applicant survey found that households where everyone was over 55 accounted for nearly half (49%) of respondents.

These findings are supported by qualitative research with heat pump applicants. Qualitative research found evidence of RHI-supported households generally being relatively wealthy, relatively well-informed about renewable heat technologies, living off the gas grid and being from older age-groups, but did also identify other household types (see next chapter for further discussion of applicant types).

Decarbonisation Outcomes

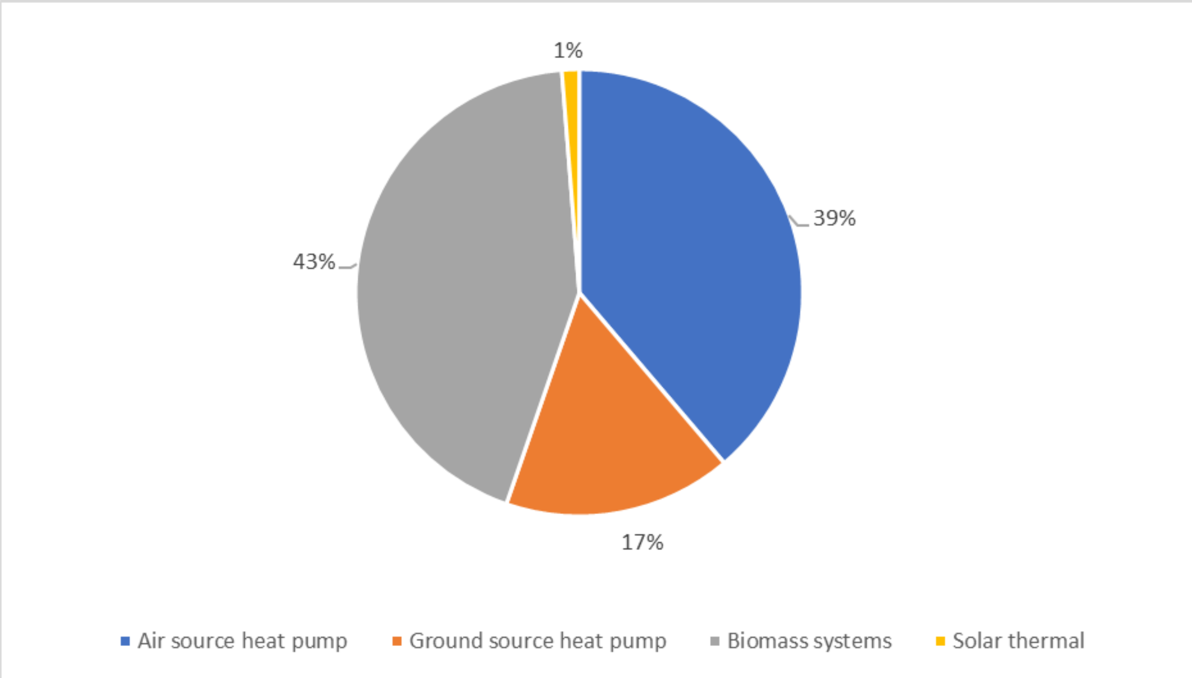
Heat generation

By the end of May 2022[52], 7,256 GWh of heat had been paid for under the domestic RHI.[53] This was predominantly 'deemed' heat, based on the estimated heat demand for each property as set out in its EPC. As shown in Figure 6, biomass systems were responsible for 43% of this heat, with ASHP representing 39% and GSHP 17%. Solar thermal installations represented only 1% of heat generated to end May 2022. The significance of the heat contribution from

[51] Application database, analysed as part of applicant survey analysis from March 2021 to March 2022.
[52] The cut-off date of end May 2022 is used for heat generated because it is consistent with the date used for carbon abatement calculations below. 'Heat paid for' will continue to increase during the 7-year period for which installations receive domestic RHI payments.
[53] This is total renewable heat generated. Additionality is considered in the next chapter on 'How did the RHI contribute to Observed Outcomes'.

heat pumps will increase since these were the most common technologies in the latter years of the scheme and many heat pumps have only recently started generating heat.

Figure 6: Proportion of heat generated and paid for by the domestic RHI, by technology, to end May 2022



Source: RHI deployment data published by BEIS to end May 2022.

Carbon abatement

To the end of May 2022, evaluation evidence indicates that the domestic RHI had saved an estimated 1,301 kilo-tonnes of CO2 equivalent. This estimate is based on carbon emissions associated with deemed and metered heat generation from renewable heat technologies compared to the assumed carbon emissions associated with the same energy being generated through the counterfactual technology[54], assessed using applicant survey responses[55]. Over half (58%) of estimated carbon reduction was attributable to heat pumps, while 42% was attributable to biomass boilers with under 1% being attributable to solar thermal installations. Each technology's contribution to carbon savings depends on the total capacity installed, the length of time for which installations have been operating, the intensity of their use and the heating technology they were replacing. Overall, the scheme's contribution to carbon abatement will increase over time, as installations supported by the domestic RHI continue to generate heat that would otherwise have been generated from non-renewable sources.

Subsidy Cost-Effectiveness

The subsidy cost-effectiveness analysis focused on the relative value for money of the subsidies for different renewable heat technologies under the domestic RHI rather than an

[54] Counterfactual technology means the heating system that the applicant would have installed or used in the absence of the domestic RHI scheme. Because consideration of additionality was an integral part of estimating carbon abatement, this estimate represents the carbon abatement attributable to RHI.
[55] Carbon abatement was calculated as part of the SCEA. This was based on a sample of 80% of domestic RHI applications to May 2022, scaled up to represent the whole scheme. The sample on which the figures are based omitted installations/applications for which incomplete data was available on both costs and benefits.

overall value for money. This is due to the lack of direct scheme comparators to the domestic RHI scheme. The analysis accounted for additionality when calculating the comparative benefits of the subsidies. While BEIS impact assessment[56] for the scheme assumed that 100% of renewable energy generation was additional and that the counterfactual technologies that new RHTs were replacing would be non-renewable heat technologies, the evaluation found that overall additionality across all technologies and the whole time period was 59%.[57]

The subsidy cost-effectiveness indicators for installations to date, by technology, are presented in Table 7. The figures are calculated based on subsidy paid and estimated benefits to the end of May 2022. They do not include subsidies and benefits in future years[58]. It is important to note that this analysis focuses only on the direct value for money associated with factors such as renewable energy generated and carbon abatement and the analysis does not capture more strategic benefits associated with factors such as developing supply chains and longer term cost reductions of these technologies.

The four main indicators used to analyse subsidy cost-effectiveness by technology, and comparing pre- and post-reform periods, are as follows:

1. Mean annual subsidy cost per kW of installed capacity
2. Subsidy cost per MWh of renewable heat generated to date
3. Subsidy cost per tonne of CO2 emissions abated to date
4. Value of Air Quality damage costs saved to date per £ subsidy invested

These indicators are not expected to change substantially over time, as the annual subsidy levels, associated heat generation and carbon abatement are expected to remain relatively consistent over the lifespan of the technologies. As such, they are useful indicators of value for money, as they enable comparison between pre and post-reform periods.

The subsidy cost-effectiveness indicators for installations to date[59], as presented in Table 7, show that:

- the mean annual subsidy cost for the domestic RHI (both pre and post-reform) was £234 per kW of installed capacity, with solar thermal representing the lowest cost at £176 per kW[60]
- solar thermal performed less well relative to other technologies in terms of subsidy cost per MWh of heat generated or per tonne of CO2e abated, because of lower load factors than other technologies

[56] BEIS (2018) The Renewable Heat Incentive: A reformed and refocused scheme. Impact Assessment
[57] Additionality is discussed further in the chapter on ‘How did the RHI contribute to observed outcomes?’ Further detail is included in Appendix B of the Technical Annex on SCEA method.
[58] This method was chosen on the basis that a full cost-benefit analysis would be based on too many uncertain assumptions about the lifespan and future use of renewable heat technologies.
[59] Assuming that technology usage levels are broadly unchanged, the subsidy cost-effectiveness indicators should not change over time or be affected by whether installations of specific technologies occurred earlier or later within the scheme. Where the indicators are ratios of cumulative subsidy costs to cumulative benefits (e.g. renewable heat generated, tonnes of CO2e abated), the cumulative subsidy cost for each technology will rise in proportion to the cumulative benefits from that technology. Where the indicator is the ratio of annual subsidy costs to overall capacity, the annual subsidy cost will rise with inflation but otherwise remain broadly unchanged, with overall capacity also being constant. The indicators are presented in real terms, taking account of inflation.
[60] The methodology used to calculate these figures is set out in Appendix B of the Technical Annex.

- heat pumps provided better subsidy cost effectiveness than biomass based on subsidy cost per MWh of renewable heat generation, but were similar in terms of subsidy cost per tonne of CO2e abated
- biomass plants incurred some air quality damage compared to air quality savings for other technologies

Table 7: Domestic RHI subsidy cost per unit of benefit, by technology - whole scheme, based on analysis up to May 2022.[61]

	Heat pumps	Biomass	Solar thermal	All technologies
Programme Data[62]				
Number of accredited installations[63]	85,326	12,117	8,720	106,163
Number of installations included in SCEA analysis	69,581	10,643	5,187	85,411
Capacity installed for whole scheme (MW)	915	318	26	1,258
Renewable heat generation for whole scheme (Twh)	5.4	2.8	0.08	8.3
Carbon abatement for whole scheme, attributable to RHI (kilo-tonnes CO2e)	750	543	8	1,301
SCEA Indicators				
Mean annual subsidy cost per kW of installed capacity (£)	235	223	176	234
Subsidy cost per MWh of renewable heat generated (£)	134	166	344	151
Subsidy cost per tonne of CO2e abated (£)	592	590	2,085	598

[61] The programme data figures have been scaled up to end May 2022, the latest data available at the time of the SCEA analysis, and are therefore lower than the figures to end July 2022 presented in the deployment section of this report. The figures for renewable heat generated are different from the May 2022 figures from BEIS deployment data because they were scaled up from 80% of the sample for which there was complete data.
[62]Additionality was taken into account in calculation of all the SCEA indicators. But the programme data presented here does not take account of additionality (except for carbon abatement estimates, which explicitly involved consideration of counterfactual technologies).
[63] Historic accreditation figures may change slightly over time because of changes in ownership of installations.

	Heat pumps	Biomass	Solar thermal	All technologies
Value of Air Quality damage costs saved to date per £ of subsidy invested (£)	0.06	-0.15	0.01	-0.03

Source: SCEA, Wavehill. All subsidy costs figures are adjusted to 2022 values. Capacity installed, heat generation and carbon abatement estimates were calculated based on a sample of 80% of RHI applications for which full cost and benefit data was available, and then scaled up to represent the whole scheme to end May 2022, the latest data point available when the analysis was undertaken. The 'All technologies' column represents a sum of the three individual technologies for the Programme Data, and represents the calculated indicator across all technologies for the SCEA indicators.

Competition and Trade Assessment

The CTA assessed the extent to which there was a risk of over or under compensation of applicants for their renewable heat technology investment. The CTA analysis provided analysis of data up to the end of the scheme, based on comparing the pre and post reform periods. As explained in Appendix B of the Technical Annex, this was based on comparing actual costs (including capital and fuel) and usage data to the assumptions made by BEIS when setting tariff levels. If actual costs to applicants were substantially less than those modelled by BEIS, for example, it would indicate greater risk that applicants may have been over-compensated through their RHI payments.

The factors assessed through this analysis included: the counterfactual technology (i.e. what heating technology would have been used by the applicant if they had not received funding through RHI), capital costs, design efficiency of technologies, fuel price, installed capacity, deemed heat demand and risk of gaming. These factors were all selected as they were used in the original modelling of tariff levels. The CTA then tested variance against the original assumptions, in order to draw inferences about the risk of over or under compensation.

