Department for
Energy Security
& Net Zero

Evaluation of the Green Homes Grant Voucher Scheme (GHGVS)

Final Outcome and Economic Evaluation Report

Ipsos with BRE, Energy Saving Trust and UCL

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Executive Summary

Introduction

This report presents the findings and conclusions of the outcome and economic evaluations of the Green Homes Grant Voucher Scheme (GHGVS). This is the final of three evaluation reports, and it builds on the preceding process[1] and the interim outcome/economic[2] evaluation reports published in January 2023. This report does not repeat findings previously presented but rather provides a final assessment against the outcome and economic evaluation questions. It is therefore complementary to these preceding reports and should not be considered a standalone summary evaluation of the scheme.

The report builds upon research conducted from September 2020 to August 2022 with applicants and installers participating in the scheme. It draws also upon management information ('scheme data') from October 2022 (the final capture of the data), secondary data relating to the employment and turnover of firms participating in the scheme, and smart meter data for participating households.

In total, the evaluation has reached 3,606 applicants through an online survey, 91 applicants through qualitative interviews, and the smart meter data of 2,428 applicants. It has also drawn upon qualitative interviews with 133 stakeholders and assessed employment information for 777 firms participating in the scheme.

The aims and reach of the scheme

The GHGVS is one of four 'Green Economic Stimulus' programmes announced by Government in July 2020 to support sustainable economic recovery after the pandemic. Although the scheme comprised a mix of economic and environmental goals, it was primarily designed to maximise job retention, grow the UK retrofit market, and to have a wide reach of beneficiaries – i.e. to cover fuel-poor and low-income households as well as those 'able to pay'. The scheme offered homeowners the opportunity to apply for a voucher worth up to two-thirds of the cost of selected energy efficiency improvements and low-carbon heat measures for their homes, with a maximum government contribution of £5,000 (£10,000 for low-income households). The scheme was initially worth £1.5bn, which was estimated to be sufficient for around 600,000 households. Homeowners were expected to identify a certified installer and apply for vouchers, with the installer receiving the grant funding once they had fitted the measure. Although tenants were not eligible for vouchers, they could apply on behalf of a homeowner, such as their landlord. The GHGVS achieved a reach of 169,430 voucher applications for 113,736 properties. As of 2nd August 2022, a total of 49,355 measures had

[1] Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Process Evaluation Report. BEIS, August 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131110/green-homes-grant-vouchers-phase-1-process-evaluation-report.pdf

[2] Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Interim Evaluation Report. BEIS, January 2023. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131112/green-homes-grant-vouchers-phase-2-interim-outcome-report.pdf

been installed in 43,168 households over the course of the scheme.[3] Of the 113,736 household applications submitted to the scheme, nearly half (52,082, 46%) were either rejected or withdrawn and a further 18,475 households (16%) had vouchers issued which subsequently expired.[4]

On the 18 November 2020 it was announced that the scheme would be extended in time to March 2022, but on 27 March 2021, it was further announced that the GHGVS would be closing to new applications at 5pm on 31 March 2021.

The National Audit Office report[5] and the Public Accounts Committee report[6] examined the performance, implementation, procurement, and management of the scheme. They discussed its failures at length, and identified recommendations and lessons for future schemes. In addition, many of the delivery issues faced by the GHGVS were identified, analysed, and presented as part of the process evaluation[5], which focused on applicants' and installers' experiences of the scheme, as well as on its reach.

Whilst acknowledging that the scheme did not fully achieve the ambitious goals expressed in its initial announcement and building upon findings from previous phases of the evaluation, this final outcome evaluation adopted a mixed-methods approach to systematically assess the extent to which the measures installed under the scheme generated measurable outcomes for scheme applicants, installers and the wider supply chain.

Overall findings of the evaluation

Although the scheme did not meet its original ambition, the evaluation has found that, overall, the measures that were delivered through the GHGVS generated benefits for both the households and participating installers. However, these outcomes were small in scale.

Satisfaction with the scheme

Households participating in the scheme had mixed views on their overall satisfaction with it. This changed over the course of the scheme, with a higher proportion of those applicants surveyed reporting dissatisfaction when surveyed just after the scheme closure in March 2021 (46%) compared to when they were asked a year later (38%) (between May and August 2022).

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[3] All statistics on the delivery of the scheme are based on scheme data shared by BEIS with Ipsos in October 2022. The same statistics have been published on Gov.uk, available here: https://www.gov.uk/government/statistics/green-homes-grant-voucher-release-october-2022, Where there are differences in any of the figures this is due to rounding in the published statistics.

[4] The scheme closed to new applications on 31 March 2021 and vouchers were eligible for around nine more months after this date. For more information, see: https://www.gov.uk/government/news/government-boosts-energy-efficiency-spending-to-13-billion-with-extra-funding-for-green-homes

[5] See Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Process Evaluation Report. BEIS, 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131110/green-homes-grant-vouchers-phase-1-process-evaluation-report.pdf

[6] See Public Accounts Committee report (December 2021) https://publications.parliament.uk/pa/cm5802/cmselect/cmpubacc/635/report.html

When asked about their satisfaction with GHGVS overall,[7] a little over half of participants in the wave 2 survey[8] (53%, 919 respondents) reported that they were satisfied with it, while 38% (650) reported that they were dissatisfied. In the wave 1 survey, when asked to consider all their experiences with the scheme, applicants' opinions were polarised: around half (46%) said they were satisfied (including 26% who were very satisfied) and similar proportions were dissatisfied (43%) (including 29% who were very dissatisfied). Higher rates of satisfaction reported in the wave 2 survey were associated with applicants who had redeemed all their vouchers, with 71% (778) of all participants in the wave 2 survey in this category stating they were satisfied.

Energy use, carbon emissions, and bill savings

The evaluation was able to identify robust evidence of participation in GHGVS generating energy, carbon, and bill savings, but savings varied by measure type. Air source heat pumps and external solid wall insulation generated clear savings in energy, with associated reductions in carbon emissions and consumer energy bills. By contrast, whilst solar thermal was one of the most-installed measures through the scheme, it did not produce observable effects on energy consumption (though some positive impacts on customers installing solar thermal installations were identified through qualitative research, as outlined under health benefits results below).

Given that past studies[9] suggest that comfort taking may be a major factor in increased energy consumption, where applicants felt their home was warmer post-installation, it is possible that less energy was saved than might have been possible if the household were not enjoying the benefits of warmer homes generated through the scheme.

Generating benefits to health and well-being linked to the home

Warmer and more comfortable homes also contribute to improved health and well-being. Overall, most households who had installed measures through the GHGVS and who participated in the applicant survey conducted as part of the evaluation reported that the measures improved the warmth and comfort of their homes, though this varied by measure. Most surveyed applicants who installed insulation through the scheme reported that their homes were warmer (63%) and more comfortable (68%) post-installation. Only a small number of applicants reported that their homes were colder (5%) and less comfortable (3%). However, for some measures installed, a smaller proportion of survey respondents reported increased comfort or warmth; for instance, only 55% of those who had installed heat pumps considered their homes more comfortable post-installation, and 16% of households installing heat pumps considered their home to be less comfortable post-installation. Similarly, 41% of households who installed heat pumps considered their house warmer and 26% (significantly higher than average) considered it colder.

[7] Base: 1,726. Refers to question E1. Taking all your experiences into account, overall, how satisfied or dissatisfied are you with the Green Homes Grant Voucher Scheme?

[8] This survey was carried out between May and August 2022 with 1,726 scheme applicants, who had already taken part in the "Wave 1 survey" between July and August 2021 and had since had at least one installation completed in their property. It explored their experiences with their measure after a full winter season.

[9] Rajabi (2022) 'Dilemmas of energy efficiency: A systematic review of the rebound effect and attempts to curb energy consumption'. https://doi.org/10.1016/j.erss.2022.102661

Qualitative research showed that some households that had installed solar thermal felt more comfortable, because the measure allowed them to take more baths necessary for certain medical conditions.

Modelling of the likely health benefits generated by the measures installed under the GHGVS suggests that measures generated modest improvements in wintertime indoor temperatures and modest reductions in mould risk from warmer air for households. The findings would correspond to a positive, though modest, change in health and a corresponding modest reduction in health sector spending estimated at £143,000 over 5 years and £2.3 million over 42 years.

A total of 303 survey participants (out of a base of 349 who said that it had changed their health) reported that the measure they had installed had had a positive impact. Those respondents that had applied through the low-income route were more likely to report a strong positive impact on health (37%) than those on the main scheme (31%); however the latter group was more likely to report any positive impact (93% compared with 84% on the low income scheme).

Alleviating fuel poverty

A key ambition of GHGVS was to alleviate fuel poverty.[10] Modelling work conducted for the evaluation, using a combination of the scheme data and responses to the applicant survey, estimated that 14% of homes likely to be fuel poor before the scheme were lifted out of fuel poverty as a result of the measure(s) they installed though the GHGVS (equating to around 3,445 households applying to the scheme). The fuel poverty modelling conducted for the evaluation found 12% of homes modelled as having an energy performance certificate (EPC) rating of band D or lower prior to the scheme were raised above band D as a direct result of the scheme. This is likely due to installations being mainly single measures that brought about only small improvements to the energy performance of the homes.

Ensuring that installations were of a high quality

To prevent poor-quality installations and protect consumers, GHGVS required that installers were registered with TrustMark and that they were certified to install measures according to specific standards (PAS 2030, MCS). By requiring TrustMark registration, the scheme also ensured that a proportion of all installations were audited for quality. Such audits were in addition to the checks for fraud and the complaints system ran by the Scheme Administrator.

Most wave 2 survey participants (72%) were satisfied with the quality of their installation. However, evidence from qualitative interviews with applicants suggests that some applicants perceived there to be quality issues with their installations.

Overall, TrustMark audit data did not indicate unusual or unjustifiable levels of non-compliance. Official audit data from TrustMark shows that there were 1,220 GHGVS audits conducted between August and November 2021. During the audit, several inspection questions were used to assess the quality of each installation. A total of 84% of inspection questions[11] were passed, with the remainder noted as either non-compliant or as ‘robust compliance checks not possible’. Some suspended floor insulation checks were not possible as they would require

[10] A household is defined as being in fuel poverty if they are living in a property with an energy efficiency rating of band D or below, and when they spend the required amount to heat their home, they are left with a residual income below the poverty line.

[11] Different sets of questions were asked depending on the type of measure installed, though they can be broadly grouped into categories such as: safety issues, installed to manufacturer instructions, airtight or sealed, and paperwork and communications.

invasive action (removing floorboards) after an installation was completed, which would have damaged flooring. Further, property characteristics were found to influence the pass rate, with measures installed in older buildings – particularly those built prior to 1950 – more likely to fail their inspections, again likely due to difficulties in carrying out robust checks due to the complexity and variation of building structures.

Effects on employment and business growth

Evaluation modelling suggests that GHGVS directly created or safeguarded a lower and upper bound range of 550 to 1,700 jobs in the firms participating in the scheme.[12] Owing to the timeframes for which the data was available, it was not possible to determine whether those jobs might have been sustained in the long-term. Evidence from qualitative interviews with a variety of stakeholders (for both process evaluation and this outcome and economic evaluation) within the home improvement supply chain also indicates that GHGVS contributed to increased employment and turnover, at least in the short term.

The results also suggested that the scheme led to a short-term reduction in unemployment levels within the local areas where installers were based. It was estimated that the delivery of each measure reduced the number of unemployed claimants by around 0.018 claimants for a period of three months. This would imply a total reduction in the number of unemployed claimants of just over 900 claimants.

Value for money of the scheme

The Cost Benefit Analysis (CBA) conducted for this evaluation suggests that some of the installed measures generated societal benefits which modestly outweighed their costs. For instance, cavity wall insulation and loft insulation provided a societal benefit cost ratio (BCR) greater or equal to one, while air source heat pumps, external solid wall insulation, loft insulation and pitch roof insulation had a societal BCR less than one.

For some households, the costs of participation are likely to outweigh the monetary benefits derived.

Influence of the scheme on applicant behaviour and post-scheme onward behaviour

Without the scheme, most participating households would not have installed any measures at all, or would have done so at a much later stage (though this varied by measure installed).

Most applicants are considering the installation of additional measures in the future. In the wave 2 applicant survey, applicants reported that they are not only willing to take advantage of future schemes but also willing to pay for measures themselves. Around 41% of wave 2 survey participants (540 of those responding to the question) had had other measures installed (to the same property) since applying for the GHGVS voucher. The most common measures participants had gone on to install were smart meters (255, 47%), which are freely available to households from their energy suppliers. The next most-common measure was double/triple glazing (194, 36%), followed by loft insulation (144, 26%), heating controls (135, 35%) and

[12] Lower and upper bounds reflect the range of statistically significant results across comparison groups for robust fixed effects regression models i.e. all lag periods (upper bound) or one lag period (lower bound). This pertains to the favoured estimates for direct jobs effects. Several different ranges of estimates are presented in Table A7.6 in Annex 7. The widest possible range is from 455 to 3,864 direct jobs. Deeper explanation and discussion is provided in Annex 7.

energy efficient doors (109, 20%). In most cases, they had paid for this from their own savings rather than through any other means, including loans and other government subsidies.

Differences in findings by measure type

More than 60% of all measures installed comprised external wall insulation, loft insulation, solar thermal, pitched roof insulation, cavity wall insulation and air source heat pumps. The higher number of installations for these measures means that there was a larger sample of data to draw from and it is possible to have a higher level of confidence in the findings for these measures (effects are observable). The evaluation has found that there are statistically significant differences between the effects of these measures on energy savings, health benefits (after five years), level of compliance with TrustMark standards of compliance, household members' perceived comfort and warmth in the home, customer satisfaction, and onward consumer behaviour.

Between these measures, higher proportions of applicants reported satisfaction with air source heat pumps (83%) and external wall insulation (87%) than with solar thermal (70%).[13] However, the energy efficiency improvements that the highest proportion of survey participants would consider making to their home in the future were solar panels (988, 62%),[14] followed by energy efficient doors (852, 54%) and draught proofing measures (826, 52%). Cavity wall insulation was the measure least likely to be considered (211, 13%). However, we do not know from the survey what measures respondents may have already had installed in their homes prior to participating in GHGVS.

[13] Refers to question E2. Taking everything into account, overall, how satisfied or dissatisfied are you with the energy efficient or heating improvement(s) listed below?

[14] Refers to question E6. Which, if any, of the following energy efficiency improvements would you consider making to the property in the future?

1 Introduction

1.1 The Green Homes Grant Voucher Scheme Evaluation

The Green Homes Grant Voucher Scheme (GHGVS) was one of four 'Green Economic Stimulus' programmes launched in 2020 and aimed at reducing greenhouse gas emissions in the residential sector. The scheme offered homeowners, including landlords, the opportunity to apply for funding in the form of vouchers to install energy efficiency improvements and low-carbon heat measures in their homes. Applicants would identify a certified installer, obtain a quote from them for an eligible energy efficiency or low-carbon heating measure, apply for a voucher subsiding that measure, and redeem the voucher once the works were installed. The installer would then be paid through the voucher redemption process with any remaining cost being paid by the applicant. A full overview of GHGVS is provided in Chapter 3.

The Evaluation of the GHGVS began in November 2020 and ran until March 2023. The evaluation was commissioned by the then Department for Business, Energy, and Industrial Strategy (BEIS) and was delivered by Ipsos in partnership with University College London (UCL), Energy Saving Trust, and the Building Research Establishment (BRE). The evaluation programme included a process evaluation, which was completed in Autumn 2021, and an outcome and economic evaluation. This report presents the final findings of the outcome and economic evaluation.

1.2 The scope and approach of the GHGVS outcome and economic evaluation final report

This is the final evaluation report of the GHGVS outcome and economic evaluation. It builds on the preceding process evaluation report[15] (February 2022) and the interim outcome and economic evaluation report[16] (August 2022), both published in January 2023. This final report does not repeat findings previously presented but rather provides a final assessment against the outcome and economic evaluation questions. It is therefore complementary to these preceding reports and should not be considered a standalone summary evaluation of the scheme. The evaluation questions covered within this report are signposted at the beginning of each relevant chapter, and they are also listed in Annex 1.