The complexity of the original modelling meant that a more definitive assessment was not possible through the evaluation. Therefore, the purpose of this method was to provide an indication of where there was greater or lesser risk of over-compensation, rather than quantifying exact amounts of under or over-compensation.

This analysis found that, based on comparison with BEIS' pre-launch assumptions, there was:

- a low risk of over-compensation for domestic biomass installations, given the significant degressions in biomass tariff levels during the domestic RHI scheme
- a medium risk of over-compensation for ASHP installations, largely because of tariff levels for ASHPs having increased significantly since the start of the scheme
- a low risk of over-compensation for GSHP installations, since tariff levels are largely in line with those originally identified by BEIS.

There was insufficient evidence to undertake the CTA for solar thermal.

As part of the CTA, a Competition Impact Assessment (CIA) Scoping was also undertaken for both the domestic and non-domestic RHI schemes[64]. The CIA Scoping did not find evidence of the RHI distorting competition in equipment production, installation / maintenance or fuel supply markets, as summarised in the findings table below. The CIA analysis considered the effect of the RHI on the entire market from the start of the policy (including anticipation of the RHI during the RHPP period). This analysis found that the overall effect of RHI tended to increase rather than decrease the number of suppliers, thereby increasing competition. While the biomass degressions and other factors led to reduced levels of biomass installations in the post-reform period, there is no evidence of the scale of the biomass supply chain falling below pre-RHI levels (see MCS installer numbers in Figure 9 below)."

Table 8: Summary of Findings from the Competition Impact Assessment Scoping

RHT product or service under assessment	Summary of findings	Conclusion on whether a more detailed assessment needed
Renewable heating technology equipment	The policy is designed to distort existing market structures to promote RHI technologies, however the scoping found no evidence of restriction of competition, and so there is no need for an in-depth assessment	No
RHT installation and maintenance	In relation to the installation and maintenance market for RHTs, there is a barrier to entry as all domestic applications, and some smaller scale non-domestic applications, require a MCS certified installer for installation, which may have affected the supplier market. However, RHI as a whole has increased demand and likely supply of installers. Findings suggest no requirement for a more in-depth assessment.	No
RHT fuels and feedstocks	The assessment found no effects of the policy on distortion of this market.	No

Consumer-related Outcomes

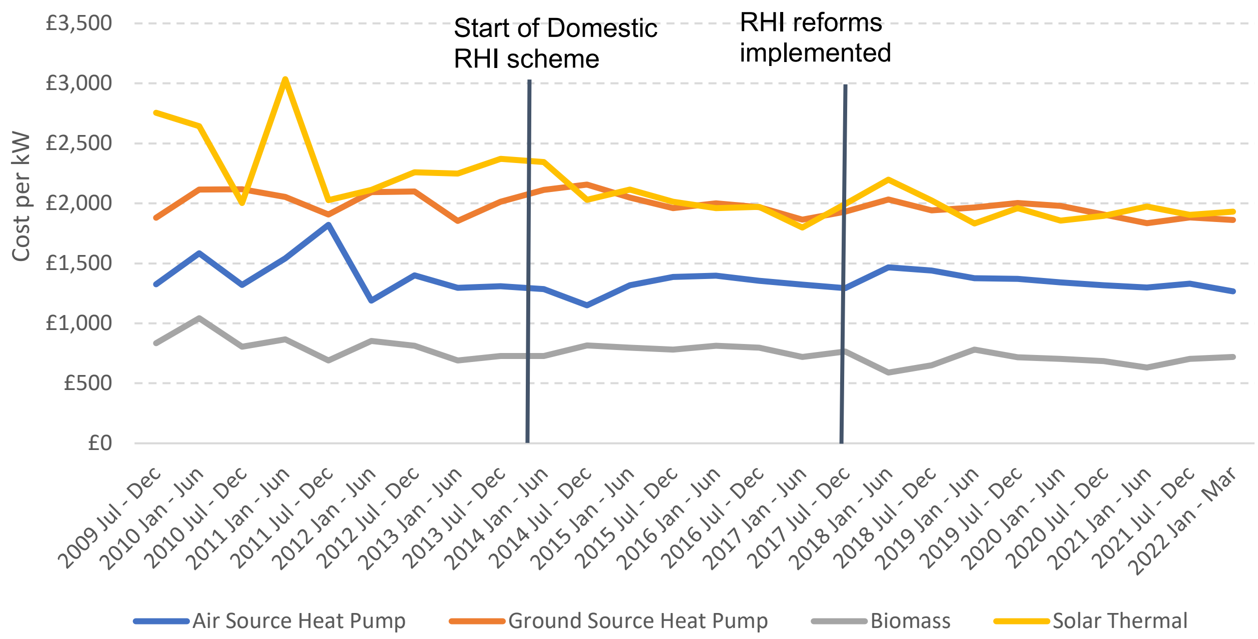
Installation costs

This section considers the outcomes for consumers from the domestic RHI. In real terms, the cost of heat pump and biomass installations has been fairly stable over time since the start of the domestic RHI scheme, in contrast to volatility pre-RHI when installation volumes were lower (see Figure 3 above). There was some movement in costs after implementation of the reforms (see next chapter). Costs of solar thermal and GSHP came down slightly since the

[64] This scoping review was undertaken in line with the Competition and Markets Authority's guidance for policymakers on Competition Impact Assessment.

start of the RHI scheme, with qualitative evidence from supply chain consultations suggesting that this was probably linked to the development of smaller heat pump systems.

Figure 7: Median cost of installed capacity in domestic RHI scheme (per kW installed)



Source: SCEA, based on RHI application database, analysed by installation date and inflated to 2021/22 prices. Note: reported costs commonly included wider costs associated with upgrading heating systems as well as the core cost of the renewable heat technology itself. Note the that figures are wave-by-wave, not cumulative.

The costs reported by applicants generally included any costs associated with upgrading heating systems to ensure that renewable heating systems worked effectively (e.g. installing larger radiators or underfloor heating for heat pump systems, if this was required). Reported costs also generally included any costs associated with upgrading the energy efficiency of properties to meet EPC requirements for the domestic RHI[65]. Applicant survey responses show that additional measures were more commonly required for ASHP installations (58%) than for biomass (34%) and GSHP (38%) installations, and that they were much less commonly required for solar thermal installations (15%) (presumably because solar thermal was generally used to supplement an existing heating system).

Running costs compared to previous heating systems

The applicant survey found that the heating systems previously used by respondents, prior to installation of the renewable heating system, ranged from oil (30%) and mains gas (24%) to electric heaters (11%) and solid fuel (7%) and LPG (5%)[66]. A further 17% did not previously have a heating system in place (e.g. because the property was a new self-build property).

In qualitative research, domestic heat pump applicants reported that modern heat pump running costs were cheaper than oil and older heat pump models, but slightly more expensive than gas (because electricity prices were high relative to gas at the time of this research). Qualitative research with social landlords suggested that social housing tenants switching from electric storage heating to heat pumps generally enjoyed better thermal comfort as well as

[65] Domestic RHI rules required applicants to submit a recent EPC for their property that did not include recommendations for improvement. Measures had to be implemented in line with any previous EPC recommendations, and a new EPC issued if needed. (Source: Domestic RHI Essential Guide, Ofgem)
[66] Note that these figures cover previous heating systems only, not previous hot water systems (in cases where the household had a separate hot water system previously).

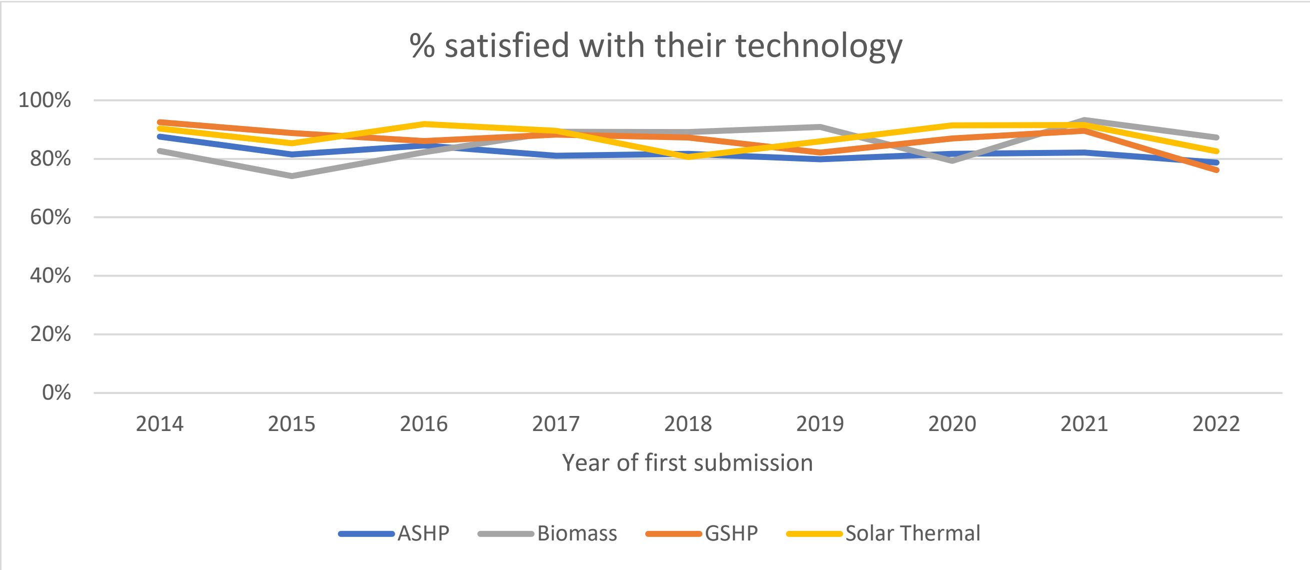
making savings on their energy bills. In some cases, tariff changes contributed to energy bill savings.

Application data analysis indicated that the mean seasonal performance factor (SPF) for ASHPs installed during the domestic RHI scheme was higher than for legacy installations (3.5 compared to 2.5 with similar improvements observed for GSHPs (3.9 compared to 2.9 for legacy installations)[67]. Higher SPFs indicated improvements in the efficiency of heat pump technology since the start of the scheme, leading to reduced running costs compared to older models.

Customer satisfaction

Consumers generally reported high levels of satisfaction, with 83% of applicant survey respondents being 'satisfied' or 'very satisfied' with their technologies, as shown in **Figure 8**.

Figure 8: Proportion of newly accredited applicants satisfied with their technology



Source: Applicant survey (includes 'satisfied' and 'very satisfied' applicants) (n = 26,594). Note the that figures are wave-by-wave, not cumulative.

A follow-up survey with heat pump applicants who had used their heat pumps for two winters post-installation found high levels of satisfaction[68]. The proportion of heat pump users who were 'very satisfied' after two winters was 66% with 26% fairly satisfied, bringing the total proportion 'very satisfied or satisfied' to 92%. This was higher than the proportion of heat pump users who were 'very satisfied or satisfied' soon after installation (53% very satisfied and 31% fairly satisfied – total 84%). Qualitative research with heat pump users suggested that this was because users could take time to get used to the slow, steady heat provided by heat pump systems, which contrasted with more responsive heating provided by biomass or gas boiler systems. The follow-up survey research found that those who were 'very satisfied' with heat pumps were slightly more likely to have previously used electricity and slightly less likely to

[67] RHI deployment data, published by BEIS. (September 2022). The minimum eligible SPF for heat pumps in the scheme was 2.5. Note that the SPF measures how energy efficient a heat pump is. The higher the value, the more efficient the heat pump.
[68] Heat Pump Satisfaction research with applicants who had installed heat pumps between April 2016 and September 2018.

have used gas. Qualitative research with heat pump users and social landlords suggested that this was because some users found electric storage heating difficult to control.

While 69% of respondents to the applicant survey reported no faults or unexpected maintenance or repairs since installation, 27% reported problems that were covered by warranty and 2% reported problems that involved additional cost, with 2% saying ‘don’t know’. The proportion of accredited applications resulting in complaints to the Renewable Energy Consumer Code was 2% across the scheme as a whole for heat pumps, 6% for biomass and 7% for solar thermal, with a temporary peak in the proportion of complaints just after the reforms in 2018 (see next chapter). The applicant survey found that the main difficulty faced by applicants from 2018 onwards was caused by the installation process.

Where the existence of faults was indicated by applicants, a wide range of issues was reported. The main faults were:

- leaks
- loss of pressure
- faulty control systems
- noise
- issues with the temperature sensors

Problems arising from incorrect installation were also mentioned, even though applicants usually said that these were fixed in a timely manner. Conversely, very few applicants reported a complete failure of the system or the system being unable to heat their homes or provide them with hot water.

Qualitative research with domestic heat pump customers identified cases where heat pump customers were dissatisfied because they felt their heat pumps systems had been poorly specified or installed. Consequences for usage included the property being too cold (or hot water being inadequate) or running costs being higher than expected.

Research with domestic heat pump applicants identified other factors affecting user satisfaction with heat pump systems, including positive factors (such as heat pumps being cleaner than oil systems), mixed factors (such as heat pumps making noises that differed from fossil fuel systems) and negative factors (such as heat pump systems being more complex than fossil fuel alternatives such as oil or gas-based systems and occupying space in the house or garden). Factors affecting the suitability of different properties for heat pumps are discussed in the next chapter.

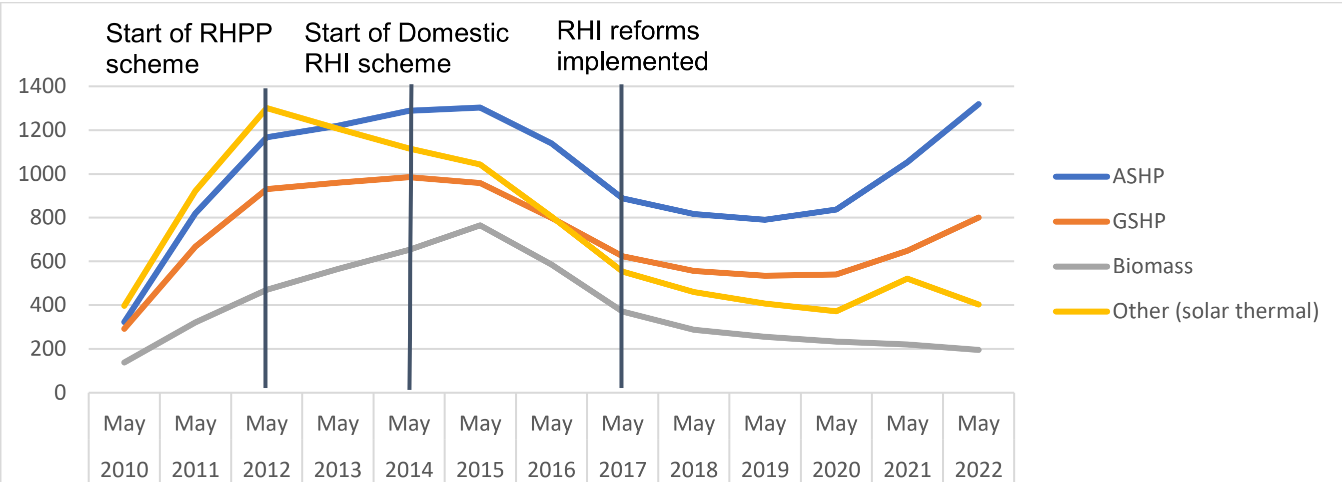
Sustainable market outcomes

One objective of the domestic RHI was to support the development of a sustainable market for renewable heat technologies. This section explains supply chain changes during the scheme.

Renewable heat installers

To commission accredited installations under the domestic RHI scheme, installers had to be accredited with the Microgeneration Certification Scheme (MCS). As shown in **Figure 9**, the number of MCS-accredited installers for all technologies rose in anticipation of the RHPP scheme, with the number of solar thermal installers peaking prior to the main RHI scheme in 2012. The number of biomass installers peaked in 2015, declining after significant degressions in the biomass tariff during 2014 and 2015. Although there were no significant degressions in heat pump tariffs during the domestic RHI scheme, the number of accredited heat pump installers also declined between 2015 and 2019. Qualitative evidence from installers just after the reforms suggested that many installers diversified or went out of business around that time, influenced by a combination of factors including the biomass degressions, changes in the non-domestic RHI scheme and degressions in the Feed-in-Tariff for renewable electricity. With many installers covering multiple renewable energy technologies, this may have had knock-on effects on the number of heat pump installations. The number of heat pump installers recovered towards the end of the domestic RHI Scheme, showing considerable growth from 2020 to 2022, stimulated by higher tariff rates and other factors (see next chapter). There was a temporary increase in solar thermal installations in May 2021: qualitative research with installers suggests that this was prompted by the temporary availability of the Green Homes Grant – Voucher (GHG–V) scheme in 2020/21, as discussed further in the next chapter.

Figure 9: Number of MCS installers by technology



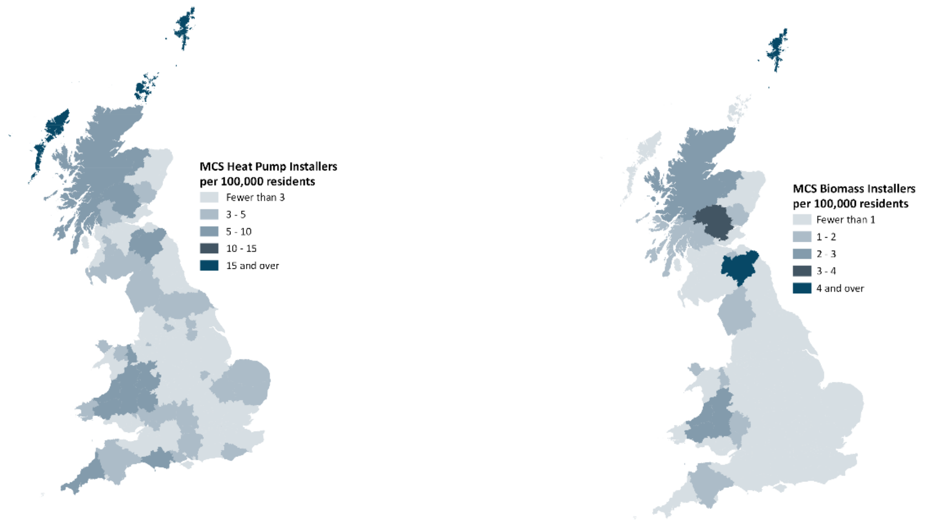
Source: MCS data, analysed for Sustainable Markets Assessment. Note the that figures are wave-by-wave, not cumulative. MCS accreditation is technology specific and installers can be accredited for multiple technologies. So the same installer may be counted under more than one technology in this chart.

Installer attitudes to MCS accreditation requirements varied. In qualitative research during 2017/18 and 2020, some installers saw the scheme as improving standards in the heat pump installation industry but others complained about the paperwork involved in MCS registration.

Qualitative evidence from heat pump installers and customers showed increasing use of ‘MCS umbrella’ arrangements in the final years of the domestic RHI scheme. Under these arrangements, an MCS accredited installer would do the initial design and final commissioning of a heat pump system, but installation could be done by plumbers or heating professionals who did not need to be MCS accredited. This implies that the size of the supply chain for heat pump installation was greater than shown in the figure above. Qualitative research suggested that the quality of installation under these arrangements depended on the level of training and supervision provided for non-MCS installers by the MCS-accredited lead organisation. In the Sustainable Market Assessment consultations during 2022, sector stakeholders suggested that the heat pump market was being held back by the quality of installers, relating less to their ability to install but rather their ability to design and install whole heat systems (i.e. the tasks for which MCS accreditation was required).

Analysis of the geographical distribution of MCS installers per head of population, by region, shows that the density of MCS installers per head of population broadly matches the density of RHI accreditations (see Figure 5 and Figure 10). This analysis is based on the headquarters of MCS installers rather than on their geographical coverage, so may understate the availability of installation services provided by installers that provide national or multi-regional coverage.

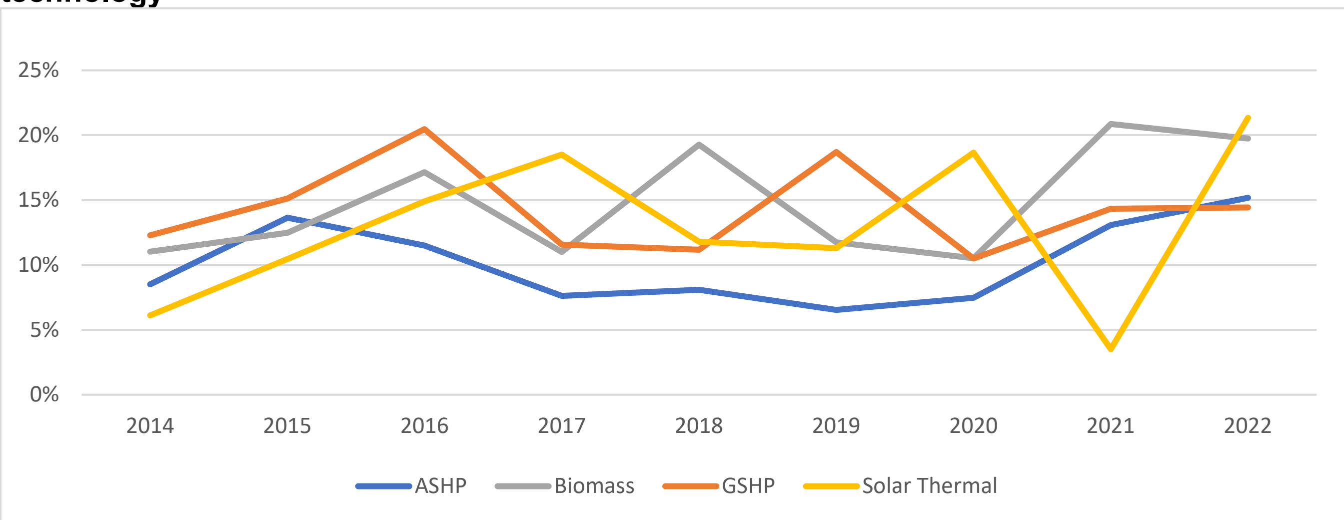
Figure 10: Geographical distribution of MCS installers



Source: analysis of MCS data

The proportion of applicant survey respondents reporting difficulty finding an installer was more stable for ASHPs than for other technologies, as shown in Figure 11. But supply chain stakeholders and heat pump customers reported supply chain issues during the final three years of the domestic RHI scheme, contributing to a rise in the proportion of applicants reporting difficulty finding an installer for heat pumps and biomass between 2020 and 2022. They attributed these issues to the EU Exit and Covid (2020), to the influence of the GHG-V scheme on heat pumps during 2020/21 (see next chapter), to Russia's invasion of Ukraine (2022) and to the spike in demand for all technologies towards the end of the scheme in 2022.

Figure 11: Proportion of recent applicants reporting difficulty finding an installer, by technology



Source: Applicant survey (n = 26,446). Note the that figures are wave-by-wave, not cumulative.