For each anticipated outcome of the scheme, we have assessed: (a) actual change – i.e. whether anticipated outcomes occurred, and (b) whether the scheme contributed to these.[17] This is reflected in the structure of Chapters 5 to 11 which describe how the scheme intended

[15] Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Process Evaluation Report. BEIS, 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131110/green-homes-grant-vouchers-phase-1-process-evaluation-report.pdf

[16] Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Interim Outcome and Economic Evaluation Report. BEIS, 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131112/green-homes-grant-vouchers-phase-2-interim-outcome-report.pdf

[17] The approach has similarities with Contribution Analysis, including the iterative approach and gathering of evidence to validate assumptions, but differs from Contribution Analysis in that the evaluation does not explicitly search for alternative Theories of Change nor consider the extent of contribution of the scheme to observed change.

to achieve each outcome (as per the Theory of Change (ToC)); evidence of a change in the outcome area over the time of the scheme; and an exploration of the scheme's contribution to the observed change.

1.3 The structure and content of this report

The remainder of this report covers:

- A brief outline of the methodology employed for this evaluation (Chapter 2).
- A description of the policy context within which GHGVS operates, and how this changed over the course of the scheme (Chapter 3).
- A description of the programme ToC (Chapter 4).
- Evidence of the effect of the scheme on fuel poverty (Chapter 5).
- Evidence of the effect of the scheme on energy consumption, energy bills and carbon emissions (Chapter 6).
- Evidence of the scheme's effects on health (Chapter 7).
- The quality of installation and service in the scheme (Chapter 8).
- Evidence of the scheme's benefits on the supply chain (Chapter 9).
- A value-for-money analysis (Chapter 10).
- Evidence of the scheme's effects on consumer demand (Chapter 11); and
- Report conclusions (Chapter 12).

A separate technical Annex includes the detailed methodology and analyses of each separate strand of the evaluation. Within it, Annex 1 sets out in detail the methodological approaches employed for the outcome evaluation. Annex 2 describes the economic evaluation, Annex 3 the health impact analysis, Annex 4 the energy, carbon, and bills savings analysis, Annex 5 the fuel poverty analysis, Annex 6 the methodology for the analysis of quality of installations and services, and Annex 7 the jobs impact analysis.

2 Methodology

This section provides a brief overview of how the evaluation team conducted the research for the final outcome and economic evaluation. The evaluation approach and research methodology are set out in greater detail in Annex 1. The methodology underpinning the process evaluation and the interim outcome and economic evaluation is detailed in the respective reports, and not repeated here.

2.1 Evaluation approach and methodology

2.1.1 Outcome evaluation

The outcome evaluation adopted a theory-based approach, and this report has been structured to discuss the key causal pathways of the GHGVS ToC. To assess the extent to which positive change occurred in the areas targeted by the scheme (e.g., fuel poverty reduction, energy savings, health impacts, jobs retention) we utilised a range of qualitative and quantitative techniques including a before and after online survey of applicants, two waves of depth interviews conducted by telephone with applicants, fuel poverty modelling, regression analysis of smart-meter data to assess changes in energy consumption, and econometric methods to assess the impact of the scheme on jobs and business turnover. Some of these methods also indicated whether the change observed could be attributed to GHGVS. Where this was not the case, we used evidence from scheme data, the applicant survey, and qualitative interviews with a range of beneficiaries and stakeholders (see 2.2 below) to test the causal hypotheses and 'contribution stories' set out in the GHGVS ToC. Our overall analytical approach fell into four steps as summarised here:

Step 1: Understanding the ToC and developing causal hypotheses. Our understanding was developed iteratively at four stages, through consultation with BEIS via ToC workshops and interviews with GHGVS policy and delivery leads.

Step 2: Outcome-specific analysis. Different techniques were used to measure the distinct outcomes of the scheme, as stated above. These techniques are outlined in Annexes 1 to 7.

Step 3: Triangulation. For several of the workstreams (health outcomes, quality, economic outcomes), several strands of research provided the evidence that was used to assess the outcome. Where this was the case, we triangulated the evidence and conducted analytical meetings to develop our conclusions.

Step 4: Developing causal explanations and lessons for future policymaking. We have cross-compared evidence and reviewed relevant literature to contextualise our findings, optimising the expertise we have within our team. As part of this step of analysis we have also assessed why some outcomes might have been more readily achieved than others and what the different enablers and barriers might have been.

2.1.2 Economic evaluation

Chapter 10 provides the final Cost Benefit Analysis (CBA) of the scheme. It updates the value for money assessment conducted in the interim outcome and economic evaluation report with final information on installations completed by measure ('scheme data'),[18] and with estimates of changes in National Health Service (NHS) spending associated with measures installed under GHGVS. It applies a quantitative cost benefit analysis that aligns with HMT Green Book advice, and the method applied is set out in Annex 2.

2.2 Data sources

This report draws upon the following data gathered throughout the course of the evaluation.

Process evaluation data (collected January to August 2021)

- An online survey of 3,606 applicants ('wave 1 applicant survey').
- A telephone survey of 218 installers.
- Qualitative interviews with:
    - scheme applicants (61 in total – comprised of: 41 homeowner-occupiers, 15 landlords, 1 tenant and 4 applying on behalf of other people),
    - installers (16),
    - non-applicants (18),
    - the wider supply chain (11 manufacturers, 5 auditors, 6 trainers, 8 certification bodies), and
    - BEIS staff members involved in the policy design and delivery (9).

Outcome evaluation data (collected January to August 2022)

- Data on applicants and installers participating in the scheme and the number and nature of measures installed ('scheme data').
- An online survey of 1,726 applicants who participated in the 'wave 1 applicant survey', provided consent to be recontacted, and had an installation completed in their property ('wave 2 applicant survey').
- Qualitative interviews with:
    - scheme applicants (30 in total – comprised of: 15 homeowner-occupiers, 15 landlords),
    - installers (10),
    - the wider supply chain (10 manufacturers, 10 auditors, 8 trainers, 8 certification bodies),
    - 1 TrustMark representative (though the evaluation team had regular contact and was able to speak to TrustMark representatives throughout the duration of the evaluation), and
    - BEIS staff members involved in the policy design and delivery (3).
- A modelling of fuel poverty status before and after a GHGVS measure installation for 2,477 households.
- Smart meter data on energy consumption for 2,428 applicants with at least one measure installed (matched to the same number of comparable households sharing their smart meter data with the Smart Energy Research Lab at UCL, representing a control group of households who did not install a measure using a GHGVS voucher).

[18] This covers measures installed as of the 7th of December 2021.

- Data for 1,221 TrustMark audits of GHGVS installations carried out between October 2020 and January 2022.
- Information on the employment size of 777 business delivering installations under GHGVS, as extracted from the ONS' Business Structure Database.

Further detail on the sampling strategy and methodology employed for data collection, as well as considerations on bias, can be found in Annex 1.

2.3 Methodological strengths, challenges, and limitations

Although this final report draws from multiple sources of primary and secondary data, it is still subject to some limitations.

- First, the evaluation has not involved an overarching analysis of deadweight, though deadweight has been assessed as part of the jobs impact analysis.
- Similarly, it was only possible to robustly quantify impacts – i.e. with reference to an appropriate counterfactual scenario – for the analysis of the scheme's impacts on jobs and energy, carbon and bill savings.
- The cost benefit analysis presented in Chapter 10 draws only on energy savings outcomes data for around 60% of all measures installed as part of the scheme due to a lack of incomplete data as drawn from ECO3 (see Annex 2 for more information).
- The analysis of smart meter data for energy savings analysis in Chapter 6 has not systematically accounted for the potential effects of post-COVID-19 changes in occupancy patterns, energy use, and base-levels of home warmth due to increased home occupancy during and immediately post-COVID-19.
- Third, there are some limitations to the modelling used to assess both fuel poverty and health impacts due to gaps in the datasets needed.
- The data collected for the evaluation through surveys and depth interviews may also be subject to recall and self-selection bias.
- Finally, in some cases survey results are presented which are not statistically significant, though they have been reported for completeness. Where this is the case we have highlighted this in footnotes. It is particularly the case for the TrustMark statistics on compliance presented in sections 8.2.2 and 8.2.3, and for the presentation of the survey findings on onward behaviour in Chapter 11.

The evaluation was designed to draw upon multiple secondary and primary sources of data and utilise multiple analytical methods to generate findings. By triangulating the findings of these analytical strands, we have greater confidence in our findings and conclusions. To summarise, the strengths of our data collection and analysis comprise:

- Statistical significance reported to the 95% confidence interval throughout, except for the energy analysis where it is to the 90% confidence level. Where any quantitative data (usually survey results) are presented which are not statistically significant, these are flagged as such and the rationale for their presentation provided.

- Enhanced credibility through extensive and systematic data collection with stakeholders; iterative analysis and a two-phase approach to the outcome and economic evaluation,
- Good validity of the findings due to the report drawing on multiple stakeholders' perspectives and types of evidence (observed, statistically representative and explanatory), and
- Good plausibility of findings due to the theory-based approach taken and the consultation of scheme experts at various stages (i.e., BEIS policy officers and partners such as TrustMark).

Further discussion of the strengths and limitations of the evaluation methodology are provided in Annex 1.

3 GHGVS delivery and policy context

3.1 Scheme overview

To enable the achievement of Britain's Net Zero goals, in July 2020 the UK government announced the creation of four 'Green Economic Stimulus' programmes, aimed at reducing greenhouse gas emissions in the residential sector. Together with the Green Homes Grant Local Authority Delivery (LAD), the Social Housing Decarbonisation Fund Demonstrator (SHDF(D)), and the Public Sector Decarbonisation Scheme (PSDS), GHGVS was designed to support sustainable economic recovery after the pandemic and comprised a mix of economic and environmental goals. It was primarily designed to maximise job creation and retention, grow the UK retrofit market, and to have a wide reach of beneficiaries, i.e., to cover fuel-poor and low-income households as well as those 'able to pay'. The scheme offered homeowners the opportunity to apply for a voucher worth up to two-thirds of the cost of the chosen energy efficiency improvements and low-carbon heat measures for their homes, with a maximum government contribution of £5,000 (up to £10,000 for those eligible to participate through the low-income scheme). Homeowners were expected to identify a certified installer and apply for vouchers, with the installer receiving the grant funding once they had fitted the measure. Tenants were not eligible for vouchers, although they could apply on behalf of a homeowner, such as their landlord.

3.2 Scheme development and duration

GHGVS was set up to stimulate both the demand and supply of energy efficiency and low-carbon heat measures. It was developed rapidly over a 12-week timeframe from design to launch. The scheme was initially designed to last six months but was later extended by one year (to 18 months in total). However, the scheme ultimately closed after six months from its launch, following the implementation of a performance improvement plan from November 2020 to March 2021.[19] Its early closure followed from the issues experienced by both applicant households and installers in the first months of the programme.

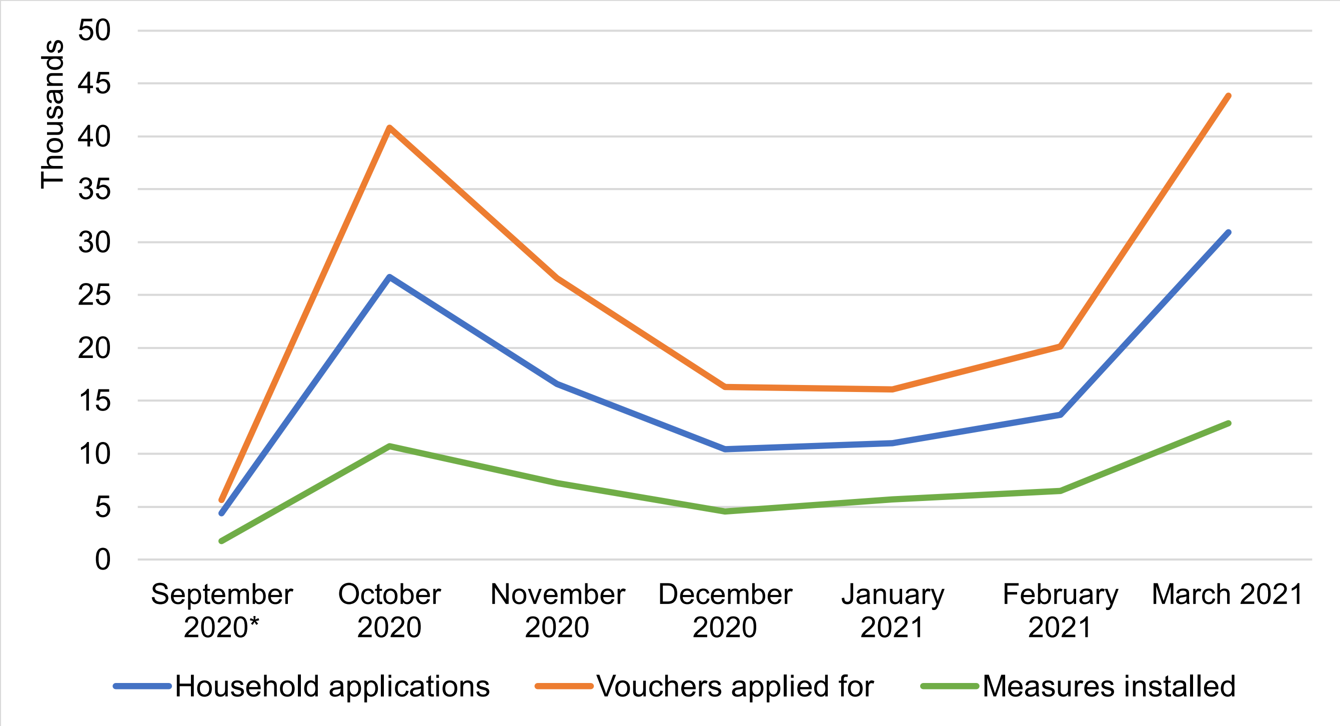
3.3 Scheme uptake and reach

In total, GHGVS received 113,736 household applications for a total of 169,430 vouchers. Two thirds of household applications were for one measure (associated with one voucher), 23% were for two measures and 11% for three or more. This averaged out at 1.49 measure applications per total household application. However, following rejections on applications, and voucher expiration, 1.14 measures were actually installed (on average) per household.

After an initial surge in applications following the scheme's launch, interest decreased. Applications increased again in March 2021, likely as a response to the scheme's announced closure.

[19] For more information on the factors around these changes, please see the National Audit Office (NAO)'s audit of the scheme published in September 2021. https://www.nao.org.uk/reports/green-homes-grant/

Figure 3.1: Household and voucher applications and measure installations, per month



* Applications for the month of September 2020 only include those on the 30th as this was when the scheme was launched. Source: Green Homes Grant Voucher (GHGV) Statistics (BEIS, 2022).

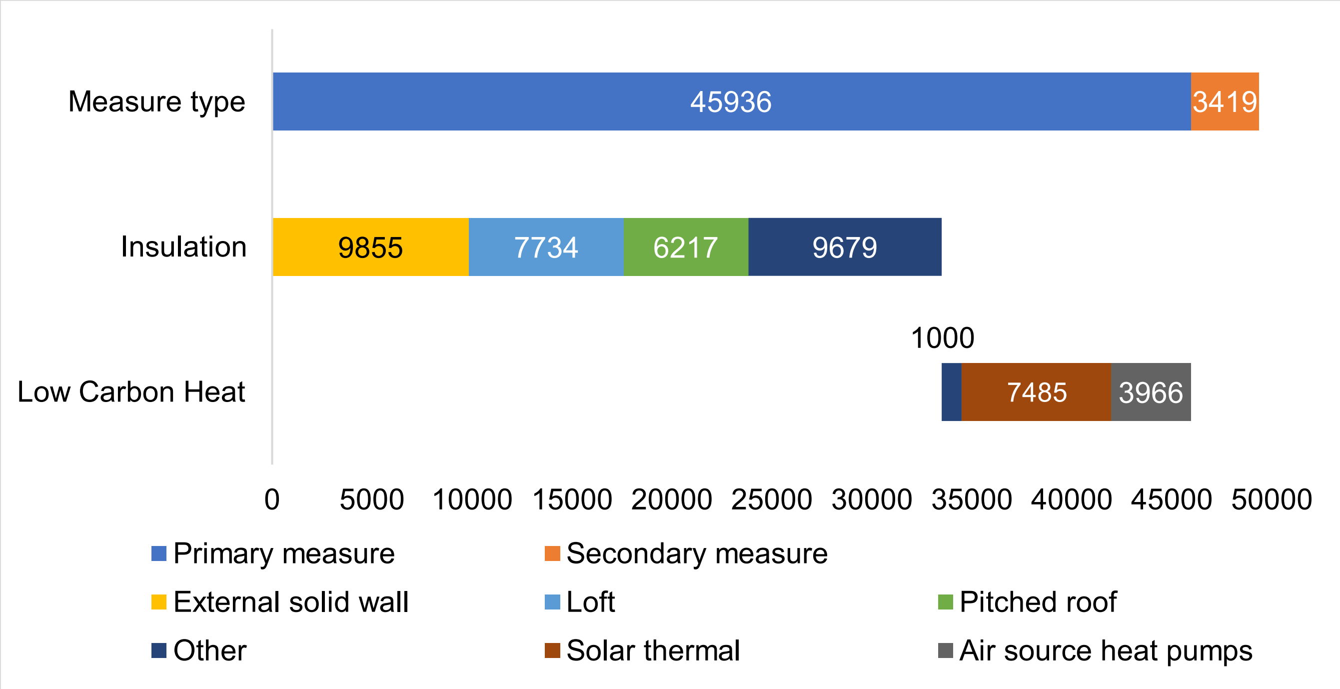
Of the 113,736 household applications submitted to the scheme, nearly half (52,082, 46%) were either rejected or withdrawn and a further 18,475 households (16%) had vouchers issued which subsequently expired.