Manufacturers

Supply chain stakeholders interviewed as part of the SMA reported that the heat pump market was more resilient and stable to supply chain disruptions, compared to other renewable heat technologies, because of manufacturing capacity within the UK. While supply chain stakeholders reported that UK manufacturing had remained largely unchanged during 2022, they reported signs of significant movement which may have a longer-term influence on the market. These developments included market leaders increasing investment and expanding their production in the UK (including Valliant, Mitsubishi and Kensa) and some broader firms entering the heat pump market (such as Octopus Energy purchasing heat pump manufacturer Renewable Energy Devices and Worcester – manufacturer of gas boilers – showing interest in the heat pump market).

Fuel supply

Evaluation of the non-domestic RHI scheme[69] found that agriculture and forestry applicants were stimulated by the non-domestic RHI to increase the supply of biomass fuel for both domestic and non-domestic biomass installations. Activity was stimulated by high biomass tariffs and the eligibility of drying uses for RHI payments during the early stages of the non-domestic RHI scheme.

The applicant survey found that the majority of accredited applicants with biomass boilers used wood pellets (91%) while a small proportion used logs (11%)[70]. Most biomass users purchased all their fuel (93%) with 7% being registered to supply some or all of their own fuel. Nearly three quarters (73%) of biomass users were happy with the availability of sustainable biomass fuels to meet their needs[71].

[69] BEIS Non Domestic RHI Synthesis Report 2023. [LINK TO BE ADDED WHEN AVAILABLE].
[70] These figures add to more than 100% because multiple responses were allowed to the survey question.
[71] The vast majority of applicant survey responses from biomass applicants were prior to 2022 so this finding pre-dates the ban on importing Russian pellets in 2022.

How did the RHI Contribute to Observed Outcomes?

An exploration of the domestic RHI's role in supporting the installation of renewable heating technologies, focusing in particular on the impact of the scheme's reforms. This chapter explores how and why the RHI contributed to observed outcomes, and in what contexts, drawing on the evaluation's realist analysis for specific groups.

Influence of RHI on Applicant Behaviour

This section explores how applicants interacted with – and were influenced by – the domestic RHI as a whole.

Additionality

A basic assessment of additionality was derived from applicants' statements about what heat technology they would have installed in the absence of RHI, with the options including both renewable heat technologies and non-renewable heat technologies. A number of internal sense-checks using other survey question responses were used to refine the assessment[72].

As shown in Table 9 below, across all technology types, the percentage of domestic applicants suggesting that they would not have installed renewable heat technologies without the domestic RHI was 59%. Additionality was highest for biomass installations, at 68%, and lowest for heat pumps (57%). Additionality was lower post-reform (56%) than pre-reform (65%). Qualitative research suggests this was because RHTs became more normalised over time.

Table 9: Average additionality across the whole domestic RHI scheme

Technology	Average additionality (pre-reform)	Average additionality (post-reform)	Average additionality (across whole domestic RHI scheme)
Heat pumps	64%	55%	57%
Biomass boilers	70%	61%	68%
Solar thermal	60%	63%	61%
All	65%	56%	59%

Source: SCEA, based on applicant survey responses. The 'all technologies' average is weighted by the proportion of installations across different technologies.

[72] Further detail is included in Appendix B of the Technical Annex on SCEA method.

This level of additionality is lower than the 100% additionality assumed by BEIS in the Impact Assessment.[73] With hindsight, the assumption of 100% additionality was possibly unrealistic. There is inevitably a trade-off between the level of subsidy offered and the extent to which it is sufficient to encourage people to invest in something that they would otherwise not have done. If subsidies had been larger, this might have encouraged more people to invest in renewable heat who would not otherwise have done so. But, because subsidy levels were carefully controlled, a significant proportion of those supported were people who would have installed these technologies anyway.

The applicant survey suggested that additionality was lower for self-build customers. Qualitative research indicated that the reasons for lower additionality in these cases were that renewable heat technology formed only one part of a much larger construction project and that building regulations and planning requirements played a role in influencing the choice of heating systems.

RHI influence on tenure groups

As highlighted in

Table 6 above, owner occupiers made up 76% of applications, while 21% of applications were from social landlords. Just 3% of applications came from private landlords. The following two sections therefore focus on the RHI's influence on owner occupier and social landlord decisions as the evaluation elicited little evidence about private landlord behaviour in relation to the domestic RHI.

RHI influence on owner occupier decisions

The applicant survey found that owner occupier applicants most often found out about the RHI via their installer (55% of applicants). Other common routes for finding out about the scheme were the Energy Savings Trust (25%), websites (22%), trades people or professionals (21%), friends, family and neighbours (17%) and national government (16%).

Insights from the qualitative research during the evaluation indicated that:

- the domestic RHI helped owner occupiers to commit to investment in RHTs (by improving their return)
- the extent of owner occupiers' support for certain RHTs was determined in part by the tariff rate (e.g. ASHPs were well-supported after the tariff uplifts, while interest in biomass decreased after a series of tariff degressions)
- the domestic RHI subsidy was complex to communicate to consumers (as opposed to a capital grant, for example)
- the scheme was not well-publicised compared with related schemes such as the GHG-V scheme
- upfront capital costs were a barrier to households, particularly lower income groups (despite the introduction of the AoR in 2018)
- a lack of familiarity with RHTs hindered take up among those used to more familiar fossil fuel systems

[73] BEIS (2018) The Renewable Heat Incentive: A reformed and refocused scheme. Impact Assessment

- a lack of independent, impartial advice was also a barrier to take up for RHTs

RHI funding helped owner occupiers to commit to investing in heat pumps[74] where:

- they were already aware of heat pumps
- they had an existing property that was already suitable for a heat pump (e.g. well-insulated, under-floor heating system, no planning issues, adequate space) or could be upgraded
- they had access to trusted information on heat pumps (or they were knowledgeable about them themselves)
- they had identified an installer/adviser whom they trusted
- they had access to savings and/or loans to fund upfront capital cost
- the capital and running costs of heat pumps were acceptable compared to alternatives, after taking potential RHI revenue into consideration
- they had confidence in heat pumps as a reliable source of heating that would provide adequate levels of comfort and convenience compared to alternatives
- they had confidence that they would be able to keep the heat pump maintained in future

Furthermore, the following characteristics were also likely to make owner occupiers more interested in an RHT:

- living in an off-gas grid property
- being environmentally motivated
- being technically-minded
- an awareness of heat pumps through a related grant scheme (e.g. GHG–V scheme)

RHI influence on social landlord decisions

Social landlords, both large and small, reported in qualitative research that they took a planned approach to asset management, meaning that they have medium to long-term plans for replacing heating systems in existing buildings. Qualitative evidence suggested that the end of the RHI encouraged some social landlords, where finance permitted, to bring forward replacement of heating systems by a few years. But even where they responded opportunistically to offers from installers, this was normally within the context of an asset management plan that identified the properties as needing new heating systems.

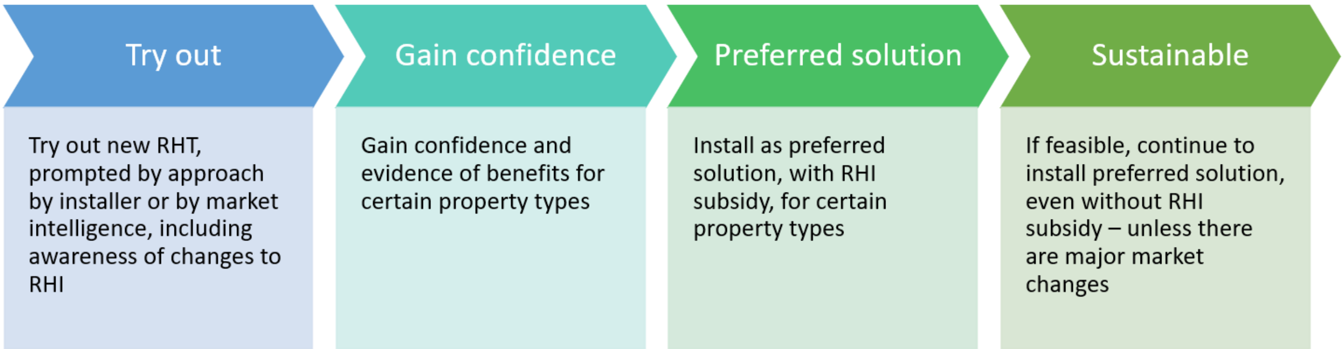
Replacement of heating systems was driven by the age of the heating system, by levels of tenant satisfaction with the current system and by housing standards requirements (e.g. Decent Homes in England, Energy Efficiency Standard for Social Housing (EESSH2) in Scotland and Welsh Housing Quality Standards).

Qualitative research evidence highlighted that the RHI helped ASHPs to become the ‘preferred solution’ for off-gas grid properties for many social landlords. It found that there are advantages

[74] Fuller qualitative evidence is available for heat pumps than other technologies because heat pumps were prioritised by BEIS in the domestic RHI evaluation research.

to landlords of settling on one type of heating solution for certain properties (e.g. economies of scale, certainty about performance, maintenance costs being lower etc), so in instances where ASHPs were regarded as favourable, social landlords often went on to install them in bulk. Figure 12: Influence of reformed RHI differed according to landlord's journey stage how the RHI supported the journey for a social landlord from trying out a new RHT to continuing to use it as a preferred solution.

Figure 12: Influence of reformed RHI differed according to landlord's journey stage



Qualitative evidence on social landlords related predominantly to ASHPs, the most common technology installed by social landlords under the RHI. Drivers for installing ASHPs were:

- meeting energy efficiency standards for social housing (e.g. EESSH2 in Scotland)
- switching tenants away from older, less controllable, expensive electric heating systems
- the health and safety risks for coal/solid fuel (and biomass) use by vulnerable tenants
- fluctuating oil prices and advance purchases problematic for social housing tenants
- lower running costs for heat pumps compared to non-renewable alternatives

The key barriers to installing ASHPs for social landlords were:

- higher upfront capital costs compared to the alternatives
- the disruption involved in installing 'wet' heating systems and insulation (meaning works were often combined with scheduled refurbishment of properties)
- space and noise restrictions to the use of ASHPs in blocks of flats

A summary of the contexts and causal mechanisms in which the RHI was found to influence demand for RHTs is set out in the revised realist demand theory in Appendix E.

Applicant Awareness of Reforms and Influence of Reforms on Applicant Behaviour

This evaluation report aims to assess the influence of the RHI reforms that were introduced during 2017 and 2018. The reforms aimed to ensure that the scheme focussed on long-term decarbonisation, promoted technologies with a credible role to play in that transition, and offered better value for money. The Government consulted on potential reforms to the RHI schemes in March 2016 and subsequently published reform proposals in December 2016[75]. The expectation was that the reforms would come into force in Spring 2017. However, implementation of the first two domestic RHI reforms were then delayed until 20 September 2017[76] with the final two reforms being delayed until mid-2018.

The September 2017 reforms that affected the domestic RHI scheme were:

- the introduction of **higher tariffs** for certain technologies, particularly ASHP and biomass – this reform was intended to stimulate take-up of ASHPs, which were seen as important for long-term decarbonisation, and to reverse the decline in biomass applications observed since the biomass tariff was degressed in 2014/2015
- the introduction of **HDLs**, capping the gross heat demand on which domestic RHI could be claimed – this reform was intended to improve value for money on large domestic installations and encourage more focus on smaller rather than larger properties

To avoid a hiatus in demand and consequential impacts on the supply chain, all applicants applying after the reform announcement (December 2016) were made eligible for the eventual tariff increases. The tariff increases were applied to RHI payments from 1 October 2017. The introduction of HDLs was similarly announced in December 2016 but did not take effect until 20 September 2017. A separate synthesis report explored applicant reactions to the 2016/17 reform announcements and the delays in their implementation[77].

Three further reforms were introduced, two in May 2018 and the final one in June 2018:

- the introduction of a requirement that all domestic heat pumps should have separate **electricity metering**, which aimed to improve value for money by enabling heat pump users to monitor their heat pump's electricity consumption
- reform of payment arrangements for an optional **Metering and Monitoring Service Package**[78] that could be taken up alongside the RHT, designed to increase take-up of this enhanced monitoring package
- a reform allowing **'assignment of rights'** was introduced during 2018. This allowed registered investors to provide credit to cover some or all of the up-front cost of an applicant's renewable heat installation, in exchange for the rights to the applicant's future RHI payments

Applicant survey data suggests that most domestic applicants in the immediate pre- and post-reform period were unaware of the reforms (60%). In the post-reform period as whole, where applicants were influenced by awareness of the reforms, this typically influenced the timing of their installation (26% of those who were aware), the timing of their application to the RHI (20%

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[75] BEIS (2016) The Renewable Heat Incentive: a reformed scheme. Government response to consultation. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/577024/RHI_Reform_Government_response_FINAL.pdf

[76] The reforms were delayed as a result of a General Election, called in April 2017 and held in June 2017. This interrupted Parliamentary legislative timetables, meaning that necessary legislation and regulations could not be introduced in the Spring, as originally intended.

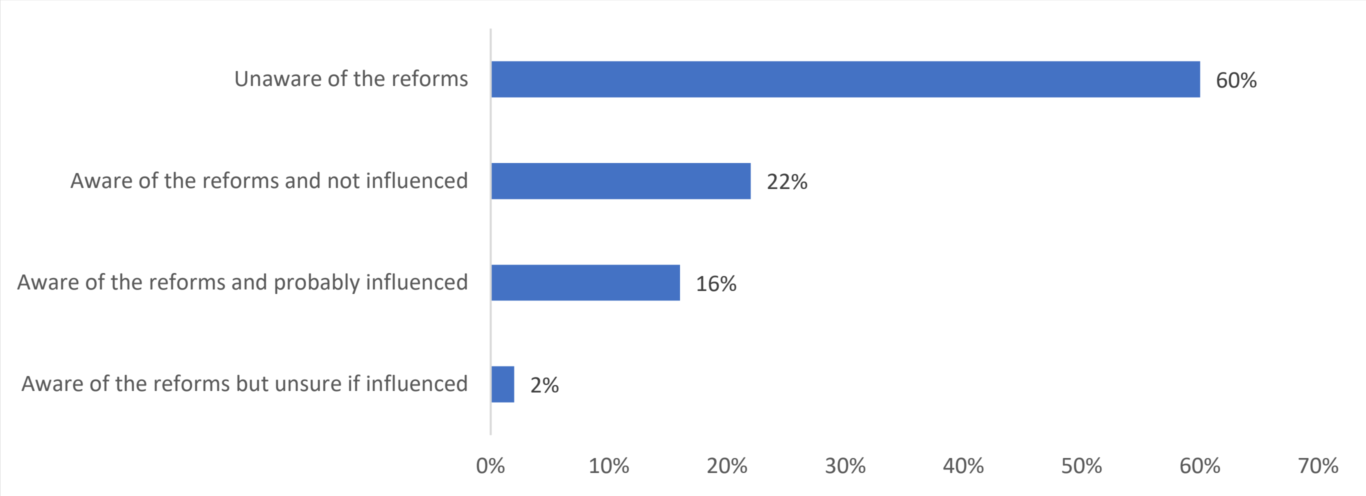
[77] BEIS (2019): RHI Evaluation Synthesis Report: Findings Summary. https://www.gov.uk/government/publications/rhi-evaluation-interim-report-applicant-reaction-to-reform-announcements

[78] The optional Metering and Monitoring Service Package provided a fuller performance monitoring package including heat meters, electricity meters and temperature sensors. The cost of installing this package was offset by an additional financial incentive, with performance data being accessible to the user and installer (and potentially shared with Ofgem for performance-related research).

of those who were aware) or their choice of technology (6% of those who were aware). Of those who were aware of the reforms, 58% reported that this did not influence their behaviour.

Combined findings for awareness and influence, as shown in Figure 13 below, suggest that 16% of respondents during the period April 2016 to April 2019 were probably influenced by the reforms.

Figure 13: Proportion of applicants reporting influence from reforms (in pre- and post-reform periods)



Source: Applicant survey data for applications submitted between April 2016 and April 2019. (n = 4623)

Influence of Individual Reforms

Tariff Uplifts

Reform details

The September 2017 reforms introduced tariff increases as follows[79]:

- significantly higher tariffs for ASHPs (increasing from 7.42 p/kWh in January 2016 to 10.18 p/kWh after September 2017) – this reform was intended to stimulate take-up of ASHPs, which were seen as important for long-term decarbonisation
- tariff ‘rebasing’ for biomass boilers (increasing from 5.14 p/kWh in January 2016 to 6.54 p/kWh after September 2017), bringing the biomass rate back to the tariff available in the final quarter of 2015 (adjusted for inflation) – this reform was intended to partially reverse the effect of earlier biomass tariff degressions
- a slight adjustment of the GSHP tariff rate from 19.10 p/kWh in January 2016 to 19.86 p/kWh after September 2017, including inflationary increases
- no tariff change for solar thermal other than inflationary increases

[79] The figures shown here are quoted in ‘money of the day’. Inflated figures are shown in Appendix C of the Technical Annex.

All domestic RHI applicants applying after the reform announcement (December 2016) were eligible for the eventual tariff increases, but the revised tariffs were not actually applied to RHI payments until 1 October 2017.

The deployment statistics presented in Figure 2 and Figure 3 above show that heat pump installations, and particularly ASHP installations, increased steadily after a post-reform hiatus in 2018. This section considers how far the increase in ASHP installations from 2018 onwards was attributable to the tariff increase or to other factors. No increase was observed in biomass applications post-reform, despite rebasing of the biomass tariff.

Applicant perceptions

Qualitative research with heat pump and biomass applicants found little awareness of tariff increases amongst applicants, either immediately after the reforms or (for heat pump applicants) in 2020. In applicant survey responses across the scheme's lifetime (n=9,084), 13% of ASHP applicants and 21% of GSHP applicants stated that they were aware of increased heat pump tariffs (despite the tariff increases for GSHP being minimal). Similarly, 12% of biomass applicants stated that they were aware of increased biomass tariffs. Awareness may have been low because future applicants were automatically eligible for the tariff increases, from the reform announcements onwards, irrespective of when they applied for RHI.

Installer perceptions

Qualitative research with installers immediately after the reforms in 2017/18 found instances of heat pump installers noticing increased levels of enquiries which they attributed to the increased heat pump tariffs. However, qualitative research with heat pump installers during 2020 found that they tended to attribute rising ASHP installations to other factors (e.g. increasing environmental motivations of customers and raised awareness of heat pumps stimulated by the GHG–V scheme) rather than to the increase in ASHP tariffs alone. There was, however, some recognition that tariff increases had played a role in stimulating the ASHP market.

Biomass installers interviewed[80] immediately after the 2017 reforms tended to perceive that the biomass market was still declining, irrespective of the rebasing of biomass tariffs. The biomass tariff rebasing was seen as too limited to reverse the negative impact of earlier degressions on the biomass market.

Specialist GSHP installers reported in qualitative research that the GSHP had been set too low at the start of the RHI scheme. They would like to have seen GSHP tariffs raised alongside ASHP tariffs.

Quasi-Experimental Impact Assessment findings

Quasi-Experimental Impact Assessment (QEIA) examined the impact of ASHP tariff increases by analysing ASHP applications that were unaffected by HDLs, comparing characteristics of applications and applicants in the 'pre-announcement' and 'post reform' periods[81]. Biomass sample sizes did not allow equivalent analysis for biomass applications. The QEIA analysis found that the ASHP tariff increases were associated with a 13% increase in the size of the

[80] Biomass installers interviewed for the non-domestic RHI evaluation tended to report covering both domestic and non-domestic installations.
[81] The QEIA analysis of tariff changes defined the pre-reform period as the 180 days prior to the launch of the consultation on the tariff reforms on 3 March 2016, with the post-reform period being defined as January 2017 to 31 March 2022. The analysis omitted the 'interim' period between the consultation in March 2016 and the introduction of higher tariffs for new applicants in December 2016.

properties (albeit still below the HDL limit), and with increasing likelihood of receiving applications from detached and semi-detached houses relative to those from flats, maisonettes and terraced houses. Post-reform ASHP applications also showed a 21% increase in annual generation intensity[82] compared to pre-announcement applications. The QEIA also found that, in the post-reform period, households with incomes below £31,200 were more likely to install ASHPs under RHI, compared to higher income bands.

Other changes identified by the QEIA, between the pre-announcement and post-reform periods (for ASHP applicants unaffected by HDLs), were that:

- owner occupiers were more likely to apply in the post-reform period compared to landlords
- the efficiency of installed technologies increased by 15%

Some of these changes (e.g. growth in owner occupiers and improved efficiency) may have been attributable to wider changes in the ASHP market rather than to the tariff increase. However, the QEIA analysis – like the installer evidence – suggests that the increase in ASHP tariffs played a role in making ASHP installations more viable, including for lower income households, despite limited awareness and perceptions of this amongst applicants.

Summary of tariff reform impacts

Overall, the evaluation evidence showed that the increase in ASHP tariffs achieved its objective of stimulating take-up of ASHP. However, there was no evidence that the rise in biomass tariffs increased biomass take-up, seemingly because it did not sufficiently reverse the effect of earlier degressions.

Heat Demand Limits

Reform details

As outlined above, the September 2017 reforms introduced HDLs, capping the gross heat demand on which domestic RHI could be claimed. This reform was intended to improve value for money on large domestic installations and encourage more focus on smaller rather than larger properties, without adversely affecting the overall market for RHTs. The HDL was set at 20,000 kWh for ASHP, 30,000 kWh for GSHP and 25,000 kWh for biomass. No limit was set for solar thermal because this technology tended to be much smaller scale.

The introduction of HDLs was announced in December 2016 and was expected to take effect in March 2017 but did not actually take effect until 20 September 2017.

Influence of heat demand limits on installations

The deployment statistics presented in Figure 3 above show spikes in heat pump installations linked to both March and September 2017. Lower-level spikes are also observable for biomass installations. Qualitative research with 'interim' applicants showed that those concerned about reduced benefits under HDLs, and those who perceived general uncertainty about the future of the RHI, accelerated their applications where it was possible to do so. Among March 2017 heat pump applicants, acceleration of applications was also driven by uncertainty related to the potential for degression in heat pump tariffs.

[82] Annual generation intensity is the annual heat generated per kW of installed capacity.

Analysis of application data found that HDLs applied to around a third of installations: 35% of biomass and GSHP accredited applications, and 31% of ASHP accredited applications, had their heat demand capped by the application of HDLs from 20 September 2017 onwards. Within properties over the heat demand cap, the proportion of applications with installed capacity over 25 KW fell from 53% in the first half of 2015 to 5% in the first half of 2018. Across all technologies, median floor space fell slightly from 151 m^2 pre-reform to 144 m^2 post-reform, while installed capacity fell slightly from 11 kW to 10.43 kW, possibly influenced by HDLs. However, median heat demand increased over this period, from 10,462 kWh pre-reform to 11,983 kWh post-reform, despite the slight reduction in installation size.

This analysis suggests that HDLs reforms did influence the heat pump and biomass installation behaviour, encouraging those applicants with large properties that would be subject to HDLs to bring forward applications to avoid introduction of the cap on RHI payments. The acceleration of applications during 2017 may have contributed to the observed hiatus in heat pump installation during 2018 (see Figure 3). Given the strong growth in heat pump installations beyond 2018, the introduction of HDLs does not appear to have noticeably constrained growth in the longer term.

Influence of heat demand limits on applicant reasoning

Applicant survey data found relatively low levels of reported influence from HDLs, across all technologies, although this data does not capture potential applicants who decided not to apply because of HDLs.