Survey participants who proceeded to install measures outside of GHGVS, or who said they were planning or considering to do so, did this for different reasons.[20] Most commonly (in 35% of the 114 cases) applicants withdrew from the scheme because the process of getting the voucher took too long. Challenges in getting the installer to complete the installation before the voucher expired or difficulties in finding an installer prevented 26 (23%) and 25 (22%) applicants respectively from using their vouchers. For 24 applications (21%), the installer had been unwilling to complete the works through the GHGVS.

As of 2nd August 2022, a total of 49,355 measures had been installed in 43,168 households over the course of the scheme. A total of 93.1% of these installations were for primary measures. The most installed measures were different types of insulation (33,485, 67.8% of all measures installed), specifically external solid wall insulation (comprising 20% of all measures (9,855)), loft insulation (15.7% of all measures installed (7,734)) and pitched roof insulation (12.6% of all measures (6,217)). One quarter (25.5%) of measures installed (12,451) were low-carbon heat measures, most commonly solar thermal measures (15.2% of all measures (7,485)) and air source heat pumps (3,966, 8% of all measures).

[20] Base: 114, covering all those who responded to the question B3_1. Why did you or the people who live at the property decide to have [measures] installed without a GHG Voucher? / Why are you or the people who live at the property having [measures] installed (or considering having them installed) outside of GHGVS?

Figure 3.2: Installed measures by measure type



Base: 49,355 installed measures. Source: Green Homes Grant Voucher (GHGV) Statistics (BEIS, 2022).

Further measures may have been installed after the scheme's closure, but data on these is not currently available.

Overall, the reach of the scheme was smaller than it could have been based on the funding available and its original ambition. This is analysed in greater detail in the process evaluation report.[21] The interim outcome and economic evaluation report[22] provides a further exploration of the profile of households benefitting from the scheme, comparing the profile of those who applied for vouchers, those who were successful in being issued vouchers and those who completed an installation.

3.4 Policy context after the scheme closure

The closure of GHGVS meant that the number of homes that were upgraded through the scheme was lower than the amount for which there was budget available: the scheme reached approximately 7% of the homes for which budget had been forecast. The scheme used £314 million (21%) of the £1.5 billion available to spend within the time available of which £50 million was administration costs.[23]

[21] Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Process Evaluation Report. BEIS, 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131110/green-homes-grant-vouchers-phase-1-process-evaluation-report.pdf

[22] Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Interim Outcome and Economic Evaluation Report. BEIS, 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131112/green-homes-grant-vouchers-phase-2-interim-outcome-report.pdf

[23] PAC Report on the Green Homes Grant scheme, UK Parliament, 2021

After the scheme ended, the policy context in which it had been delivered changed rapidly, with the cost of energy rising rapidly, leading to an increased risk of fuel poverty amongst UK households further underlining the impetus to shift away from a dependency on gas for heating in the UK and towards more energy efficient homes through better insulation and draught-proofing.

No direct replacement for GHGVS has been put in place. However, policies to decarbonise and improve the energy efficiency of homes in the UK remain central to Government action to support the achievement of Net Zero by 2050.[24, 25] Programmes aimed at enabling and encouraging energy efficient and low carbon upgrades to homes launched since the launch of GHGVS include the Boiler Upgrade Scheme, Sustainable Warmth programmes (comprising the Home Upgrade Grant and phase 3 of Local Authority Delivery) and Great British Insulation Scheme. The Government has also launched several programmes aimed at addressing fuel poverty through subsidies for energy bills: the Warm Homes Discount provides a £140 rebate off an annual energy bill for eligible households, the Energy Bills Support Scheme provided additional support in 2022 and 2023, and the Minimum Energy Efficiency Standards for private landlords establishes a minimum standard of EPC band E for domestic and non-domestic private rented properties, affecting new tenancies and renewals.

3.5 Levels of satisfaction with the scheme

When asked about their satisfaction with GHGVS,[26] a little over half of participants in the wave 2 survey (53%, 920 respondents) reported that they were satisfied with it, while 38% (650) reported that they were dissatisfied. The proportions of survey participants reporting satisfaction with the scheme were higher for the wave 2 survey (which was carried out in Summer 2022) than for the wave 1 survey (conducted in Summer 2021). In the wave 1 survey, when asked to consider all their experiences with the scheme, experiences were polarised: around half (46%) said they were satisfied including 26% who were very satisfied, and similar proportions were dissatisfied (43%) and very dissatisfied (29%).

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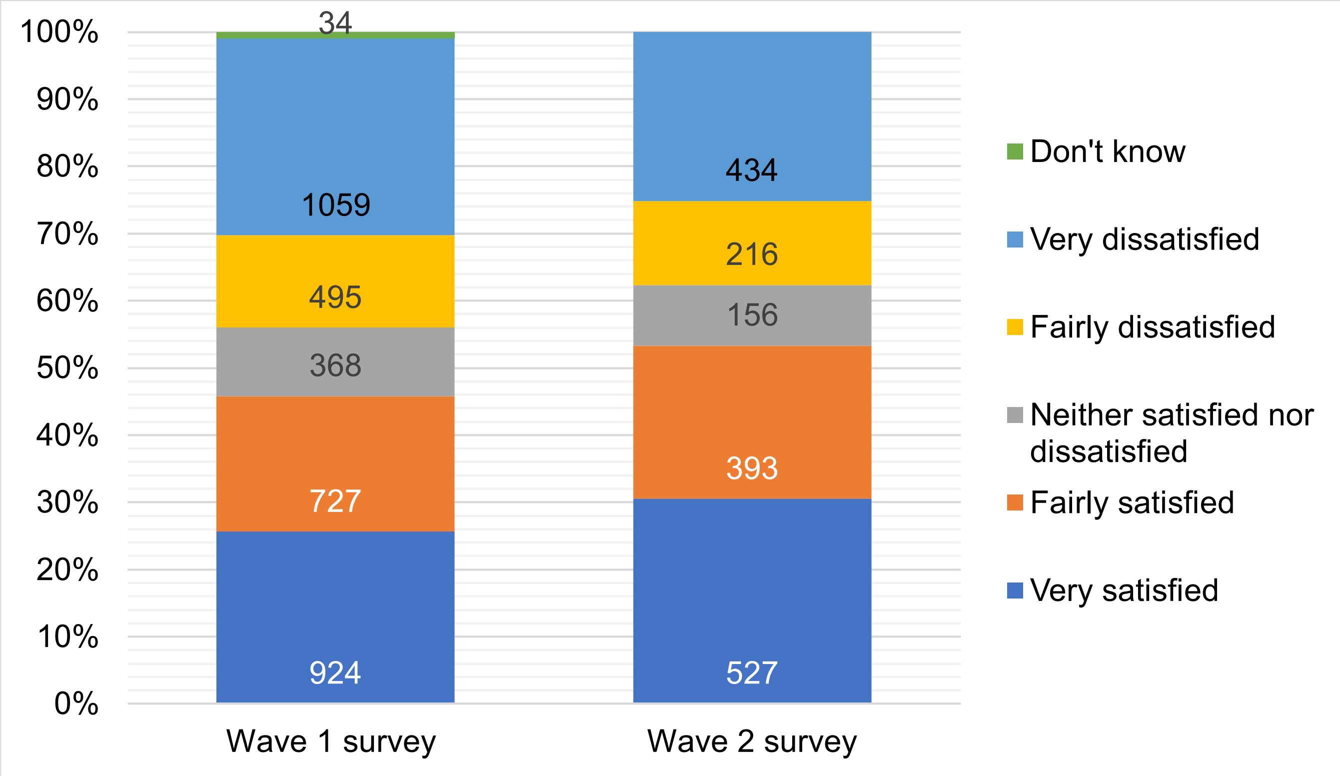
[24] Heat and Buildings Strategy, HM Government, October 2021: https://www.gov.uk/government/publications/heat-and-buildings-strategy

[25] Government Response to Consultation on Updating the Fuel Poverty Strategy for England, February 2021: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/960083/fuel-poverty-strategy-for-england-government-response.pdf

[26] Base: 1,726. Refers to question E1. Taking all your experiences into account, overall, how satisfied or dissatisfied are you with the Green Homes Grant Voucher Scheme?

Figure 3.3: Scheme satisfaction rates



Bases: 3,606 applicants responding to the wave 1 survey, responses to the question I1. Taking all your experiences into account, overall, how satisfied or dissatisfied are you with the Green Homes Grant Voucher Scheme? And 1,726 applicants responding to the wave 2 survey, responses to the question E1: Taking all your experiences into account, overall, how satisfied or dissatisfied are you with the Green Homes Grant Voucher Scheme?

Higher rates of satisfaction reported in the wave 2 survey were associated with applicants who had redeemed all their vouchers, with 71% (778) of respondents in this category stating they were satisfied with the scheme, compared to 39% (92) of respondents who had at least one voucher unredeemed. Applicants to the low-income scheme were slightly more satisfied than those from the main scheme, with 55% (538) and 51% (382) stating satisfaction respectively.[27] Scheme satisfaction levels were also constant across age, gender, and income, where in most cases levels of satisfaction hovered around 55%. There was similarly little difference in satisfaction with the scheme between survey participants who had applied for any primary measure (53%, 919), any insulation measure (52%, 643) or any low-carbon heating measure (56%, 291). However, applicants who had applied for any type of secondary measure reported lower levels of satisfaction, with only one third of survey participants who had this type of measure installed (33%, 127) stating that they were satisfied with their overall experience with the scheme.

Amongst wave 2 survey participants who had had at least one installation completed, rates of satisfaction with the specific measure they had installed tended to be higher than overall scheme satisfaction.[28] Satisfaction with the installation was high for all measures, with rates of 79% on average for all measure types that had at least 100 installations in the survey sample. This is consistent with findings from the wave 1 survey, in which results showed that most

[27] This difference in satisfaction between main scheme and low-income scheme participants is not statistically significant at the 5% level.

[28] Base: 1,546. Refers to the question E2: Taking everything into account, overall, how satisfied or dissatisfied are you with the energy efficient or heating improvement(s) listed below?

applicants whose installations were complete by the time of the survey were satisfied with their new installation. High numbers of survey participants were satisfied with their external solid wall insulation (87%, 246) and air source heat pumps (83%, 133). Proportionally fewer survey participants were satisfied with their cavity wall insulation, loft insulation, and pitched roof insulation (all above 75%). As can be seen in table 3.1 overleaf, in relation to different quality themes, there was no significant variation between measures in terms of how households experienced satisfaction, except in relation to aesthetics and (less so) effectiveness. Significantly higher numbers of applicants who had external solid wall insulation expressed satisfaction with the effectiveness of the improvement and the aesthetics of the installation than those receiving other measures; and significantly lower numbers of applicants installing loft insulation and pitched roof insulation expressed satisfaction with the aesthetics of these measures than for other measures. There was little variation in satisfaction rates across key metrics such as age, gender, and income.

Table 3.1: Net satisfaction rates per category per type of measure (selection)[29]

	Base size	Considered to be free of defects or health and safety issues	The effectiveness of the improvement	The suitability of the installation	The aesthetics of the installation
Air source heat pumps	160	80% (128)	77% (124)	83% (132)	65% (103)
Cavity wall insulation	127	78% (99)	73% (92)	78% (99)	66% (83)
External solid wall	283	73% (208)	**81% (231)**	84% (239)	**82% (233)**
Loft insulation	287	78% (222)	68% (195)	79% (225)	**51% (146)**
Pitched roof insulation	133	72% (96)	70% (93)	73% (97)	**40% (53)**
Solar thermal	226	72% (162)	72% (163)	75% (170)	64% (146)
Average satisfaction %	-	76%	74%	79%	61%

Base: See column 1. Responses to the question: C6. Our records show that you redeemed a Green Homes Grant Voucher(s) after an installation was completed. Which, if any, of the difficulties shown below did you experience in redeeming the voucher(s)? Measures reported on are those that received 100 or more installations across the survey sample. Statistically significant differences are highlighted in bold; the remaining differences between responses are not statistically significant and are presented for completeness.

[29] All survey responses to these questions have been presented for completeness for the most common measures installed and are subject to margins of error which vary with the sample size specific to each question and the percentage figure concerned. This means that not all differences reported are statistically significant.

4 Programme Theory of Change

4.1 The overall strategy and aims of GHGVS

The stated aims of GHGVS were:

- To bring forward investment in domestic energy performance and low-carbon heating through subsidies, supporting an industry impacted by COVID-19, by securing jobs and creating new long-term jobs.
- To accelerate the installation of energy performance upgrades to the housing stock including installation of low-carbon heat technologies, delivering increased carbon savings, and fuel poverty alleviation, in the residential sector, to support the Government's Carbon Budgets and Fuel Poverty Target.

GHGVS was developed within the context of COVID-19 driving a new mission for BEIS, of Leading Britain's Recovery and its priorities of Backing Business and Tackling Climate Change.

The GHGVS also had the following objectives:

- To help the Government meet its commitment to upgrade all fuel poor homes to EPC Band C by 2030, and as many other homes as possible to EPC Band C by 2035.
- To ready homes for low-carbon heating technologies.[30]
- To support the adoption of 'least regrets' – i.e., future-proofed – low-carbon heating measures (particularly in existing off gas grid homes).[31]

Support for energy efficiency installations through GHGVS was designed to:

- Increase the energy performance (and thermal comfort) of homes and reduce their carbon emissions.
- Raise households' disposable income because of reduced energy costs, allowing them to increase their spending elsewhere in the economy.
- Support jobs throughout the economy, as materials manufacturing (much of which is UK based) ramps up to meet demand, and accredited installers bring back furloughed staff and grow their workforce to deliver the physical work.
- Prepare the energy efficiency/performance industry for the growth needed to fully decarbonise homes and meet carbon budget and net zero obligations.

Support for low-carbon heating under GHGVS was designed to:

[30] In conjunction with wider BEIS policy to: (a) set minimum energy performance standards across tenure types at key trigger points (e.g., point of rental, sale, financing, home improvement); (b) support market enablers such as information, communications, supply chain quality / skills, consumer redress, and availability of low-cost green finance); and (c) target public funding where it is most needed to drive improvements to fuel poor / vulnerable households, and accelerate adoption of higher cost, more disruptive measures).

[31] As set out in the October 2021 Net Zero Strategy, no or low-regrets actions are those which are cost-effective now and will continue to prove beneficial in future. For example, installing energy efficiency measures reduce consumer bills now, while making buildings warmer and comfier, but have the added benefit of making future installations of low-carbon heating more cost effective. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf

- Contribute to decarbonising heating in the UK and to meeting carbon budgets.
- Develop the low-carbon heat market and supply chain to support the mass roll out of low-carbon heating technology required in the 2020s.
- Contribute to the UK Government's legal obligation to reach net zero emissions by 2050.

The above was based upon the assumption that, by subsidising low-carbon heat installations through GHGVS, the cost differential between installing fossil fuel and low-carbon heating systems could be reduced, incentivising deployment of low-carbon technologies.

4.2 Causal pathways and assumptions

Outcome pathways

In November 2020, BEIS led a workshop with policy officers to develop a more detailed ToC that set out causal pathways and underpinning assumptions. Six outcome pathways were identified, as follows:

- Energy efficiency improvements to participating households,
- Low-carbon heat market growth,
- Decreased fuel poverty,
- Increased employment and improved skills within the installation sector,
- Improved quality standards, and
- Market improvements (market competition, increased awareness of new technology and/or decreased cost of measures).