- 4% of applicants since 2017 reported some influence from the cap on payments (4% of ASHP applicants; 2% of biomass applicants and 5% of GSHP applicants)
- as might be expected, applicants with higher heat demand (above 20,000 kWh) reported more influence from introduction of HDLs than those with lower heat demand – 24% of those reporting influence were in the 20,000-25,000 kWh band
- while 62% of respondents reporting influence from the cap had heat demand greater than the cap, 38% of respondents reporting influence had total heat demand lower than the heat demand cap – this implies that the cap may have influenced the design or timing of installations that eventually came in under the heat demand cap

The influence of the cap on payments was evident in various years post-reform, not just immediately post reform. For example, there was an increase in the proportion of applicants reporting influence of the cap on payments early in 2022. An explanation for this, is that a number of applicants accelerated their applications during the final stages of RHI, where they were aware that they would receive lower benefits under the successor scheme - the Boiler Upgrade Scheme (BUS). Indeed, 73% of applicants in the last seven months of the scheme indicated that they installed their RHT via the RHI instead of the BUS because they felt they would be financially better off under the RHI, according to applicant survey responses.

HDLs were not identified as barriers to installation in qualitative interviews with households who had considered installing heat pumps but had not gone ahead (interviews undertaken in winter 2018).

Qualitative research with domestic heat pump installers found some impact on the market for heat pumps in older, larger properties. Multiple-technology installers also reported knock-on effects on their businesses from HDLs reducing the market for larger biomass installations. However, installers not specialising in larger domestic properties reported that HDLs had very little impact on their heat pump business.

Quasi-Experimental Impact Assessment

The QEIA analysed the impact of HDLs, combined with uplifted tariffs, on the characteristics of applicants for different technologies. This analysis compared the pre-announcement period (pre-March 2016) to the post-reform period (i.e. post September 2017 for the HDL reforms).

Key findings for biomass applicants were that floor space declined by 10% and gross heat demand declined by 16% after implementation of the reforms. This is consistent with the intention of the policy.

The QEIA found similar effects of HDLs on GSHP installations, which saw a very slight tariff increase as well as the introduction of HDLs. The analysis found that applications from households with income above £52,000 were less likely post-reform, and there was a 14% decrease in gross heat demand density.

More complex results were found for ASHP installations where the effect of HDLs was combined with significant tariff increases. Amongst properties above the HDL limit, there was a 9% decrease in the size of properties in post-reform applications, and the likelihood of applications from detached and semi-detached houses fell slightly relative to applications in flats, maisonettes and terraces. However, there was no change in gross heat demand for this group because annual generation intensity increased by 17%. There was a shift away from high income households relative to households in the lowest income band (i.e. up to £31,200). Other changes were that owner occupiers were more likely to apply for RHI in the post-reform period, compared to landlords compared to the pre-announcement period.

In summary, the QEIA results confirm that the combination of HDLs and tariff uplifts increased applications from households with lower levels of demand, size of property and household income. Cluster analysis undertaken as part of the QEIA research found that the HDL reforms delivered a reduction in typical heat demand in the case of biomass, GSHPs and ASHPs, in line with policy objectives.

While growth in the heat pump market was strong enough to withstand the introduction of HDLs, given accompanying tariff increases, qualitative evidence suggests that the introduction of HDLs may have contributed to the decline of the biomass market.

The implications of HDLs on value for money are discussed in the value for money section below.

Summary of HDL reform impacts

The introduction of HDLs encouraged a focus on smaller properties and reduced gross heat demand for biomass and GSHP, in line with reform objectives. Findings for ASHPs were mixed because of the combined influence of HDLs and higher tariffs, but HDLs helped to improve the value for money of RHI subsidies overall. Given the strong growth in heat pump installations beyond 2018, the introduction of HDLs does not appear to have noticeably constrained heat pump market growth in the longer term, although some installers suggested that it contributed to the biomass market decline. On balance, the HDL reform met its objectives.

Metering Requirements

There were three separate types of metering requirements under the reformed RHI, from May 2018 onwards[83], two of which were affected by the reforms:

- metering for performance – the reforms introduced a requirement that all new heat pumps should have a dedicated electricity meter so that users could monitor their heat pump's electricity consumption – some heat pumps already had 'on-board meters' that met this requirement
- metering for payment - most domestic RHI payments were based on deemed heat, but Ofgem required payments to be made on a metered basis in certain circumstances, where deeming was likely to overcompensate the user (e.g. where the property was not exclusively heated by the heat pump/biomass system, or was not consistently occupied)
- Metering and Monitoring Service Packages (MMSP)– the reforms restructured the payments made to applicants installing this optional performance monitoring package. MMSP worked like a service contract, helping households to check how well their heating system was performing. The performance data was accessible to the user and installer (and potentially shared with Ofgem for performance-related research). Additional payments were provided as an incentive to install the optional MMSP package (which included heat meters, electricity meters and temperature sensors). Pre-reform, these payments were made over the lifetime of the equipment, but the reforms introduced an upfront payment of 50%, with the remaining 50% being paid over the remaining payment lifetime. The rationale was that this would help to pay MMSP installation costs and encourage take-up of MMSP packages

The metering reforms (metering for performance and MMSP) were intended to improve value for money by encouraging and enabling better monitoring of heat pump performance. MMSP subscribers were still generally paid on deemed rather than metered heat unless the domestic RHI rules required them to have metered payments.

Qualitative research on metering requirements was not prioritised by BEIS during the evaluation, so findings on these reforms were limited and were not based on realist analysis, unlike analysis of the other reforms.

Impact of electricity metering for heat pumps

The applicant survey found that 40% of ASHP respondents and 45% of GSHP respondents were aware of the requirement for all new heat pumps to have electricity monitoring, but only 5% of heat pump respondents reported that it influenced their installation decision[84]. Installers had mixed views about the requirement for electricity meters, with some viewing them as unnecessary but others reporting that they helped customers to pick up on problems with heat pump performance.

Impact of restructuring MMSP payments

Installers reported that take-up of the MMSP was fairly low, despite the change to payments, because of low returns for consumers and the package's purpose being unclear. Some manufacturers and installers offered their own internet-based monitoring packages. However,

[83] Ofgem (2022), Domestic RHI – Guide to Metering.
[84] These statistics relate to post-reform applicants (from September 2017 onwards).

Ofgem data showed an increase in MMSP take-up post-reform, from 302 households at end May 2018, when the reforms were introduced, to 3,228 households at end April 2022[85].

Summary of metering reform impacts

In summary, the payment reform appears to have aided in stimulating take-up of MMSP, but there was mixed evidence about the introduction of the electricity metering requirement. The impacts of metering reforms were not researched in depth by the evaluation.

Assignment of Rights

Overview

The AoR reforms gave RHI applicants the option to assign their right to RHI payments to a third party that had paid for all, or part, of their renewable heating system. The principle aims of the reforms were to help householders overcome the barrier of the initial capital cost of a renewable heating system and improve access to the scheme for consumers less able to pay.

There were 1,319 accredited AoR applications[86] by the end of July 2022[87]. This equated to 2.1% of total post-reform domestic RHI applications[88]. Nearly all AoR applications - 1,302 – were for ASHPs, with only 16 AoR applications for GSHPs, one for a biomass boiler and none for solar thermal.

Just over half of accredited AoR applications were for owner occupiers (666 applications), a little under half were for social landlord properties (593) and 60 were for private landlord homes. Nearly three quarters (918) of AoR applications were for off grid properties, while 398 were for on grid homes.

As Table 10 Table 1highlights, while the AoR option was introduced to the scheme in June 2018, the first accredited applications did not begin until the following year, with demand then growing. There were 126 AoR applications in 2019, 412 in 2020, 462 in 2021 and then 319 in the 2022, the year in which the scheme closed in March 2022.

Table 10: Number of Assignment of Rights applications by year and by technology

Technology	2019	2020	2021	2022
ASHPs	125	407	453	317
GSHPs	1	5	9	1
Biomass	0	0	0	1
All	126	412	462	319

[85] https://www.ofgem.gov.uk/environmental-and-social-schemes/domestic-renewable-heat-incentive-domestic-rhi/contacts-guidance-and-resources
[86] RHI application data (end July 2022), supplied by BEIS.
[87] Note that a small number of applications were either 'pending' or 'under review', so the final number of accredited AoR applications may change. Historic accreditation figures may change slightly over time because of changes in ownership of installations.
[88] 'Post-reform applications' includes all domestic RHI applications from October 2017 to March 2022.

Source: RHI application database, to end of July 2022.

There were 28 registered AoR investors[89] in November 2021[90]. Analysis of online information about each of these suggests that a wide range of different organisations registered to become investors, including heat pump and renewable energy installers, renewable heat finance companies, Community Interest Companies (CICs), and others.

Analysis of investor interview evidence suggested that AoR investors could be split into two main motive types:

- commercially driven investors, aiming to use the AoR option to develop their organisations strategic aims and make a return while doing so
- community driven investors, aiming to use the AoR option to meet social and/or environmental objectives

Even among commercial AoR investors, there was often a willingness or ability to accept lower rates of return relative to comparable schemes (e.g. the Feed-in Tariff third party ownership schemes). Commercial investors who were motivated by wider strategic aims were more likely to accept lower return rates as they foresaw wider, longer-term benefits from being an investor. Community driven investors did not have any hurdle rates[91], other than needing to meet costs. Investors anticipated returns of between 6% and 7% ahead of the scheme, and in practice these returns were often lower. Indeed, the lower rates of return meant that some initially interested organisations decided not to go ahead with investor registration.

Non-commercial investors were reliant on match-funding to enable them to offer free heat pumps to their target customer base (typically the fuel poor and/or vulnerable customers). The Warm Homes Fund and the Energy Company Obligation (ECO) were highlighted as sources of match funding, the former being regarded as particularly useful.

Issues and challenges

Qualitative research found that BEIS and wider stakeholders felt that the number of AoR applications was significantly lower than originally expected. This view was supported by AoR investors, who reported selling far fewer AoR packages than they had expected to. The most commonly cited reasons for this low uptake are described below.

Covid and resulting lockdowns were a key barrier. Installations were initially stopped during the pandemic, causing delays and difficulties in obtaining equipment and materials for installations. This severely hampered marketing and installation activity, stunting growth in the AoR market in 2020, not long after the AoR option had begun to be promoted by investors.

The GHG–V scheme was also an issue. Investors reported that many individual household and social landlord clients previously interested in or lined up to do AoR-supported installations switched their interest to the GHG–V scheme because of the size of the grant available for heat pumps (and the possibility of combining the GHG voucher with RHI payments). Issues with the implementation of the GHG–V scheme meant that many of these customers were not

[89] An organisation approved by Ofgem to sell the AoR option to consumers. To qualify as an investor, an organisation had to join one of two consumer codes - the Renewable Energy Consumer Code or the Home Insulation and Energy Systems Contractors Scheme – and receive its approval for any contracts they intended to use with applicants. The organisation could then submit an application to become a registered investor with Ofgem.

[90] Data supplied by Ofgem, November 2021.

[91] A hurdle rate in the minimum rate of return required by an investor.

able to use the voucher but converting those customers back to the AoR was time consuming and customers were lost in the process.

There were AoR implementation issues too. Not all investors and potential investors were satisfied with the AoR model contract design. There were examples where this had put potential investors off registering or stopped registered investors from promoting the AoR scheme.

Concerns related to the balance of contractual responsibility between the consumer and investor, as well as the sequencing of contracting. On the former, there were concerns that investors were reliant on customers fulfilling their contractual obligations before investors could receive their RHI subsidy, putting their investments at risk. Related to this, a key issue for some investors was that the contract was with the individual not the home, causing issues for investors in instances where the householder had died, had decided to sell their property, or had decided to change their heating system. Investors reported that even with contractual provisions in place designed to protect them, pursuing claims against consumers in such instances had been a time-consuming and challenging process, to the extent to which some had concluded it was more efficient to write the agreements off rather than persevere with the claims.