These were expected to eventually lead to the following scheme impacts:[32]

- Reduction of future carbon emissions,
- Improved health outcomes,
- Warmer and more comfortable homes,
- Homes that are cheaper and more efficient to heat,
- A reduction in energy bills in fuel poor homes,
- Growth in the energy efficiency and low-carbon heating sector contributing to recovery from the COVID-19 related economic recession,
- An increase in the quality of future installations (outside of the scheme), and
- An increased understanding of the use of energy efficiency measures/tech for installers and consumers.

In November 2021, Ipsos led a second ToC workshop with BEIS to understand the outcome pathways in more detail. This led to further understanding for Ipsos around BEIS' assumptions underpinning the improved energy efficiency, low-carbon heat growth and consumer behaviour, employment and skills, fuel poverty, and improved quality standards pathways; the findings of which have been integrated into the relevant chapters of this report.

[32] It is not within the scope of this evaluation to assess these impacts.

4.3 Validity of the ToC assumptions

In the first (November 2020) ToC workshop, BEIS identified several assumptions, which Ipsos reviewed as part of the process evaluation. Based upon research conducted for the process and outcome evaluation, Ipsos can confidently conclude that the following scheme design assumptions were **valid**:

- Demand was not affected by household unwillingness to go ahead with installations in the light of COVID-19 or adverse publicity about the scheme. As shown in section 3.3, scheme uptake rose when it was announced that the scheme would be closing. Indeed, our research for this evaluation has indicated that applicants were drawn to the scheme because they recognised that installing measures through the scheme could improve the comfort of their home and possibly generate energy bill savings. Owner occupiers and landlords were also prepared to contribute to costs, meaning that the scheme's delivery model (of providing subsidies up to a proportion of the total cost) was acceptable and attractive to applicants. Applicants were not significantly deterred from participating in the scheme by COVID-19 lockdowns.
- In terms of onward behaviour, the evaluation has found that those participating in the scheme would be likely to consider future retrofits.
- In terms of the scheme's delivery, the supply chain who chose to participate in the scheme, including TrustMark, certification bodies for PAS and MCS, were able to build skills and scale up to meet the requirements of the scheme.
- The assessment of installation quality conducted for this evaluation found that the protections, inspections, and auditing processes were overall sufficient to prevent significant problems with the quality of installations and criminal activity, though the qualitative research for the evaluation did identify a few instances of these still occurring.

However, the following assumptions were **not valid** due to the way that the scheme materialised:

- The scheme did not achieve the levels of demand for which there was budget available. This was, in part, because it was not possible to get the scheme administrator platform up and running in an effective manner to the timescales set. Some installers were also deterred from participating in the scheme due to the requirements to register with TrustMark and gain specific certifications. The first round of the Skills Training Competition.[33] which was set up to support the scheme (and which was funded through it) also faced some issues with delivery due to COVID-19.
- Findings from the process evaluation indicate that applicants found it challenging to identify suitably certified or TrustMark registered installers and that this sometimes hindered them applying for measures. This suggests that, overall, the supply chain did not meet the demand of the scheme.

[33] Evaluation of the Green Homes Grant Skills Training Competition. Winning Moves, 2022. https://www.midlandsnetzerohub.co.uk/wp-content/uploads/2022/06/GHG-Skills-Competition-Evaluation-report-FINAL-003.pdf

- In relation to the assumption that the supply chain would not face a loss of investment due to participating in the scheme, initial findings from the process evaluation of the GHGVS indicated that installers faced a loss of investment due to the scheme. However, the subsequent outcome evaluation indicated that any negative impacts generated by the scheme in its initial stages were largely rectified once the efficiency of scheme delivery improved and installations increased. The process evaluation found that messages from BEIS related to the scheme and in relation to future policy were insufficiently clear, and that the short duration of the scheme undermined the supply chain's trust in Government to support the sector towards accelerated decarbonisation of the UK's homes.
- In relation to the assumption that installations would be completed in enough time for vouchers to be redeemed, some were not completed in time for this to happen, though this was not found to be significant in scale.

This evaluation has not assessed whether training in the supply chain was delivered in line with industry standards, as this falls outside of the scope of this evaluation. Additionally, the evaluation did not explore whether any regional differences in supply chain were minimised.

BEIS, with inputs from the Scheme Administrator, estimated the range of residual fraud of the scheme as being within the originally agreed tolerance of 2% of spend. Although some instances of fraud or wrongdoing occurred, as emerged from qualitative research with applicants conducted as part of the GHGVS process evaluation, their measurement aligned with the departmental fraud tolerance level of 'low/very low'. However, it was not within the scope of this evaluation to fully validate this.

5 Effects of the scheme on fuel poverty

One of the aims of GHGVS was to reach people, particularly those who are fuel poor, who may be struggling to afford to adequately heat their homes – either because they have low incomes, energy inefficient homes, or a combination of the two. This chapter examines the extent to which GHGVS reached those likely to be in fuel poverty and the number of households who were taken out of fuel poverty as a direct result of the scheme improvements. It therefore provides an initial response to the evaluation question:

- How effectively has the scheme engaged low-income households, including those at risk of fuel poverty?

The findings in this chapter are based upon an analysis of a modelling of participating households' fuel poverty status, conducted by BRE. BRE developed a fuel poverty proxy methodology in which scheme, Trustmark, EPC, and survey data were used to model the energy efficiency of the dwellings and identify which have low energy efficiency. Applicant survey data were used to identify low-income households. The combination of these enabled the identification of households defined as fuel poor under the current definition of fuel poverty (Low Income, Low Energy Efficiency (LILEE) metric) both prior to, and after, the measures were installed through the scheme.

This analysis did not involve a post-installation assessment of income. To isolate the effects of the GHG installation measures, other factors which influence a household's fuel poverty status such as changes in household composition, household income, fuel prices and any other changes to the dwelling were held constant for the purpose of the analysis. A full report on the fuel poverty modelling work, with detailed explanation of its methodology and limitations, is available in Annex 5. Data on specific building metrics that would help determine fuel poverty status (including pre- and post- EPC ratings and household income data) was not collected through the scheme, meaning it was not possible to assess actual information on how many homes were in fuel poverty at the time of their application to the scheme and after it.

5.1 How the scheme intended to address fuel poverty

A key aim of GHGVS was to support fuel poor households and lift them out of fuel poverty. This was to support wider Government policy on reducing fuel poverty across the United Kingdom.

In 2020, 13.2% of households (3.16 million) in England were estimated to be in fuel poverty.[34] A household is defined as being in fuel poverty if:

- They are living in a property with an energy efficiency rating of band D or below, and
- When they spend the required amount to heat their home, they are left with a residual income below the poverty line.[35]

This is referred to as the Low-Income Low Energy Efficiency (LILEE) definition. The three critical factors that impact fuel poverty are: household income, household energy requirements

[34] Annual Fuel Poverty Statistics in England, BEIS, 2022 (2020 data), This is the latest date for which statistics are available.

[35] Fuel poverty statistics. DESNZ and BEIS, 2023. https://www.gov.uk/government/collections/fuel-poverty-statistics

and the price of energy. GHGVS aimed to address two of these factors. First, GHGVS provided a higher amount of subsidy for households eligible to access GHGVS through the low-income scheme (up to £10,000 compared to the £5,000 available for main scheme applicants). This reduced the financial barriers of installation for low-income households. Second, by helping households to improve their home's energy efficiency (through the GHGVS measures), there was an expectation that the households' energy requirements would be lower post-installation.

The low-income scheme was not exclusively targeted at fuel poor households. The funding was open to homes that may already have an energy efficiency of band C or above, and the main scheme was open to all, regardless of household income.

5.2 Evidence of impacts on fuel poverty

5.2.1 The extent to which GHGVS reached those likely to be in fuel poverty

The modelling carried out by this evaluation concluded that, where a fuel poverty assessment could be made, an estimated 57% of applicant households were likely to have been in fuel poverty prior to installation. Of those applying under the low-income scheme, 73% were estimated to likely be in fuel poverty, compared to 34% of those applying under the main scheme. The modelling also found that 85% of the homes in which GHGVS installations took place were low energy efficiency (band D or below). Where homes have a low energy efficiency, this places them at risk of becoming fuel poor should there be an unanticipated rise in energy prices or a drop in their income. These findings therefore suggest that the scheme was successful at attracting those more likely to be fuel poor by attracting those living in the least efficient homes.

Analysis of scheme data from 2nd August 2022 indicates that the majority (60%) of installations completed under GHGVS were for the low-income scheme, totalling 25,888 low-income households reached. This suggests that the scheme succeeded in attracting those households where their income status may put them at a greater risk of being fuel poor.[36]

Just over a fifth (22%) of households responding to the applicant survey reported belonging to the lowest household income band of below £15,999. This further supports the finding that the scheme was accessed by a significant number of lower income households.

5.2.2 Changes in fuel poverty status of those participating in the scheme

Following GHGVS installations, the modelling suggests that 14% of fuel poor households were lifted out of fuel poverty because of the installed measures. This means that 86% of treated households estimated to be fuel poor are likely to have remained in fuel poverty after installation works were complete. This assessment was based on modelled estimates of the relative effects that different measures would have on a home's energy efficiency.

[36] However, as noted in the GHGVS process evaluation, the low-income scheme did not assess household income but used receipt of specific benefits as a proxy. This included disability benefits which are not necessarily means tested, meaning that some people accessing GHGVS via the low-income scheme may not have necessarily had a low income.

Determining a change in fuel poverty status

For this evaluation, the key determinant of a change in fuel poverty status was whether the GHGVS measure installed was likely to have moved a property's energy efficiency rating ('EPC') above band D (i.e., band C or above) or not.[37] The evaluation did not assess any changes in income status. Energy efficiency of buildings in the UK is calculated using Standard Assessment Procedure (SAP) scores which run on a scale from 1-100 points. Scores are banded A-G where 100 (Band A) is the most energy efficient. In the context of fuel poverty, the top of band D corresponds to an SAP score of 68, meaning that a low-income household living in a house below that score could be defined as fuel poor.

The modelling work showed that installations typically brought about an average SAP score improvement of just 4.5 points. For context, the range of 'band D', the band nearest the fuel poverty threshold, is 13 points and the most effective single measure modelled (wall insulation) would bring about an average improvement of 9.6 points.

Taken together, these findings suggest that for homes with the poorest energy efficiency (EPC bands E-G), multiple energy improvement measures may be required to raise the energy efficiency to an EPC band C or above, as a single measure is unlikely to be sufficient. For low-income households living in E-G dwellings, this means that multiple installation measures are likely to be required to take them out of fuel poverty.

5.2.3 The effects of the rise in energy prices on fuel poverty

Since 2021, average domestic energy bills have increased 74%, from £1,333 per year to £2,316.[38] As a rise in prices will increase the required spend to heat UK households, the number of people in fuel poverty is also likely to increase. The income threshold used in the current LILEE fuel poverty definition is based on the household income after housing costs and fuel costs. Given the modest improvements in energy performance detailed above, it could be expected that some households that participated in the scheme may find themselves deeper in fuel poverty or, indeed, in fuel poverty now when they were not before. While the long-term outlook on energy prices is unclear, and the quantifiable impact on fuel poverty is not yet known, this situation does highlight that even where measures installed under GHGVS have improved energy efficiency of the home, it is unlikely to have provided significant protection to its participants from the effects of the energy crisis on their fuel poverty status.

5.3 Exploring contribution

This evaluation has found that fewer homes were likely to have been lifted out of fuel poverty post-installation than initially anticipated. This is not surprising given that the scheme fuel poverty impacts were modelled on the volume of measures that the funding available could have installed. The most significant explanatory factor behind this is likely to be that the majority (79%) of modelled fuel poor households that proceeded to installation only installed a

[37] EPC band was used as a proxy for FPEER rating as information regarding income-related benefits such as the Warm Home Discount was not available. See Technical Annex A.5.1 for more details.

[38] Quarterly Energy Prices - Statistical Release 22 December 22. BEIS, 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1126144/quarterly-energy-prices-december-2022.pdf

single measure. On average, a home's energy rating increased by just 4.5 points as a result of the GHGVS installation. As band D spans 13 SAP points, this highlights that for any property below band D (i.e., bands E-G), the single-measure installations that were most prevalent under GHGVS were highly unlikely to lift a property out of fuel poverty. Indeed, only 7 out of the 909 properties (< 1%) that were modelled as bands E-G, were subsequently modelled as band C or above following installation. By comparison, 280 homes were lifted from band D to band C. The total 287 homes lifted out of bands D-G represent 12% of all homes (regardless of income).

Table 5.1: Modelled energy efficiency ratings before and after installations for households

Numbers of households in each energy band	EPC band B after	EPC band C after	EPC band D after	EPC band E after	EPC band F after	EPC band G after	Total
EPC band B before improvement	16						16
EPC band C before	7	338					345
EPC band D before		280	927				1,207
EPC band E before		7	344	319			670
EP band F before			11	56	115		182
EPC band G before				2	21	34	57
TOTAL	23	625	1,282	377	136	34	2,477

Base: 2477. Note: the figures in the table concern all survey respondents for whom it was possible to model EPC ratings. This includes both those likely to be in fuel poverty (e.g., due to income status) and those unlikely to be in fuel poverty

This suggests that the contribution of the scheme to addressing fuel poverty was likely to have been lower than its original ambition of lifting half the fuel poor households out of fuel poverty, which was modelled on the package of measures that the funding available could have installed. This was largely due to the typically small improvements brought about by single-measure installations. The challenging nature of the administration process, the difficulties faced by applicants in finding installers, and the rejection of applications that did not pass some of the checks are all factors likely to have caused households that applied for multiple measures to proceed with the installation of single measures instead. Based on the final number of households that received installations under GHGVS (43,168) and the modelled estimate of 57% of households being fuel poor, it could be estimated that the scheme carried out installations in 24,606 fuel poor households.[39] Based on the estimate that 14% of installations in fuel poor households resulted in a change in fuel poverty status, this would suggest around 3,445 households were lifted out of fuel poverty. This number would likely

[39] It should be noted, however, that the distribution of households for whom an assessment could be made was not representative of the full applicant sample, so these contribution figures should be seen as notional, rather than representative.

have been higher if the administration of vouchers had been smoother and more certified installers had been available to provide quotes/install measures, so that more low-income households could have installed more than one measure.

5.4 Summary and conclusions

Despite the limitations to the modelling method (as compared to conducting actual before-and-after-assessments of home energy efficiency ratings), there is strong evidence that GHGVS succeeded in its aims to reach fuel poor households. The higher number of applicants to the low-income scheme over the main scheme route shows that GHGVS was well accessed by the former group.

However, based on modelling conducted for this evaluation, the achieved impacts on fuel poverty appear to be relatively small. The analysis estimates that just 14% of homes likely to be fuel poor (~3,445 households) were lifted out of fuel poverty as a direct result of the measure(s) installed under the scheme.

As installations were mainly single measures, they did not bring about sufficient improvement in the energy performance of the homes to raise most fuel poor households out of fuel poverty. Indeed, the fuel poverty modelling conducted for the evaluation found only a small proportion (12%) of energy inefficient homes (including households likely and unlikely to be in fuel poverty when taking income into account) were raised above ‘band D’ as a direct result of the scheme.

It can therefore be concluded from this that for GHGVS to have made a bigger impact on fuel poverty it would have needed to support multiple measures that would have resulted in greater energy efficiency improvements. In turn, this would have been likely to lift more households out of fuel poverty and further up their performance ratings.

6 Effects of the scheme on energy savings, energy bills and carbon emissions

6.1 How the scheme intended to generate energy and carbon-saving benefits

The UK has some of the oldest and least energy efficient housing in Europe. Furthermore, it is estimated that 17% of the UK's greenhouse gas emissions come from heating homes.[40] Reducing these emissions is therefore a key priority for tackling climate change. GHGVS aimed to reduce emissions in two direct ways:

- by improving the energy performance of homes (primarily through energy efficiency measures) to reduce the amount of energy needed to keep homes warm, and
- by decarbonising heat in homes by supporting the installation of low-carbon heating technologies.

In addition to the direct impacts, the scheme aimed to develop the market and supply chains for domestic energy efficiency and low-carbon heating to support the mass roll out of low-carbon heating in the 2020s and the wider aims to decarbonise homes as part of the UK's net zero transition. These market impacts are explored in more detail in Chapter 9.

In delivering the energy and carbon savings detailed above, the scheme also intended to reduce energy bills for consumers. Specifically, as a COVID-19 stimulus scheme, it was hoped that reducing energy bills for consumers might raise households' disposable income, allowing them to increase their spending elsewhere in the economy.

6.2 Evidence of changes in energy consumption, household energy bills and carbon emissions from homes

The previous chapter explored how the scheme impacted the energy performance of homes (as this relates to fuel poverty). While the energy performance of a home is typically linked to its consumption, there is a wealth of evidence showing that actual, realised energy savings following retrofit works are often lower than modelled.[41] Reasons for this can vary from consumer behaviour – where households don't use their measures as expected or increase their levels of comfort thus reducing their realised energy savings – to measures being inadequately installed meaning that they underperform. Therefore, to assess the scheme's impacts on energy savings, energy bills and carbon emissions, this evaluation gathered evidence of actual energy consumption (through smart meters) before and after installation, and triangulated this with evidence from the applicant research.

[40] BEIS (2021) 'Heat and Buildings Strategy'. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1036227/E02666137_CP_388_Heat_and_Buildings_Elay.pdf

[41] Rajabi (2022) 'Dilemmas of energy efficiency: A systematic review of the rebound effect and attempts to curb energy consumption'. https://doi.org/10.1016/j.erss.2022.102661

6.2.1 Energy savings resulting from GHGVS measures

The primary source of evidence for this strand was an analysis of smart meter data from 2,428 GHGVS households, pre- and post-installation. This represented 6% of all participant households and 6% of all measures installed. This was an opportunity sample based on positive responses to an invitation sent out to all applicants initially invited to participate in the applicant survey for the evaluation, who had consented to recontact and met the criteria of the research (including having a registered smart meter installed at least 90 days before the installation). The sample comprised 54% main scheme applicants and 46% low-income scheme applicants. To determine contribution of GHGVS, the treatment group was compared to an equivalent control group of households, for whom smart data was taken from the Smart Energy Research Lab (SERL) Observatory.[42] Machine learning regression was used to isolate the effects on a measure-by-measure basis, allowing for an estimated average energy saving to be calculated for each measure. Note that the analysis does not systematically account for the potential effects of post-Covid changes in occupancy patterns, energy use, and base-levels of home warmth due to increased home occupancy during and immediately post-lockdown. This could magnify or attenuate observed effects (though it should not result in directional bias). For more details on the methodology used in this analysis see Annex 4.

The results of this analysis showed that only some of the measures installed through GHGVS had an observable effect on energy savings, and only in households that had gas central heating prior to installation. Installations in homes previously heated by other heating technologies (e.g. electric heating) did not produce an observable effect. For this analysis, effects were identified when statistical significance at the 10% level, meaning that there is at least a 90% likelihood that an effect can be attributed to the installation of a measure. The lack of a significant result does not necessarily mean that the measures were not effective, just that there is insufficient evidence to be confident (at the 10% level) of an effect and may be due to the fact that an insufficient number of households installed the measure for the effects to be observable. This is likely to be the case for previously electrically heated homes, as the evaluation had access to a comparatively smaller sample size than the sample for homes previously heated by gas.

Insulation measures

The analysis showed that, on average, for gas centrally heated homes, insulation measures correlated with a reduction of 2.7 kWh/day for gas, representing an 8.4% reduction in gas consumption. Average reductions for individual insulation measures installed in gas-heated homes, where a statistically significant effect was observed, are presented below:

- External solid wall insulation – 3.3 kWh/day (9.9% reduction)
- Cavity wall insulation – 1.9 kWh/day (5.8% reduction)
- Loft insulation – 1.4 kWh/day (4.2% reduction)
- Pitched roof insulation – 1.3 kWh/day (4.7% reduction)

No other individual insulation measures had an observable effect on electricity or gas use over the evaluation period for gas centrally heated homes. Either the effects on energy use were too

[42] SERL is an ongoing UKRI-funded research project, with one of its aims being to collect smart meter and linked contextual data from over 13,000 participants, who have consented for their data to be used for research into the public good that has been approved for access to the data via SERL’s governance procedures.

small to be detected or there were too few homes in the treatment group for the study to be able to detect the effects of these measures using this approach.

The findings differ slightly from modelled estimates of the effects of different measures on gas energy consumption from the National Energy Efficiency Data-Framework (NEED).[43] According to NEED modelling, loft insulation generates a 2.6% reduction in gas usage, cavity wall insulation a 8.1% reduction, solid wall insulation a 17% reduction, and solar PV a 10% reduction.

There were no observable changes in energy consumption pre and post insulation measures within electrically heated homes, nor pre and post insulation when comparing buildings of different ages or located in different regions. This, again, means that any effects of GHGVS home improvements on energy consumption that may have been present were too small to be detected in this study given the number of homes in each of these categories.[44]

Low Carbon Heating

At the individual measure level, air source heat pumps[45] installed in homes previously heated by gas central heating correlated with a reduction in gas consumption of 26.8 kWh/day (95% saving) and an increase in electricity consumption of 6.2 kWh/day (46.3% increase). This resulted in a net energy saving of 20.6 kWh/day. While a 100% reduction in gas consumption wouldn't be expected (as applicants may still use gas appliances such as cookers and gas fireplaces), a higher reduction than 95% may be expected. Reasons for this finding are unclear but may include data quality issues.[46] For more detail, please refer to the technical annex.

No statistically significant effect was observed from other low-carbon heating measures. However, this cannot be due to low sample numbers in the case of solar thermal, as this measure represents the largest number of low-carbon heating installations in the sample (397, compared to 290 air source heat pumps[47]). This may suggest that the energy savings from solar thermal installations were too small to detect within the scope of this sample. This may also be an expected result, as solar thermal is a hot water technology rather than a space heating technology, and the typical domestic energy consumption associated with water heating is much lower than space heating.[48]

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[43] The modelling uses data collected for DESNZ sub-national energy consumption statistics reporting; information on energy efficiency measures installed in homes from the Homes Energy Efficiency Database (HEED), Green Deal, the Energy Company Obligation (ECO) and the Feed-in Tariff scheme; and data about property attributes and household characteristics obtained from a range of sources. Available here: https://www.gov.uk/government/collections/national-energy-efficiency-data-need-framework#accessing-need-data

[44] Amongst GHGVS applicants who had measures installed and who consented to share their SM data with UCL for the evaluation ('treatment group'), there were ~50 individuals or fewer who had had flat roof insulation, internal solid wall insulation, park home insulation, room-in-roof insulation, solid floor insulation, biomass boilers, ground source heat pumps, hybrid heat pumps, double/triple glazing, draught proofing, energy efficient replacement doors, and secondary glazing. For these measures statistically significant findings would not have been possible due to the sample size being too low.

[45] Base size – 290 installations in the sample (representing 10% of all installations in the sample).

[46] Energy savings for the air source heat pumps were recalculated to account for anomalies in the data. Full details can be found in Annex 4.

[47] Note that these are the numbers of measures in the smart meter analysis sample. Across the full GHGVS, there were 7,413 solar thermal and 3,924 air source heat pump installations.

[48] We do not present group-level effects for low-carbon heat, as these do not have a meaningful interpretation given the two disparate measure types comprising the group, namely solar thermal and heat pumps.

6.2.2 Carbon savings resulting from GHGVS measures

The above analysis formed the basis for estimating carbon savings by applying emission factors to the gas and electricity savings detailed previously. For the measures that produced statistically significant effects, the average annual carbon savings are detailed below in Table 6.1.

Table 6.1: Average carbon savings by fuel and individual measure installed in gas centrally heated homes

Measure type	Gas carbon savings (tCO_2e/year)	Electricity carbon savings (tCO_2e/year)	Total carbon savings (tCO_2e/year)[49]
Air Source Heat Pump	1.8	-0.6	1.2
External Solid Wall Insulation	0.2	No effects observed	0.2
Cavity wall insulation	0.1	No effects observed	0.1
Loft insulation	0.1	No effects observed	0.1
Pitched roof insulation	0.1	No effects observed	0.1

As shown in Table 6.1, the variation in carbon savings that can be attributed to individual measures installed in gas centrally heated homes varied from -0.1-1.8 tCO_2e/year. Air source heat pumps were typically responsible for the highest reductions, resulting in net savings (offsetting gas related savings against electricity related gains) of 1.2 tCO_2e/year.

Applying these savings at a scheme level can provide a sense of scale of carbon reductions associated with measures as follows:

- Air source heat pumps: 3,924 installations x 1.2 = 4,709 tCO_2e/year
- External solid wall insulation: 9,562 installations x 0.2 = 1,912 tCO_2e/year
- Cavity wall insulation: 4,435 installations x 0.1 = 444 tCO_2e/year
- Loft insulation: 7,757 installations x 0.1 = 776 tCO_2e/year
- Pitched roof insulation: 6,222 installations x 0.1 = 622 tCO_2e/year

These figures should only be viewed to give a notional sense of scale, as the impact of measures will vary significantly dependent on a wide range of factors, including whether the measure was installed individually or alongside other measures, typical scale of installation and physical characteristics of applicants' homes.

6.2.3 Energy bill savings resulting from GHGVS measures

Similarly to carbon savings, bill savings were calculated by applying inflation adjusted retail energy prices (electricity and gas) to the energy savings calculated above.[50] The impact on

[49] Note that for hybrid heat pumps and external wall insulation there is only one statistically significant figure available for one fuel type. Therefore the total carbon savings for these measures may be higher or lower than this, were we able to include figures for both fuel types.

[50] The calculations use 2022 scenario B domestic retail gas price (7.36 in 2021 p/kWh) and 2022 central domestic retail electricity price (30.73 in 2021 p/kWh). The data can be accessed from https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

energy bills for each measure that generated a statistically significant effect is detailed below in Table 6.2.

Table 6.2: Average energy bill savings by fuel and individual measure installed in gas centrally heated homes

Measure type	Gas bill savings (£/year)	Electricity bill savings (£/year)	Total bill savings (£/year)
Air Source Heat Pump	721	-692	29
External Solid Wall Insulation	88	No effects observed	88
Cavity wall insulation	51	No effects observed	51
Loft insulation	38	No effects observed	38
Pitched roof insulation	36	No effects observed	36

As can be seen in Table 6.2, based on 2021 energy prices, individual measures produced savings on annual energy bills ranging from £29 to £88. A key figure in this analysis is the saving associated with installing an air source heat pump. Whereas air source heat pumps produced the largest energy and carbon reductions in the analysis, they led to the smallest bill savings. This is ultimately due to the unit price-per-kWh disparity between gas and electricity, with electricity unit prices being over four times the unit price for gas.

Energy bill savings were also explored with participants of the applicant survey.[51] When asked about energy bills post installation, 36% of respondents to the wave 2 survey said their energy bills were lower and 36% said their bills were higher, with 17% saying their bills were the same as before. The energy consumption analysis found that energy bill savings were more common amongst respondents with an insulation measure installed. This finding is matched in the survey findings, with nearly half (49%) of all survey participants with insulation installed reporting perceived bill savings compared to 26% of survey participants who had a low-carbon heating measure installed.

6.3 Occupant comfort and the potential impacts on energy consumption

As previously noted in this chapter, actual energy consumption and expected consumption of energy (either from models or performance rating improvements) are rarely in line with one another following retrofit works. Occupant behaviour is often cited as the primary factor explaining why energy savings (and then bill and carbon savings) are lower than expected.

[51] It is important to note that the timing of the applicant survey predated the high energy bills and levels of concern around energy security experienced at the time of writing this report in 2023. Therefore, while energy unit prices may have reportedly increased for applicants over the installation period, their responses are not affected by the major energy price raises experienced since the spring of 2022.

Two complementary ideas are sometimes offered to explain this - the 'rebound' and 'prebound' effects.[52] The rebound effect, in the context of retrofit, describes a situation where occupants increase their consumption of energy (typically through heating), offsetting some of their expected energy savings, potentially to enhance their comfort. This is also referred to as 'comfort taking'. The prebound effect describes a situation where an occupant was previously underheating their home, using less energy than expected, but is subsequently able to afford to heat their home to a more comfortable temperature following completion of retrofit works. In the case of the prebound effect, this is typically more common in more inefficient homes and/or where occupants are fuel poor. In both cases, however, bill savings are lower while occupants experience higher levels of thermal comfort.

The applicant surveys covered multiple questions that explored occupant comfort, and comfort taking behaviour, and how this may relate to bill savings. First, when asked about motivations for applying for the scheme, wave 1 survey participants gave bill savings (86%) and a warmer or more comfortable home (70%) as the top two answers, highlighting that these two outcomes were widely important across applicants.

Applicants were asked in the wave 2 survey about whether it had become easier to heat their home to a comfortable temperature following the installations. A total of 68% reported that this was the case. Further, 77% of those with an insulation measure installed reported that it was easier, whereas only 47% of those with low-carbon heating measures reported the same.

Similarly, 68% of respondents reported that their property had become more comfortable since installation works had been completed. Significantly more participants reported that wall insulation had improved their comfort levels and significantly fewer participants reported that heat pumps, solar thermal and secondary measures had improved comfort (see Table 6.3 overleaf).

[52] Galvin and Sunikka-Blank (2016) 'Quantification of (p)rebound effects in retrofit policies – why does it matter?'. https://doi.org/10.1016/j.energy.2015.12.034

Table 6.3: Reported levels of comfort compared to the same time last year[53]

	Wall insulation	Roof and floor insulation	Low carbon–heating - heat pumps	Low carbon–heating - solar thermal	Draught proofing, glazing and replacement doors	Secondary measures
No difference	13% (54)	23% (115)	27% (45)	**50% (109)**	31% (57)	32% (82)
More comfortable	**82% (331)**	72% (361)	**55% (93)**	**39% (85)**	60% (109)	**59% (153)**
Less comfortable	1% (4)	1% (5)	16% (28)	2% (5)	3% (6)	3% (7)
Don't know	3% (13)	4% (21)	2% (4)	8% (18)	5% (9)	6% (15)
Total	100% (402)	100% (502)	100% (171)	100% (217)	100% (181)	100% (257)

Base: 1,206. Responses to the question: D4. And still compared with the same time last year, since [MEASURES] [IF ONE MEASURE: was / IF TWO OR MORE MEASURES: were] installed, how comfortable has the property generally been? Measures reported on are those that received 100 or more installation across the survey sample.

Reported comfort improvements were higher for insulation measures than low-carbon heating measures. Similarly, a higher proportion of survey participants installing insulation reported that their homes got warmer post-installation than the proportion of survey participants reporting this post the installation of low-carbon heating, as detailed in Table 6.4 overleaf.[54]

[53] Survey responses have been presented for completeness. They do not always demonstrate a statistically significant difference. For ease, statistically significant differences between the measure-specific response and the average response are highlighted in bold font in Table 6,3.

[54] Survey responses have been presented for completeness. They do not always demonstrate a statistically significant difference. For ease, statistically significant differences between the measure-specific response and the average response are highlighted in bold font in Table 6,4.

Table 6.4: Perceived change in temperature in their home following installation, by type of measure

	Heating controls & hot water tank insulation	Wall insulation	Roof and floor insulation	Park home insulation	Low-carbon heating – heat pumps	Low-carbon heating – biomass boilers and solar thermal	Draught proofing, glazing and replacement doors	Secondary Measures	Average response regarding the perceived change[55]
Don't know	9 (8%)	**12 (3%)**	18 (4%)	1 (8%)	4 (2%)	**23 (10%)**	7 (4%)	16 (6%)	5%
Colder	2 (2%)	**7 (2%)**	7 (1%)	0 (0%)	**45 (26%)**	4 (2%)	3 (2%)	5 (2%)	2%
About the same	**57 (53%)**	**55 (14%)**	**126 (25%)**	2 (21%)	52 (30%)	**129 (60%)**	59 (32%)	92 (36%	31%
Warmer	**39 (37%)**	**328 (82%)**	**352 (70%)**	7 (71%)	**70 (41%)**	**62 (28%)**	113 (62%)	144 (56%)	59%
Total	107 (100%)	402 (100%)	503 (100%)	10 (100%)	171 (100%)	218 (100%)	182 (100%)	257 (100%)	

Base: 1206, covering all occupiers who have had installation(s) completed through GHGVS: Responses to question D2. And still comparing back to the same time last year, since [MEASURES] [IF ONE MEASURE: was / IF TWO OR MORE MEASURES: were] installed, how much warmer or colder has the property generally been?

[55] Average is the median response per option of the percentages for each measure type presented in the table.

A key finding of note here is that while 41% of wave 2 survey respondents who had installed a heat pump reported that their home was warmer than last year, 26% reported that it was colder. This appears to align with 16% of the same group who reported that their home was less comfortable following installation.

These findings suggest that occupants, on the whole, had experienced increases in their thermal comfort following their GHGVS installations, finding it easier to heat their homes to a comfortable temperature. As previously noted, an increase in comfort can be linked to the rebound and prebound effects, indicating that occupants may be achieving lower energy and bill savings than might be expected due to taking greater improvements to comfort.