Furthermore, there were concerns that the sequencing of the contract meant that the installer had to install the renewable heat technology first, before the consumer then submitted the RHI application and assigned the rights to the installer[92]. This arrangement was regarded as too risky for some potential investors.

Investors also reported that the AoR contract had been a barrier to take up for consumers, in part because its complexity and content was not regarded as consumer friendly. One investor, for example, reported that around 20% of their leads had fed back that it was the contract that prevented potentially interested consumers from taking up the AoR option.

Another barrier was a lack of awareness. Awareness levels of the AoR option were relatively low among the RHI applicant population, with 70% of applicant survey respondents indicating they were unaware of the option, and 2% reporting that they had considered using it. Stakeholders also described awareness of the AoR option as low and felt that greater promotion would likely have resulted in significantly more take up. As highlighted elsewhere in the report, a lack of promotion of the RHI more broadly by BEIS was considered by stakeholders to have hindered scheme awareness and engagement.

Finally, delays in implementation, first in designing the AoR model contract, and then in registering investors, were also highlighted as an impediment to delivery.

Successes

Qualitative interviews with stakeholders, investors and applicants highlighted a number of successes of the AoR option:

- consumer protection - consumer protections were generally regarded as good, and there had been no consumer complaints to stakeholders' knowledge
- the basic propositions developed by investors had been well-received and there is evidence that these helped to remove the upfront cost barrier for a good proportion of

[92] Note that this sequencing was consistent with the RHI in general, whereby application accreditation was dependent on having an installed RHT.

the participating applicants (note that other applicants still faced upfront cost barriers because of the costs of installing ancillary measures, such as upgrading radiators)

- the availability of complementary schemes, such as the Warm Homes Fund, had enabled investors and social landlords to match fund the AoR with other sources of income and deliver more installations to fuel poor customers than otherwise would have been possible
- the AoR option enabled CICs to become investors – they were less sensitive to return rates and focused delivery amongst low income households in their communities, building on previous community renewables and energy efficiency activities
- the AoR was successful in enabling commercial investors to support longer-term aims, improve market positioning and gain experience and expertise in offering finance for renewable heat (with examples of investors now considering offering finance and energy services options to consumers alongside the BUS).

Applicant survey data indicates that the AoR reforms did partially meet one of their aims in that AoR applications included more low income households than the general RHI applicant population. 18% of AoR applicants had a household income of less than £20,799, compared with 10% for RHI applicants in general. Given the relatively small numbers of AoR applications in total, however, this suggests that the AoR had only a minor impact in relation to increasing the number of RHI applications from lower income households.

Summary of AoR reform impacts

In summary, the evaluation found that the contribution of the AoR reforms to improving access to the RHI for consumers who were less able to pay was significantly less than intended by BEIS.

Influence of Reforms on Value for Money

The SCEA estimates of pre-reform and post-reform outcomes are summarised in Table 11 below, based on 80% of applications[93].

The table highlights that:

- for heat pumps, the evaluation findings indicated weaker additionality in the post-reform period, as well as higher subsidy rates for ASHPs, which meant subsidy cost effectiveness slightly reduced – the indicators around carbon abatement and air quality savings improved however in the post-reform period, partly reflecting a different mix of counterfactual technologies indicated by applicants for the post-reform period, as well as well as benefits to cost effectiveness from the introduction of HDLs
- for biomass installations, all four indicators showed improved subsidy cost-effectiveness in the post reform period, primarily reflecting lower subsidy rates in the post reform period compared with the pre-reform period

[93] The SCEA compares subsidy cost and output achievements for the respective indicators, and therefore omits installations/applications for which incomplete data was available on both costs and benefits. Further details are given in Appendix B of the Technical Annex.

- for solar thermal installations, the changes in subsidy cost-effectiveness indicators between pre and post reform periods are mostly minor, and partly reflect evaluation findings of slightly higher additionality in the post-reform period

Table 11: Cumulative heat generation and carbon abatement to end May 2022

Technology	Mean annual subsidy cost per kW of installed capacity (£)	Subsidy cost per MWh of renewable heat generated (£)	Subsidy cost per tonne of CO2e abated (£)	Value of Air Quality damage costs saved to date per £ of subsidy invested (£)
Heat pumps – Pre reform	220	128	633	0.05
Heat pumps – Post reform	245	150	513	0.07
Biomass – Pre reform	229	167	594	-0.15
Biomass – Post reform	180	132	491	-0.10
Solar thermal – Pre reform	172	344	2,101	0.01
Solar thermal – Post reform	193	346	1,934	0.01
All technologies – Pre reform	230	151	619	-0.05
All technologies – Post reform	240	149	515	0.06

Source: SCEA, Wavehill.

Influence of Reforms on Degressions and Perverse Outcomes

Where installation numbers risked breaching the overall budget cap for the domestic RHI scheme, the scheme design allowed for automatic degression of tariffs for new installations of specific technologies[94]. Any degressions were implemented on a quarterly basis (at end March, end June and so on).

As shown in Appendix C of the Technical Annex, there were significant multiple degressions of the biomass tariff between 2014 and 2016, in the pre-reform period, and minor degressions in the ASHP and GSHP tariffs in these years[95]. There were quarterly spikes in installations during these years, as shown in Figure 3, because applicants tried to avoid possible degressions at the end of each quarter.

There were no degressions in the domestic scheme in the post-reform period, after September 2017. This was because installation numbers did not reach levels that risked breaching the budget cap, with biomass installations continuing to decline post-reform and heat pump installations growing but not reaching the levels anticipated in the Impact Assessment and budget projections. The tariff increases introduced by the reforms did not boost demand sufficiently to necessitate future degressions.

Nevertheless, the risk of potential tariff degressions was still a concern for some applicants. When asked about the influence of the RHI reforms, some applicants sometimes made comments about degressions or other scheme changes rather than the reforms themselves. For example, the applicant survey found that, amongst the 1,732 respondents who reported influence from the RHI reforms on their installation (e.g. on installation timing), 50% cited concern about potential reductions in tariffs (i.e. the risk of tariff degression), while 62% cited general uncertainty about how long the domestic RHI scheme would be available.

The evaluation did not find evidence of perverse outcomes being generated by the domestic RHI scheme, either before or after the reforms. Payments were generally made on deemed heat demand, based on the property's EPC, rather than actual heat demand, so there was no incentive for participants to use more heat than they needed.

Influence of Reforms on Supply Chain Behaviour

This section considers the impact of RHI reforms on installers, equipment manufacturers, financiers and biomass fuel suppliers.

Installers

As shown in **Figure 9** above, the number of biomass installers declined post-reform. The slight increase in the post-reform biomass tariff was counteracted by the introduction of HDLs for larger properties and by the ongoing effect of significant tariff degressions since the start of the domestic RHI scheme, and was not sufficient to boost demand for biomass installations. Qualitative research with installers in 2017 and 2020 indicated that many biomass installers closed down or diversified to survive during this period. Qualitative research with installers indicated that many installers covered multiple renewable energy technologies, so the decline was influenced by a range of factors, including the effect of domestic biomass degressions, similar degressions in the non-domestic RHI scheme and degressions in the Feed-in-Tariff for renewable electricity. Some installers reported that they diversified into biomass boiler

[94] https://www.gov.uk/government/publications/domestic-rhi-mechanism-for-budget-management-estimated-commitments

[95] The biomass tariff degressed from its initial rate of 14.22p/kWh down to 5.08p/kWh by 1 July 2016. The ASHP tariff degressed from its initial rate of 8.52p/kWh to 8.18p/kWh in April 2016, and the GSHP tariff degressed from its initial rate of 21.91p/kWh to 21.05p/kWh in December 2016. (All figures inflated to 2021/22 prices).

maintenance and fuel supply, while others focused on non-domestic RHI installations or on other low-carbon technologies (e.g. heat pumps, solar PV, batteries, Electric Vehicle (EV) chargers).

The number of heat pump installers also declined post reform, from May 2017 to May 2019, but then grew significantly until the end of the scheme. As many installers offered multiple technologies, it is likely that the post-reform decline arose from firms withdrawing from the installation market altogether, in response to the factors outlined in the previous paragraph.

Qualitative research with installers during 2020 suggested that the rise in heat pump installer numbers from 2020 onwards was attributable to a number of factors including:

- installer confidence in ongoing Government support for the domestic heat pump market, provided by the domestic RHI scheme and its successor, the BUS
- growing environmental awareness within the population, linked to COVID lockdown experiences, growing climate change movements and the UK-based climate change summit (COP26)
- growing consumer confidence in heat pumps as acceptable heating solutions for both off-gas grid and on-gas grid properties, supported by the domestic RHI scheme and other policies and by improvements in heat pump performance
- the stimulus to heat pump demand and public awareness of heat pumps generated by the GHG–V scheme between July 2020 and March 2021[96]

As noted in the tariff section above, higher tariffs for ASHP and GSHP introduced by the reforms made some contribution to improving installer confidence, by improving the viability of investments in heat pumps, particularly for smaller properties below the HDL.

Manufacturers

As noted in the previous chapter, there were signs of increased interest in UK manufacture of heat pumps during supply chain consultations undertaken as part of the SMA in 2022. This was linked to the scale of growth in the heat pump market between 2020 and 2022, driven by the factors outlined under the installer section above. The supply chain consultations suggested that manufacturer investment decisions taken during 2022 are more likely to be driven by ongoing Government commitment to the BUS and long-term policies on renewable heat[97] than to the introduction of RHI reforms in 2017.

Biomass fuel supplies and boiler maintenance

There was little evidence of the supply chain for biomass fuel supplies and biomass boiler maintenance being positively impacted by the reforms. Qualitative evidence from interviews with installers in 2017/18 and 2020 suggested that some biomass installers diversified into fuel supply and maintenance in response to the declining biomass market, driven by degressions in

[96] This scheme was announced in July 2020, as part of the Government's 'green recovery' from the pandemic. The scheme opened to voucher applications in September 2020. The scheme closed at end March 2021, despite an announcement that it might be extended to end March 2022. (Public Accounts Committee, Report on Green Homes Grant Scheme - https://publications.parliament.uk/pa/cm5802/cmselect/cmpubacc/635/report.htmlHGV Scheme)

[97] Long-term policies include the BEIS 'Heat in Buildings Strategy' (2021) and a proposed market-based mechanism for low carbon heat (which was consulted on between October 2021 and January 2022).

both the domestic and non-domestic RHI tariffs between 2014 and 2016. This may have temporarily increased the supply chain for these elements of the biomass market.

However, the introduction of HDLs by the reforms further constrained biomass installations in large off-gas grid domestic properties and was only slightly counteracted by the slight increase in biomass tariff, so the biomass market continued to decline.

There was evidence of the number of registered wood log suppliers declining from 3,335 in 2018 to 222 in 2022 (possibly linked to new regulations that limited the maximum moisture content of logs sold in small quantities), but there was a slight increase in the number of registered wood pellet suppliers over this period[98]. Most domestic biomass boilers used pellets, as set out in the previous chapter.

Supply chain stakeholders consulted during 2022 as part of the SMA reported that supply chain problems might arise in future for biomass fuel supplies and (potentially) maintenance of biomass boilers, because of firms leaving the biomass market completely.

Financiers

The AoR reform stimulated a number of investors to offer financial agreements to domestic RHI customers. However, the impact of the reform on financial services provision was lower than anticipated, as outlined in the AoR section above, partially due to external factors such as Covid and the GHG–V scheme, but also as a result of reform-related barriers (such as delays in AoR investor registration and model contract design).