A more detailed exploration of how the installation of GHGVS measures brought about other benefits for occupants, including health, is covered in Chapter 7.

6.4 Exploring contribution

The findings in this chapter point to a varied contribution of the GHGVS to energy, carbon and bill savings dependent on the measure installed. Air source heat pumps and insulation measures generated clear savings in energy, with associated reductions in carbon emissions and consumer energy bills. When considering consumer comfort, insulation reportedly had a more consistently positive effect on warmth and comfort than heat pumps.

Reports that most applicants felt their home was warmer following the installation works are indicative of potential rebound and prebound effects (‘comfort taking’) that may be associated with lower energy savings than expected. In this way, some of the potential energy savings that might have been generated through GHGVS might have been diminished by how the scheme enabled consumers to enjoy the benefits of warmer homes (by e.g., improving their comfort and well-being).

Although it was possible to apply for multiple measures under the scheme, most applicants applied for a single measure. As a result, the scheme did not bring about significant savings (also discussed in the previous chapter regarding fuel poverty impacts). This is highlighted by the fact that only a limited number of measures generated statistically significant energy savings. While a multiple measure approach would have likely brought about larger savings, the measure-level savings outlined in this report would not stack one-by-one, as there is a diminishing absolute contribution of measures to energy and carbon savings as more measures are added.

The carbon impact of heat pumps installed under GHGVS reported in this chapter is based on current emission factors associated with UK electricity generation, but it is important to note that these impacts will change in future as the carbon intensity of electricity changes. As the UK electricity grid progresses towards the goal of decarbonisation by 2035, the carbon impacts will improve. This evaluation’s analysis indicates that the carbon impact of installing an air source heat pump based on gas consumption reduction is 1.8 tCO_2e/year, offset by 0.6 tCO_2e/year due to carbon emitted by electricity consumed in operation. This suggests that the carbon impacts of installed heat pumps under the scheme could grow from 1.2 to 1.8 tCO_2e/year by the time the grid is decarbonised.

In terms of energy costs, since the completion of data collection for this evaluation (in August 2022), energy prices have more than doubled as a result of the global energy crisis. At the time of writing, it is difficult to know what the long-term costs of energy are likely to be and whether unit costs of gas and electricity will return to levels similar those observed at the time of the scheme.

Prior to the energy crisis, average annual energy bills were £1,335.[56] At the time of writing, the Energy Price Guarantee is in place to limit annual bills to £3,000 per year, representing a £1,665 increase in average energy bills. By comparison, this chapter has shown that annual energy bill savings achieved by installing measures under GHGVS are much lower (£29 for air source heat pumps and £36-88 for insulation). Whilst it can be argued that participation in the scheme will have led to smaller rises in bills for applicants than might have otherwise been the case, it does suggest that the impact of the scheme has been lower than the impact of the energy crisis on applicants in terms of their energy bills.

6.5 Summary and conclusions

This chapter has highlighted that GHGVS has had some positive impact on energy savings, carbon savings and bill savings. However, these impacts have been highly dependent on the measures taken up by participants. The smart meter data analysis conducted for the evaluation was unable to find statistically significant effects from most categories of GHGVS approved measures. However, in some cases this is due to the small numbers of installations of these measures in the sample, rather than a non-existent or small observed effect.

The measures that brought about statistically significant changes in households (previously) heated centrally with gas were air source heat pumps, external solid wall insulation, cavity wall insulation, loft insulation and pitched roof insulation. Each of these measures generated savings in energy, carbon emissions and energy bills, although bill savings for air source heat pumps were comparatively lower than the energy and carbon savings due to the higher unit cost of electricity over gas.

A review of applicant survey data revealed that most applicants found their homes to be warmer and more comfortable following installations. Given past studies that suggest that comfort taking may be a major factor in ‘rebound’ and ‘prebound’ effects, that explain lower post-retrofit energy savings, there is evidence for the possibility that energy, carbon and bill savings may be lower than they otherwise would have been due to applicants taking the opportunity to improve their comfort rather than realise savings.

[56] UK Parliament (2023) "Research briefing: domestic energy prices, 13th March 2023”. https://commonslibrary.parliament.uk/research-briefings/cbp-9491/

7 Effects of the GHGVS measures on health

As described in Chapters 4, 5 and 6, GHGVS was intended to benefit households by making their homes warmer and cutting their energy bills, with this leading to carbon emissions reductions, energy saving and health benefits in the long term. This chapter sets out the extent to which GHGVS contributed to improving the health of those who installed measures through the scheme. In this way, the chapter outlines the evaluation's findings against this question:

- How effectively have the GHG schemes improved the health and well-being of households receiving installations?

The evidence has been gathered from analysis of two waves of a survey amongst applicants to the scheme, two waves of interviews with participating households, and a modelling of estimated health impacts based upon an analysis of the installations finally achieved through the scheme. For more information see Annex 3.

7.1 How the scheme intended to benefit households

Energy inefficient homes impose unnecessary energy costs on occupants and the wider economy and can lead to poor health outcomes, with a resulting resource pressure on health services.[57] Poor quality or inadequate insulation, especially when combined with heat pump technologies, can also lead to problems with condensation, mould, and poor air quality in the home.

Based on a review of evaluations on the influence of energy efficiency retrofits on the indoor environmental quality conditions, dampness and mould tends to decrease and thermal comfort, thermal discomfort, non-asthma respiratory symptoms, general health, and mental health nearly always improved after retrofits.[58] GHGVS was intended to benefit the health of households by: (1) helping households to make their homes warmer; (2) supporting quality of installation (to reduce the risk of condensation) (see Chapter 8); and (3) targeting fuel poor households who are often the most affected by these problems.

7.2 Evidence of changes in the health of occupants

7.2.1 Evidence of changes in problems in the home known to have negative effects on health

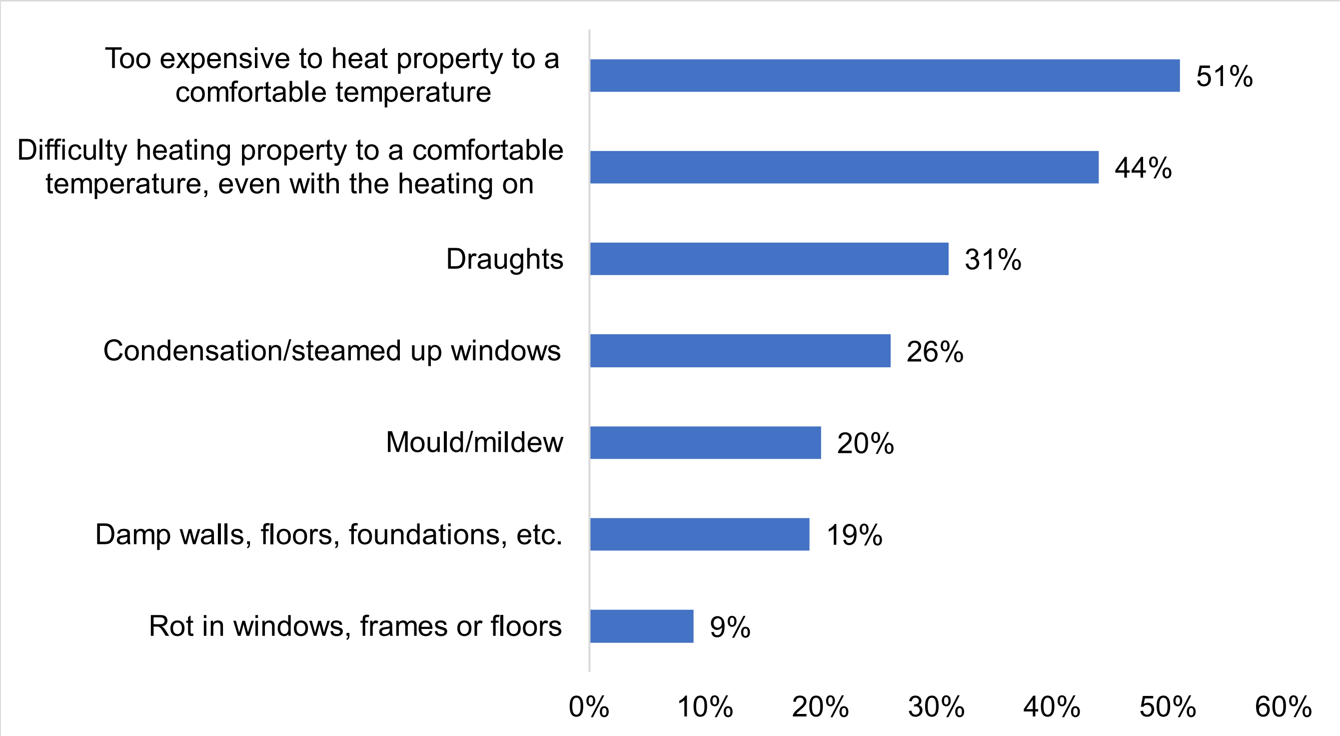
GHGVS applicants participating in the wave 1 survey for this evaluation indicated that households applying to the scheme were experiencing heating-related problems. Half (51%) reported that it was too expensive to heat their property to a comfortable temperature, with a

[57] Age UK estimate this to cost the NHS roughly £1.4bn per year (The Cost of Cold, Age UK, 2012) https://www.ageuk.org.uk/globalassets/age-uk/documents/campaigns/the-cost-of-cold/age-uk---the-cost-of-cold.pdf

[58] Fisk, Brett, Chan (2020). Association of residential energy efficiency retrofits with indoor environmental quality, comfort, and health: A review of empirical data. Building and Environment, 180. https://doi.org/10.1016/j.buildenv.2020.107067

slightly lower proportion (44%) reporting that it was difficult to heat their home to a comfortable temperature even with heating on. Just over a third (31%) reported draughts, a quarter (26%) reported condensation on windows, a fifth (20%) reported mould / mildew, and a fifth (20%) also reported damp walls / floors as problems present in the home prior to the scheme. A tenth (9%) reported rot in windows, frames, or floors. Figure 7.1 shows the proportion of respondents who reported problems with their property that might affect their health and/or comfort.

Figure 7.1: Prevalence of survey respondents with reported issues with the comfort and health of their property (pre GHGVS installation)



Base: 3,606. Responses to the question: C5. Before you applied for a Green Homes Grant Voucher, which, if any of the following problems were there in the property?

Post installation, GHGVS applicants who had received a completed installation under the scheme (1,206) were asked about how the property had changed since the installation. Figure 7.2 shows the responses.[59] It shows that, amongst those surveyed for this question, a large proportion (59%) considered that the measure(s) installed had positively affected their ability to heat the property to a comfortable temperature.

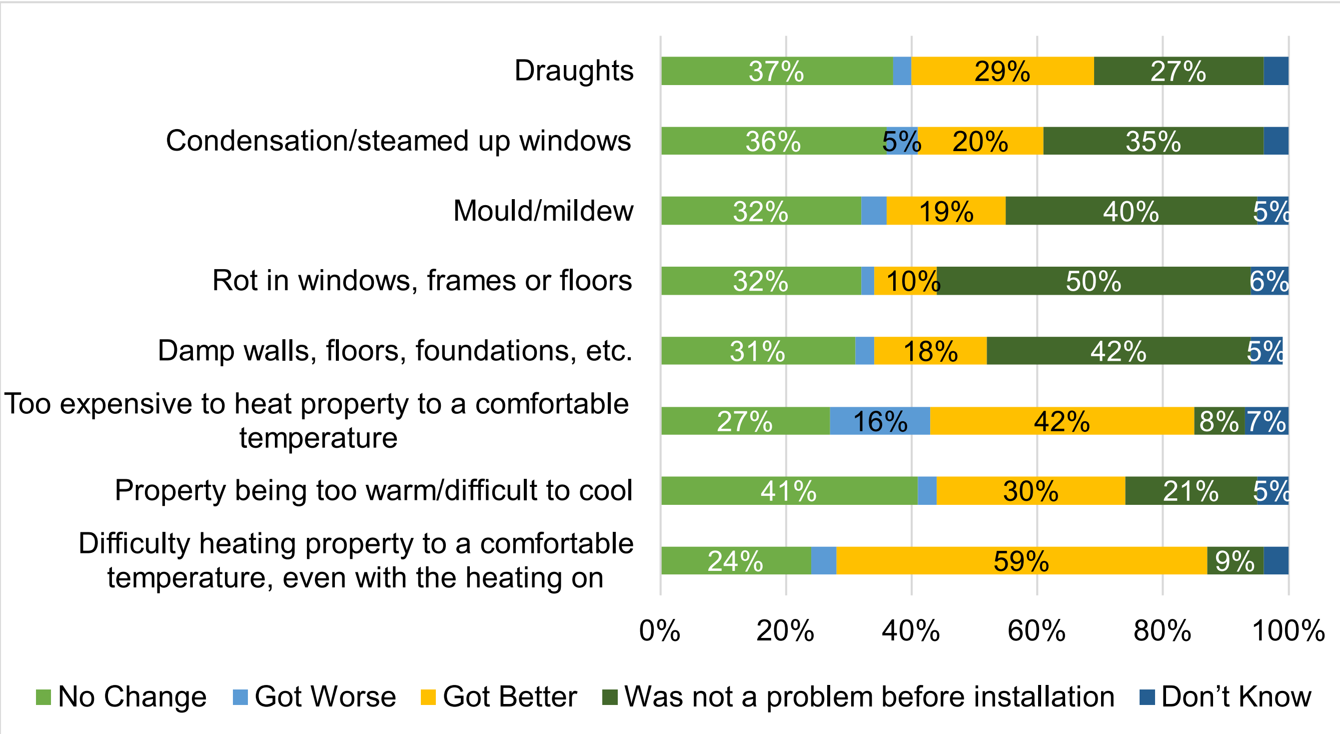
A high number of wave 2 survey respondents (1,118) had also found their property expensive to heat prior to installation, with 42% (507) stating that this improved post-installation, but 16% (193) finding that it got worse. A higher than average proportion of households reported that it had become more expensive to heat their home post-installation when they had installed air source heat pumps through the scheme (37%, 57).

Participants in the wave 2 survey indicated that they were experiencing several types of problems in their properties prior to having the GHGVS measure installed, with difficulties heating the property being the most common. As outlined in Figure 7.2, as well as being the main existing problem experienced by survey participants prior to the GHGVS installation,

[59] Question D5 was not linked to previous responses to the wave 1 survey, so wave 2 survey participants (who had had an installation) were asked about the issues listed whether they had referred to them in the wave 1 survey or not.

difficulties heating the home and the expense of heating the home were the two issues most likely to be reported as having improved in the wave 2 survey. According to these survey results, GHGVS measures had no observable effect on draughts, condensation, mould/mildew, wood rot, damp or overheating. Whilst there are some limitations of the survey results due to sample size for some measures and the self-reported nature of the data (as outlined in Chapter 2 and Annex 1), this lack of observable effect is also likely do to the fact that only some of the measures (e.g. doors and windows, certain types of insulation) could address these issues, whereas all of the measures had the potential to improve home temperature. These findings were supported by health modelling results which showed an overall change in indoor temperature due to fabric and heating system measures of between 0.1 - 0.3 ºC during wintertime conditions. However, drawing on existing research about the causal links between heat and mould risk, the evaluation also concludes, based on the health modelling, that this change in indoor temperature would lead to a related reduction in mould risk from warmer households.

Figure 7.2: Changes in problems with survey respondents' properties compared with the same time last year (post GHGVS installation)



Base: 1,206. Responses to the question: D5. Compared with the same time last year, since [MEASURES] [IF ONE MEASURE: was / IF TWO OR MORE MEASURES: were] installed, how, if at all, have the following problems changed in the property? Measures reported are those that received 100 of more installation across the survey sample. Percentages below 5% are not labelled in the chart.

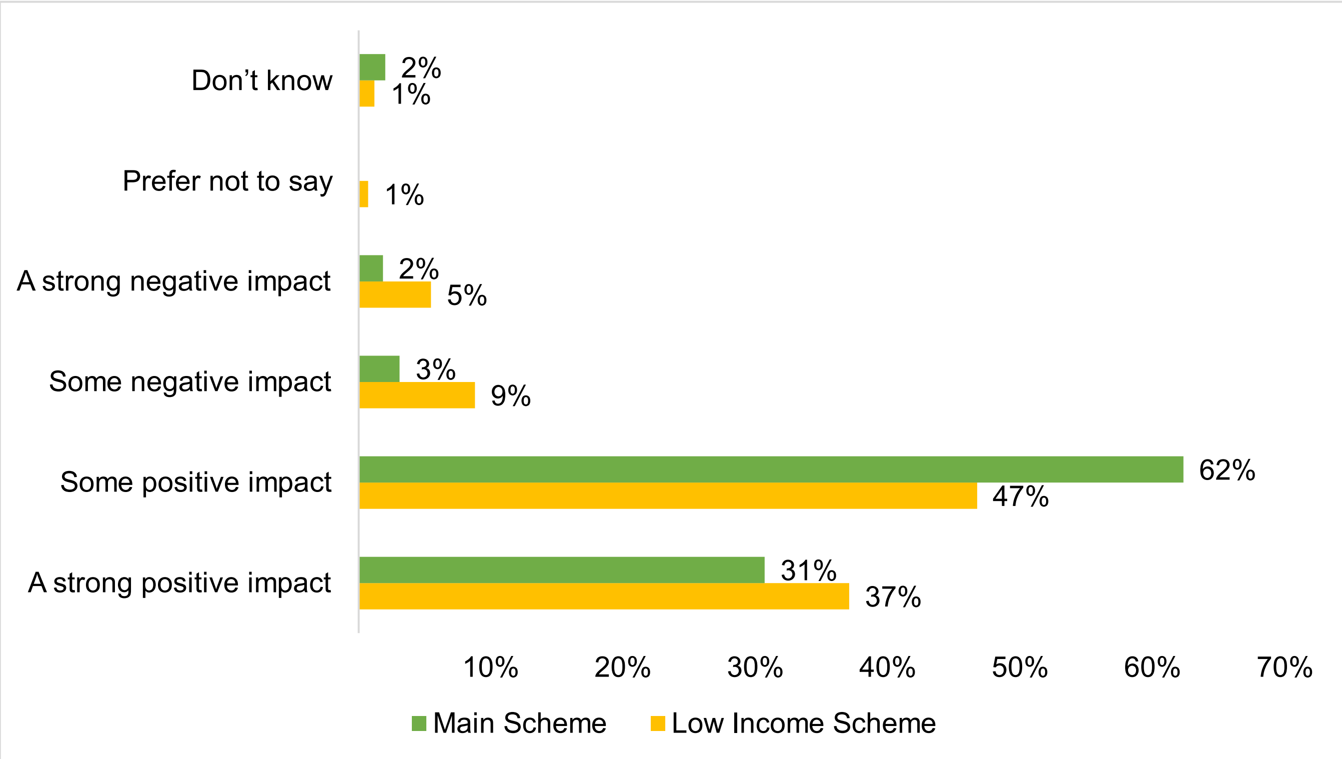
7.2.2 Reported changes to health post-installation

Applicants to the wave 2 survey were also asked about the impact of the installation on their health / the health of those in their household. A total of 349 respondents (out of an initial base of 1,218) responded that the installation had impacted on their health, with 87% (303) reporting that it had impacted on it positively. These results were aligned to health modelling findings that associated changes with indoor temperatures with a positive change in health. Very few survey respondents reported a negative impact (11%, 39).

Those on the low-income scheme were more likely to report a strong positive impact on health than those on the main scheme, but those on the main scheme were more likely to report any positive impact (with the difference between those on the main scheme responding 'some positive impact' and those on the low-income scheme responding this being statistically significant). A total of 33 respondents (24 of whom were participating in the low-income scheme) reported that the installation had a negative impact on health. Amongst these 33 respondents, 11 had had an air source heat pump installed and 10 had had solar thermal installed. The qualitative research with applicants undertaken for this evaluation did not indicate why the survey participants who had experienced a negative impact on their health from heat pumps and solar thermal. Those participating in the qualitative research reported positive effects of installations on their health (as set out in the GHGVS interim outcome evaluation[60]). Survey participants who had had heat pumps installed were asked about their experiences of the technology which may give some indication of the potential negative impacts on health (as set out in section 7.3).

In addition to those participating in the qualitative research reporting positive effects of installations on their health, they also indicated that it led to increased comfort, wellbeing, and physical and mental health for benefitting households and where the installation increased the functionality of the house (e.g., by making rooms 'usable' because they were warmer), this also brought benefits in well-being.[61]

Figure 7.3: Type of health impact by low-income and main scheme



Base: 349, covering responses to the question 'What type of impact has it had on the health of you and/or other people in your household? Please select one answer only'

[60] Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Interim Outcome and Economic Evaluation Report. BEIS, 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131112/green-homes-grant-vouchers-phase-2-interim-outcome-report.pdf

[61] Ibid.

Table 7.1 overleaf presents the different responses by measure type. It shows that there was little variation between measures in terms of their impact on health. Only households that had air source heat pump and cavity wall insulation (for which there was sufficient sample available from the survey) installed indicated a significantly different experience.

Analysis of health impacts by age, gender, property type, presence of children in the household, presence of person with a disability and fuel poverty status showed no significant differences between groups.

Overall, the survey responses suggest that households installing measures through GHGVS perceived that the measure had had at least some positive impact on their health. This is supported by health impact assessment modelling conducted for this evaluation, which found that measures installed through GHGVS were likely to have resulted in a modest improvement to wintertime indoor temperatures of between 0.1ºC and 0.3ºC and a reduced risk of mould of between -0.1 and -0.6 in the Mould Severity Index for measures that had a positive effect in benefitting households.[62]

[62] Temperature increases were found for all measures and reductions in mould risk were found across all measures with the exception of draught proofing which led to an increase in mould risk.

Table 7.1: Type of health impacts by measure

	Air source heat pump	Cavity wall insulation	Energy efficient replacement doors	Double/ triple glazing	External solid wall insulation	Loft insulation	Pitched roof insulation	Solar thermal	Under-floor insulation: Suspended floor	Total
A strong positive impact	16 (31%)	**7* (24%)**	6 (23%)	8 (38%)	46 (50%)	13 (20%)	5 (20%)	19 (34%)	6 (30%)	122 (35%)
Some positive impact	20 (39%)	**22* (74%)**	18 (70%)	11 (53%)	39 (43%)	49 (72%)	13 (60%)	25 (46%)	12 (56%)	181 (52%)
Some negative impact	9 (17%)	-	1 (4%)	-	2 (3%)	3 (5%)	2 (7%)	7 (12%)	-	24 (7%)
A strong negative impact	**6* (12%)**	1 (2%)	1 (3%)	-	3 (3%)	3 (4%)	1 (3%)	4 (7%)	-	15 (4%)
Prefer not to say	-	-	-	-	-	-	-	-	-	2 (0%)
Don't know	1 (1%)	-	-	2 (9%)	1 (1%)	-	2 (9%)	-	3 (13%)	5 (1%)
Total	51 (100%)	30 (100%)	26 (100%)	21 (100%)	91 (100%)	69 (100%)	22 (100%)	54 (100%)	21 (100%)	349 (100%)

Base: 349, covering responses to the question 'What type of impact has it had on the health of you and/or other people in your household? Please select one answer only.' The table provides data on for measure for whom at least 20 respondents had reported a health impact. The results have been reported for completeness. Only households that had air source heat pump and cavity wall insulation installed indicated a significantly different experience with lower and higher levels of impact on health reported respectively (marked with an asterisk).

7.3 Exploring contribution

The survey findings presented in section 7.2.1 and those stated in the health analysis suggest that measures installed were associated with improvements in the temperature in the home (or household's ability to heat the home). This is supported by the findings of qualitative interviews with households installing measures through the scheme, as presented in the interim outcome evaluation.[63] The correlations between measure installation and improvements to damp, condensation, and rot is less clear; but is more probable for mould, though this is likely because only certain measures can address these issues, whereas most measures eligible under the scheme would have been likely to have improved indoor temperature.

As set out in Chapter 6 (Table 6.3), survey participants were more likely to report that their home had got warmer and more comfortable post-installation than staying the same or getting colder. However, the findings differ from insulation, where the effect was significantly positive, to heat pumps, with 16% (28) survey participants reporting that their home was less comfortable post-heat-pump-installation, compared to 27% (45) survey participants who responded that there was no difference in comfort post-installation, and 55% (93) who responded that it was more comfortable.

When considering the relationship between heat pump installation and temperature in the home, as set out in Table 6.4, while 41% of survey participants (70) stated that their home had got warmer after installing a heat pump, 26% (45) responded that it had got colder and 30% (52) stated that the temperature remained the same. The survey further explored the satisfaction of survey participants who had had heat pumps installed with the noise levels of the technology and the heat it generated.

In relation to the performance of the heat pump and how effective it was at achieving the desired temperature, 77% (136) stated that they were satisfied with this compared to 14% (25) who were dissatisfied. Satisfaction with the temperate generated by the heat pump showed little variation across all key metrics.

Amongst those interviewed for the evaluation, one homeowner, consulted for the interim outcome evaluation, who had installed internal solid wall insulation reported that two rooms had changed from being the coldest to the warmest in the house. Two interview participants, both of whom had people living with disabilities in the home, reported that the installations had improved their health: one who had had solar thermal installed reported that this supported their health, because they had needed more time for bathing due to their disability and the measure provided them with more reliable water heating for this. The qualitative research also indicated that improved heating and draught-proofing meant that households were able to use rooms more freely (e.g., opening curtains where previously they had kept them closed to keep out draughts) and that this improved their mental health.

The survey and qualitative research findings suggest that some households participating in the scheme perceived that the measures installed had positively impacted on their health. The survey findings indicate that those installing heat pumps through the scheme had mixed views on the effects of the technology on their health. Those installing insulation through the scheme were more likely to consistently perceive that the installation had impacted positively on their

[63] Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Interim Outcome and Economic Evaluation Report. BEIS, 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131112/green-homes-grant-vouchers-phase-2-interim-outcome-report.pdf

comfort and health, with this likely being linked to the fact that they perceived the measure to have made their homes warmer.

7.4 Summary and conclusions

The findings from the survey, the qualitative interviews, and the health impact modelling suggest that GHGVS installations were associated with health benefits (or perceived health benefits) for at least some households installing a measure through the scheme and that many of these benefits were linked to improved indoor environmental conditions. The combined evidence from the survey and qualitative research with applicants indicates that this was mainly the case when the measure installed led to the occupants being able to better warm their home or heat their water.

8 Quality of installation

This chapter provides an assessment of the quality of installations and the service received by applicants from installers under the scheme. It draws on TrustMark lodgements and audit data, combined with the findings of the wave 2 survey of applicants and qualitative research with the supply chain and with applicants. It answers the following evaluation question:

- To what extent did the scheme deliver energy efficiency installations which were of high quality?

8.1 How and why the scheme was intended to support quality

8.1.1 The rationale for quality of installation and service

The rationale for the GHGVS quality assurance system (described below) was informed by learnings from the delivery of previous UK energy efficiency programmes, particularly the Green Deal Home Improvement Fund (2014-2016) and Warm Front (2012). It also built upon findings from a review into the Australian Home Insulation Programme (2009-2010), which had a high and rapid take up. The GHGVS quality assurance standards also respond to the Each Home Counts Review,[64] which recommended that registration with TrustMark be a requirement to participation in Government schemes and that a framework of standards be introduced (which led ultimately to the requirement for PAS 2030: 2017[65] in GHGVS).

Poor quality of installation can have negative effects on comfort, safety, and efficiency of the home, as well as sustainability of the installation and well-being of the building's occupants. Poor quality of the installation service received can affect the extent to which people will want to have further measures installed in their homes and have confidence in such schemes in the future.

8.1.2 How the scheme was intended to support quality

The means through which the scheme was intended to support quality of installation were set out in detail in the interim outcome evaluation[66]. In sum, quality was expected to be achieved through:

1. Installers registering with the government endorsed TrustMark quality scheme. TrustMark requires registered businesses to keep up to date with the most recent standards and practices and provides guidance on technologies and procedures. BEIS required that all installations be 'lodged' within the TrustMark database for the voucher to be redeemed. Only registered installers could make the necessary lodgements for the

[64] Each Home Counts: An Independent Review of Consumer Advice, Protection, Standards and Enforcement for Energy Efficiency and Renewable Energy. BEIS, DCLG, 2016. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/578749/Each_Home_Counts__December_2016_.pdf

[65] Publicly Available Specification 2030 of 2017. More information can be found on the UK Accreditation Service (UKAS) website: https://www.ukas.com/resources/latest-news/ukas-pas-2030-green-homes-communication-to-certification-bodies-change-in-beis-transition-policy/

[66] Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Interim Outcome and Economic Evaluation Report. BEIS, 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131112/green-homes-grant-vouchers-phase-2-interim-outcome-report.pdf

agreed measure type at the property, and they had to demonstrate that installations lodged met the PAS 2030 standard. To register with TrustMark, businesses must gain an appropriate level of qualification; certify that they will operate to the appropriate standard for all installations they wish to offer under TrustMark by becoming a member of an accredited certification body; and register via a TrustMark scheme provider. TrustMark then ran audits on a sample of installations completed by every registered business.

2. To carry out work under GHGVS, installers had to attain the following standards:

    a. PAS 2030:2017 for any energy efficiency measures.
    b. PAS 2035:2019 for any energy efficiency measures in park homes, high rise buildings and buildings that were both traditionally constructed and protected.
    c. MCS for any low-carbon heat measures such as heat pumps.

3. There were also assumptions underpinning scheme design around the level of information that households would have before seeking an installation. BEIS assumed that the scheme would attract 'early adopters' of low-carbon heating technologies and rarer types of insulation who would be well-informed about these technologies either through prior research or through research conducted in preparing to apply for a voucher. BEIS also explicitly linked the voucher application process up with the Simple Energy Advice (SEA)[67] website, which provided information on different types of energy saving improvements that can be made to homes and whether these are right for the household needs, as well as information on TrustMark installers operating within postcode areas. SEA also hosted the website through which applicants could assess their eligibility for the scheme, search for local scheme-registered installers and apply for a voucher.

4. It was the responsibility of the Scheme Administrator, who audited all applications, to assess whether measures were appropriate for the building concerned.

8.2 Evidence of quality under the scheme

8.2.1 Audit outcomes

There were 1,220 GHGVS installation audits[68] recorded in the most recent TrustMark Site Audit Data Report available (January 2022). Most of these audits (approximately 1,100) took place in August and September 2021, with the remainder taking place in October and November 2021. Questions are used by auditors during a visit to the property to assess the quality of installations. Different sets of questions are asked depending on the type of measure installed, though they can be broadly grouped into categories such as: safety issues, installed to manufacturer instructions, airtight or sealed, and paperwork and communications. The number of questions asked differs by the type of measure installed. The results outlined here are based on the number of inspection questions passed or failed.