Administration of the Domestic RHI Scheme

Applicants were generally satisfied with the domestic RHI application process, with 67% of respondents to the applicant survey reporting no problems with the process. When asked to identify problems, just over 10% of applicants reported that they found it difficult to supply all the information they needed about their installation. Other common responses to this survey question, which allowed multiple answers, were that respondents were not clear what information they needed to provide (9.5%) and that the official guidance on the RHI was overly complex (8.5%).

Satisfaction with the process for receiving payments was also high, with 74% of respondents saying that they were ‘very satisfied’ or ‘fairly satisfied’. A further 14% of respondents to this question had not yet received any payments at the time of the survey.

There was indirect evidence from qualitative research with heat pump installers during 2020 that the domestic RHI scheme could have been better promoted to potential applicants. They pointed out that greater public awareness of heat pumps was generated by publicity about the GHG -V scheme in 2020 than for the RHI scheme, which they reported was less widely publicised.

[98] BEIS (2018, 2022) Biomass Suppliers List.

Lessons for Future Policies and Programmes on Renewable Heat

A summary of learning from the scheme for future policies and programmes on renewable heat.

Introduction

This chapter provides a summary of strategic learning from the scheme for future policies and programmes on renewable heat.

What did the domestic RHI Scheme do well?

The domestic RHI was one of the first policies in the world to provide subsidies for generation of renewable heat. From the outset, it was designed as a policy that would make a significant contribution to the development of a sustainable market for renewable heat, providing subsidies over a seven-year period.

Qualitative research with applicants and supply chain stakeholders confirmed that long timeframes and policy certainty were important in supporting major investments in renewable heat. Unusually, the timeframe for the domestic RHI extended beyond Government Spending Review cycles, with the introduction of RHI reforms being the point at which Government spending approval was sought for the final years of the scheme. Given the degressions mechanisms that formed an integral part of the scheme, and the changes introduced by the reforms to improve cost-effectiveness and stimulate heat pump take-up, supply chain stakeholders still perceived there to be change within the scheme, but this was within the context of a longstanding policy.

The requirement for equipment, installers and installations to be MCS accredited was an integral part of the domestic RHI, so the scheme introduced mandatory product and installation quality standards where industry standards had previously been voluntary. Application data showed that the average ‘seasonal performance factor’ for heat pumps installed during the domestic RHI scheme was higher than pre-RHI levels, probably influenced by these product standards as well as developments in heat pump technology. In qualitative research, some installers also commented that MCS standards had helped to improve industry practices.

Evidence presented in this report demonstrates that the policy was successful in stimulating take-up of RHTs. The domestic RHI was principally successful in encouraging applicants who were considering RHT and could afford it to actually make the investment. The scheme supported the ongoing transition towards the normalisation of RHTs. Applicant experiences of scheme application and administrative processes were broadly positive.

The scheme reforms introduced between September 2017 and May 2018 provided strategic opportunities to flex the scheme to help improve desired outcomes, responding to market changes influenced by the scheme. The reforms positively influenced the take-up of heat pumps, in particular ASHPs, alongside other more recent influences such as increases in consumer environmental awareness and the GHG-V scheme.

The combination of HDLs and tariff uplifts increased applications from smaller properties and lower incomes, without significantly reducing overall heat pump market growth. Furthermore, there was evidence to show that the introduction of HDLs improved cost effectiveness. BEIS monitored future spend commitments on the RHI scheme as a whole to ensure that the budget cap was not exceeded. The introduction of metering requirements helped provide opportunities for householders to better understand RHT performance and the introduction of AoR helped support increased participation from lower income groups in a limited way.

What did the domestic RHI Scheme do less well?

Whilst the scheme was successful in stimulating take-up of RHT, there is evidence to suggest that RHTs still need considerable further support to achieve sustainable market growth.

Qualitative evidence from installers found that MCS requirements were regarded as burdensome by some installers, with some complaining about the paperwork involved. While the increasing emergence of MCS umbrella schemes may have reduced this burden, qualitative research suggested that the quality of installation under umbrella schemes depended on the level of training and supervision provided for non-MCS installers by the MCS-accredited lead organisation.

The scheme's design did not help with capital costs, which limited scheme participation to those who were better able to afford to install RHT. AoR was designed to help overcome this issue but it had very limited take-up before the scheme ended.

The scheme was not well publicised and heat pumps, despite awareness of them growing during the domestic RHI, remain relatively unfamiliar to consumers. For example, in the BEIS Public Attitudes Tracker survey for Winter 2021, 29% of respondents were unaware of ASHP, 51% knew a little or hardly anything about them while 20% knew a lot or a fair amount. Awareness of GSHP was slightly lower.[99] Qualitative interviews with installers and customers showed that heat pumps were significantly different and more complex to understand than traditional alternatives, and that RHI incentives were more complex to market to consumers than grants. More recent upfront grants such as the GHG-V scheme were reported by installers to have been more influential in raising awareness of RHTs, partly because of the widespread marketing campaign that BEIS funded for GHG-V.

A common challenge for householders was finding independent, trusted information and advice on heat pumps and other renewable heating options. Those who progressed with RHT installations tended to be those who had familiarity with the technologies or high levels of trust in their installers.

RHI installation numbers did not reach levels that risked breaching the budget cap post the scheme reforms. Increases in tariffs, particularly for ASHPs, did increase installation numbers, but they did not increase as much as hoped and they also slightly reduced scheme cost-effectiveness. Recent increases in installations post the reforms were influenced by tariff changes but were also attributed to other influences, such as observed increases in householder environmental awareness. Biomass installations continued to decline, a legacy of

[99] BEIS Public Attitudes Tracker shows that the proportion of respondents reporting that they were aware of or knew about ASHP rose from 31% in September 2015 to 71% in December 2021, with figures for GSHP rising from 37% in September 2015 to 67% in December 2021. The latest BEIS Public Attitudes Tracker data (December 2021) show that 33% of respondents were unaware of GHSP, 49% knew a little or hardly anything while 19% knew a lot or a fair amount. (Figures may not add to 100% owing to rounding.)

RHI tariff degressions from between April 2014 and October 2015, despite a small rebasing of the tariff as part of the reform package in 2017.

As described above, whilst AoR provided a financing route to help overcome upfront installation costs, a combination of Covid, negative impacts of the GHG-V scheme, and issues with AoR implementation resulted in limited take up before the end of the scheme,

Towards a Sustainable Market for Domestic Renewable Heat

The evaluation has monitored progress towards a sustainable market for non-domestic renewable heat, examining impacts on demand, supply and costs. High-level findings on progress towards a sustainable market, across these three elements, can be summarised as follows.

Demand

Demand for biomass and solar thermal peaked in 2015 but both declined significantly afterwards, despite the biomass tariffs increasing as part of the scheme reforms. Demand for heat pumps fluctuated, but showed steady growth since 2016, principally amongst larger and more affluent owner-occupied households, with a spike in applications prior to closure of the scheme in March 2022. In recent years, consumer awareness, knowledge and demand for heat pumps have increased particularly for ASHPs, as shown by BEIS Public Attitudes Tracker evidence (see previous section) and by interviews with heat pump installers. The evidence suggests this is due to various factors including recent increases in environmental awareness and the GHG-V and upcoming BUS schemes.

Consumer complaints associated with heat pumps have reduced since the outset of the policy. Consumer satisfaction with RHTs has remained good and has not changed considerably during the policy.

Analysis of additionality suggests that more than half (59%) of installations were subsidy-dependent. Qualitative research indicated that additionality was lower for off-gas grid customers, social housing tenants, wealthy applicants, self-build homes and more expensive, larger heat pump installations.

Supply

Given that more than half of RHI-subsidised renewable heat demand (59%) has been dependent on subsidy, supply chain activity and investment have been influenced by changes in RHI subsidies.

Both the SMA and qualitative research found evidence of a boom in small and medium biomass supply chains during 2014/15, followed by a decline in the subsequent years. However, the heat pumps market has shown more steady development, stimulated by the RHI (domestic and non-domestic), except for disruptions during 2020 attributable to Covid, EU exit and closure of the non-domestic RHI scheme in 2021.

The number of MCS accredited installers for biomass and solar thermal RHTs has fallen substantially since the start of the policy, by 70% and 64% respectively. The number of MCS accredited heat pump installers also fell initially but has since recovered to 2015 levels. MCS statistics may understate the size of the heat pump supply chain because of the increasing use of MCS umbrella schemes. The proportion of RHT owners finding difficulty sourcing an installer has fallen since the outset of the policy for heat pumps and solar thermal but risen for biomass, providing a positive context for demand for heat pumps and solar thermal.

Costs

In real terms, the cost of heat pump and biomass installations was stable over time after the start of the domestic RHI scheme. Evidence from qualitative research with installers suggested that recent broader market disruptions (e.g. EU Exit, COVID and the GHG-V scheme), as well as increases in consumer demand since 2020, had resulted in upward pressure on the capital cost of heat pumps but this is not evident in the quantitative data. Heat pumps are considered mature technologies[100] and so cost reductions in RHT were perceived to be principally dependent on economies of scale and therefore closely linked to the volume of supply and demand. Interviews with supply chain and industry stakeholders suggested that costs would only be likely to decrease, rather than increase, if large-scale increases in demand occurred.

Perceived Market Barriers and Enabling Factors

In the latter years of the domestic RHI, qualitative research and analysis of RHI applications suggest that there has been progress towards a sustainable market in certain parts of the market, supported by the policy. Areas where the most progress has been made include:

- owner-occupied, primarily off-gas grid (but also to a lesser extent on-gas grid), larger properties and people with higher incomes
- social housing schemes with properties which are off-gas grid, or unsuitable for gas heating, where ASHPs have become the preferred solution

The synthesis of evaluation evidence indicates that other areas of the domestic RHI space have shown less progress towards a sustainable market. Qualitative research findings suggest that the main perceived barriers to further use of domestic RHTs include:

- RHTs with high capital costs, particularly for GSHPs which are expensive compared to fossil fuel alternatives
- cost and hassle of retrofitting buildings with suitable levels of insulation to improve the operating efficiency of heat pumps
- lack of familiarity with heat pumps
- issues with finding trusted and independent sources of advice on RHTs

Perceived Needs for Future Support

Over half (59%) of domestic applications reported that they would not have installed RHTs without the domestic RHI. This suggests that RHT support schemes, such as the BUS, will continue to be needed to further progress towards sustainable markets for RHTs.

Evidence from the qualitative research suggests that the new BUS grant is simpler conceptually than a renewable heat tariff, so easier to understand and communicate to

[100] For example in other northern European markets.

consumers and the wider market. A grant is also much better placed to overcome installation affordability issues, and therefore more likely to enable participation from lower income households.

As described above, future schemes need greater publicity to help break into the broader domestic heating market, with GHG-V scheme marketing providing an example of this.

Furthermore, as described above, a common challenge for consumers was accessing independent and trusted knowledge and advice to help inform them about RHTs, particularly for more unfamiliar and complex technologies such as heat pumps.

Installer feedback regarding the development of the domestic RHT market indicated a need for increasing grant levels and making them technology specific, particularly for GSHPs, where the anticipated level of support from BUS (or the 'Clean Heat Grant', as then proposed) was thought to be low considering the technology's high cost.

Installers, reflecting on how the GHG–V had worked, suggested that future schemes would need to carefully consider the implications of any voucher arrangements for installer cashflow to ensure this would not negatively impact installations.

Finally, findings from installers and the wider supply chain suggest that a stable, long-term policy framework will contribute to the further development of a sustainable market for RHTs, helping to maintain and grow confidence in the market, and thereby encouraging supply chain investment.

This publication is available from: www.gov.uk/government/publications/reforms-to-the-domestic-renewable-heat-incentive-evaluation.

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