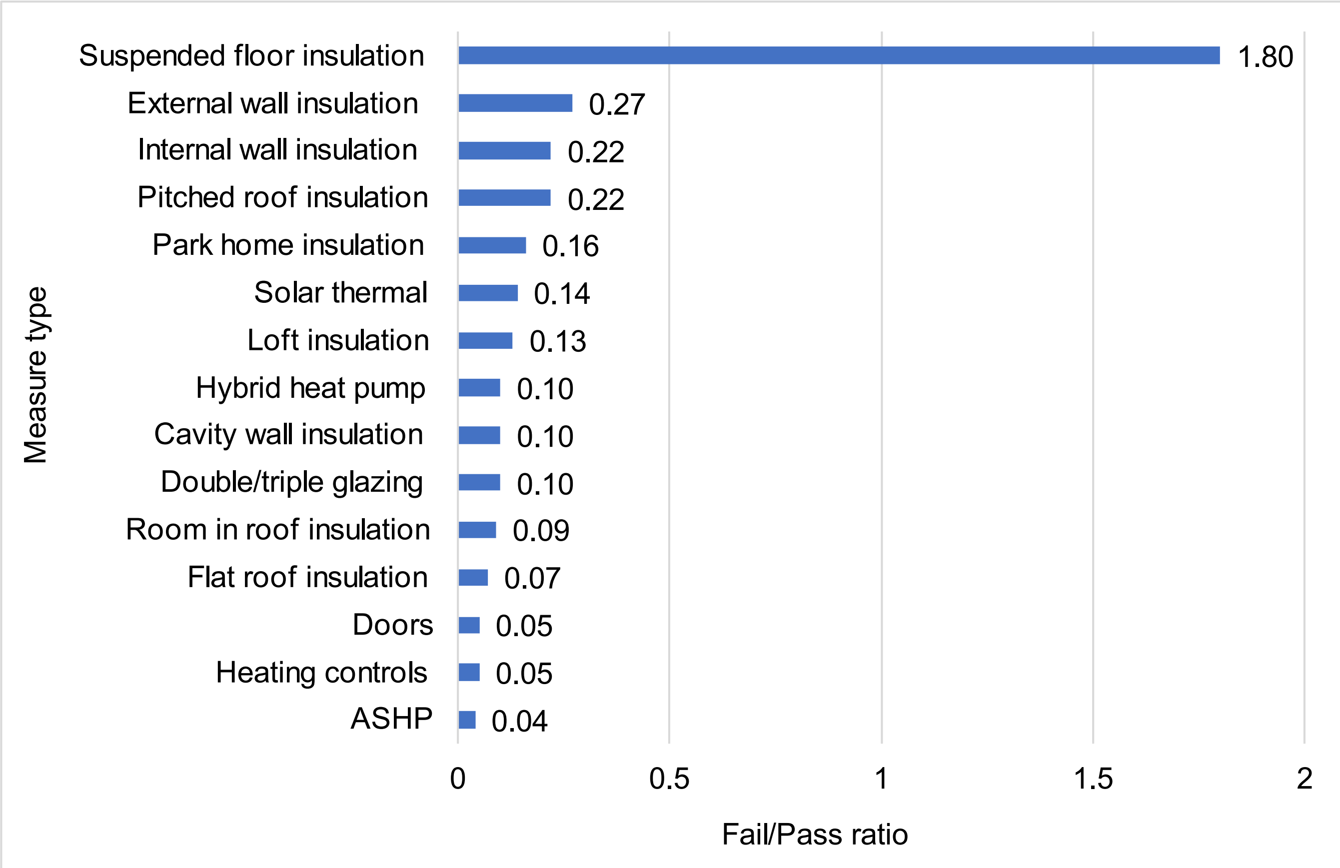
A total of 21,852 inspection questions were scored across all scheme audits, 18,264 were given a pass rating (amounting to 84% compliance). Those that were not given a pass rating

[67] Find ways to save energy in your home, GOV.UK, available at: https://www.gov.uk/improve-energy-efficiency

[68] Each audit related to only one of the measures installed in each property. On average, 1.14 measures were installed per household under the scheme.

were either non-compliant or were unable to be robustly checked. TrustMark data from audits presented in Figure 8.1 provides a contextualised overview of compliance. The “fail/pass” ratio was calculated by dividing the number of inspection questions failed (or where it could not be verified) by the number of questions passed, to provide a relative rate for comparison across the measures. Suspended floor insulation was the only measure with more instances of failures than passes (i.e., a fail/pass ratio greater than 1). However, auditors explained that many of these instances were classed as a fail because customers refused to give access, as checks can require invasive action (removing floorboards) after an installation is completed.

Figure 8.1: The fail/pass ratio of each measure type



Note: The fail / pass ratio has been calculated as: instances of failures / instances of passes. Data is calculated using all questions asked across all installations. A fail may be due to the auditor not being able to check for compliance and not necessarily non-compliance.

Overall, GHGVS had a fail/pass ratio of 0.20, which equates to one instance of failure for every five instances of passes. If suspended floor insulation (which, as mentioned above, was frequently recorded as a "fail” because auditors could not inspect the installation) is removed, the overall fail/pass ratio for the scheme would be 0.18.

8.2.2 Correlations between property and building characteristics and quality of installation[69]

Property characteristics heavily influenced the rate of non-compliance in GHGVS. Figure 8.2 illustrates GHGVS non-compliance rate by property age. The chart shows that older buildings, particularly those built prior to 1950, were more likely to fail their inspections, while properties

[69] The statistics from TrustMark data presented in this section 8.2.2 have not been assessed for statistical significance.

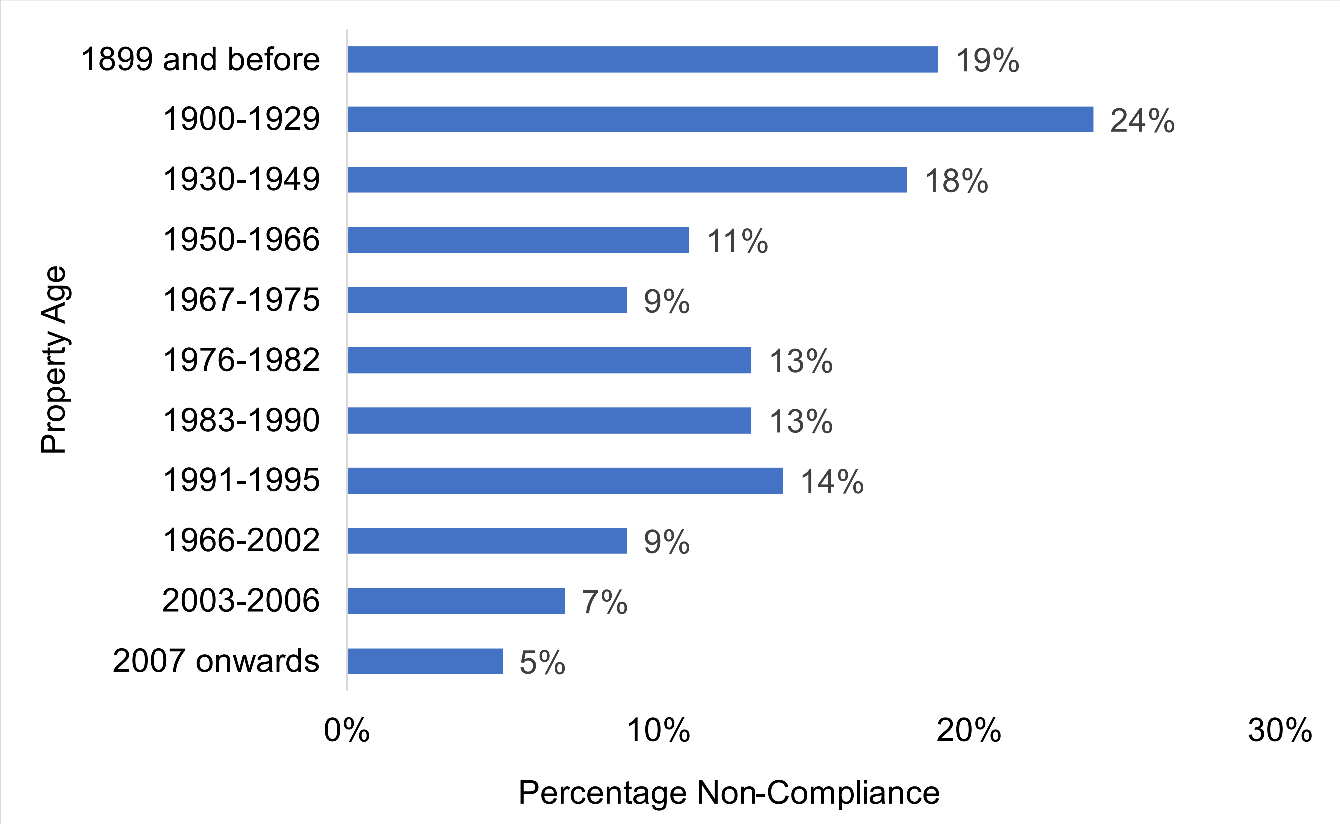
built after 1996 had the lowest rates of non-compliance. Most of the inspected properties built before 1950 were traditional solid wall buildings (83%), and over half (55%) were mid-terrace (42%) or end-terrace (13%) properties. In contrast, 62% of inspected properties built after 1950 were conventional, cavity wall buildings, and only 20% were mid-terrace (14%) or end-terrace (6%).

Building characteristics associated with property age are linked to non-compliance of specific measures, such as external wall insulation and internal wall insulation, which had the second (21%) and third (18%) highest non-compliance rates under GHGVS, respectively. A total of 85% of all external wall insulation inspections and 87% of all internal wall insulation inspections were on installations in properties older than 1950. Furthermore, roof insulation measures had a noticeably higher rate of non-compliance in properties constructed before 1950 compared to those built after this year. This included pitched roof insulation (21% non-compliance in properties built before 1950; 15% non-compliance in properties built after 1950), room-in-roof insulation (13% non-compliance in properties built before 1950; 9% non-compliance in properties built after 1950) and flat roof insulation (12% non-compliance in properties built before 1950; 4% non-compliance in properties built after 1950). The general trend for poorer quality in older buildings may be due to the additional challenges faced. Insulating older buildings is generally considered to be riskier and more complex due to:

- The higher risk of damp problems from altering vapour flows through the fabric of the building.
- The need to accommodate aesthetic and historical features such as internal mouldings and external stonework or brick detail, which may lead to increased thermal bridging.
- Complex geometry of the building leading to thermal bridging and potentially installers taking shortcuts.
- Inconsistent maintenance over the lifetime of the building leading to pre-existing damp issues and fabric damage and hence greater risk of inappropriate installation.
- Limited familiarity amongst installers with older and more variable building techniques, which could lead to ill-informed and inappropriate design choices.

Another reason that older buildings had a slightly higher rate of non-compliance for measures (other than suspended floors) could be inspectors' inability to check all the installations in every case due to the complexity and variation of building structures that are inherent in properties built before 1950, as inability to check for compliance results in a fail.

Figure 8.2: The percentage of non-compliance by property age (non-compliance also includes cases where compliance was unable to be verified)



8.2.3 Correlations between tenure and location and quality of installation[70]

As illustrated in Figure 8.3, owner-occupied properties (16%) had almost triple the rate of non-compliance than privately rented properties (6%). Whilst there was a low representation of private rented properties in the audit data (only 1% of inspection questions (278 of 21,852) asked were in private rented properties), there are a couple of differences to highlight:

- There were no enclosed mid-terrace houses or maisonettes amongst private rental properties under GHGVS. It is possible that these types of properties are more commonly correlated with non-compliance as restricted access makes installing measures challenging for the installer. Figure 8.4 illustrates percentage non-compliance by property detachment.
- Only five measure types were installed in private rented properties: external wall insulation, internal wall insulation, loft insulation (these three had a lower non-compliance rate in private rental properties), pitched roof and cavity wall insulation (these two had a higher rate of non-compliance in rental properties).

[70] The statistics from TrustMark data presented in this section 8.2.3 have not been assessed for statistical significance.

Figure 8.3: Non-compliance rate by property tenure (non-compliance also includes cases where compliance was unable to be verified)

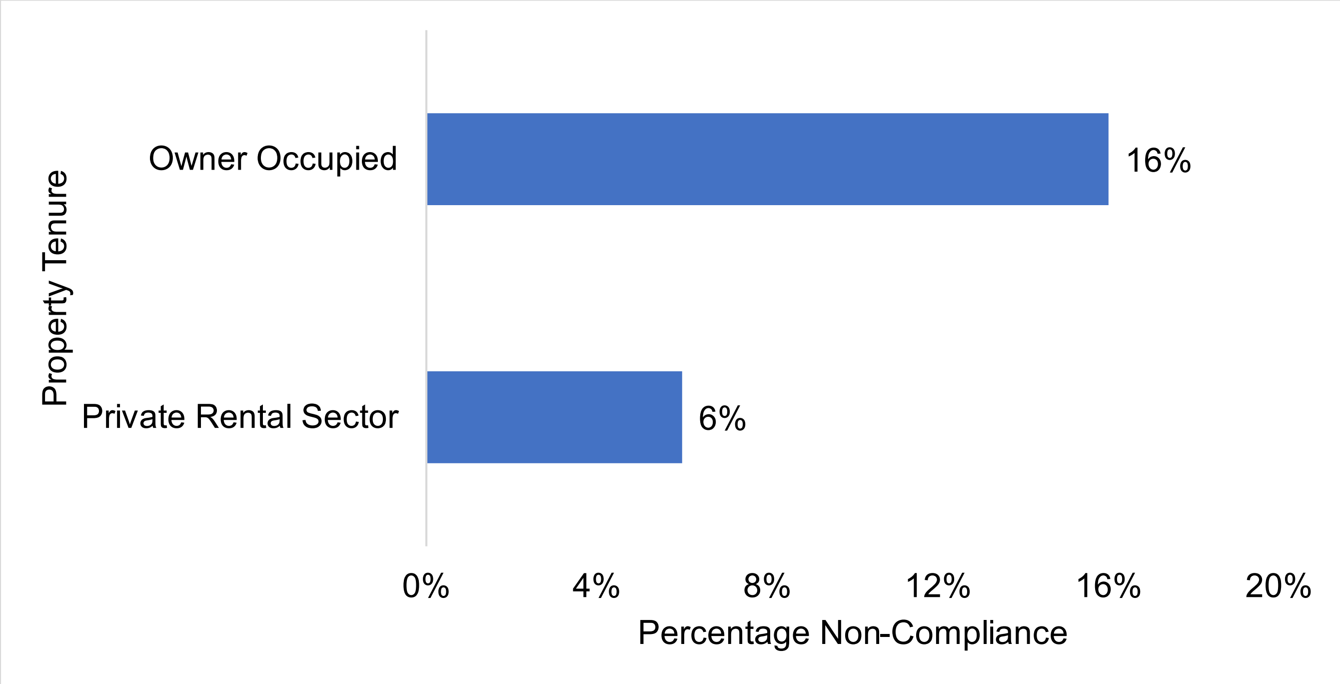
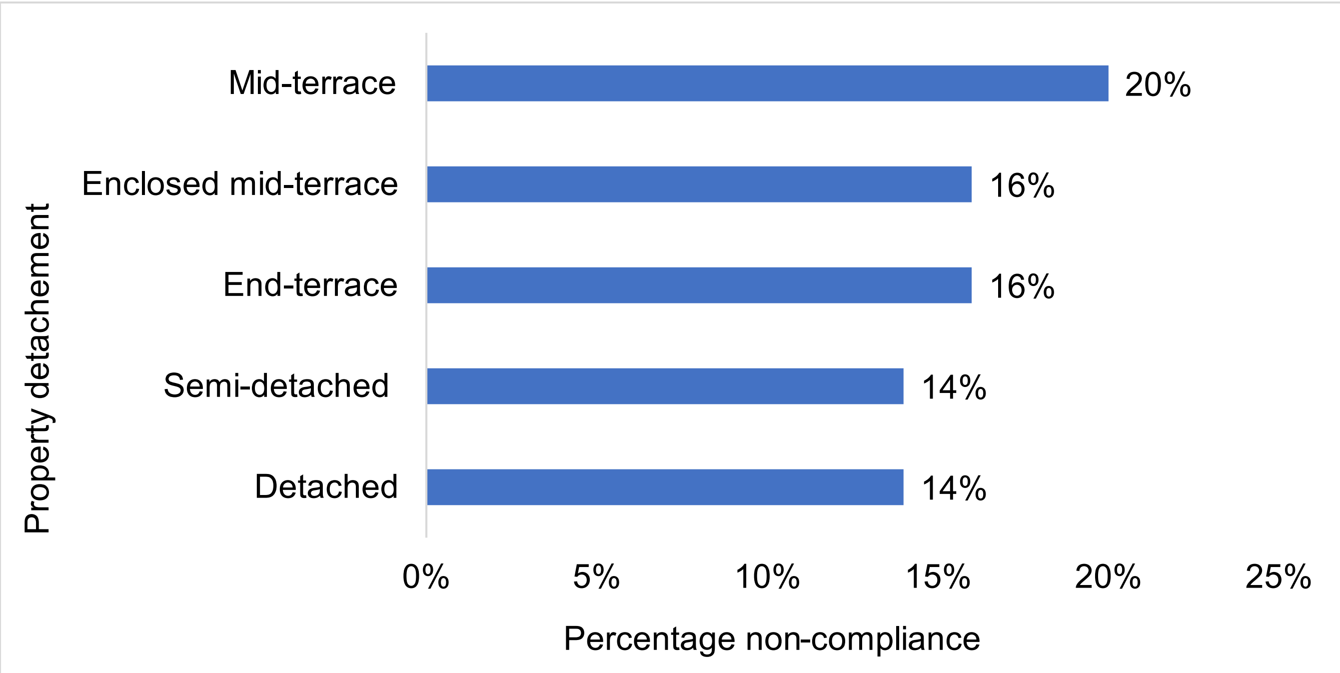


Figure 8.4: Non-compliance rate by property detachment (non-compliance also includes cases where compliance was unable to be verified)



Typically, large cities, particularly in the Midlands and Northwest of England, saw the highest rates of non-compliance. Areas with the highest instances of non-compliance for suspended floor insulation include Birmingham, Bradford, Bristol, Dewsbury, Ipswich, Manchester, Liverpool, Newcastle, Nottingham, Portsmouth, and Preston. Areas with the highest rates of non-compliance for external wall insulation include Birmingham, Coventry, Hull, Leicester, Liverpool, London, Luton, Peterborough, Sheffield and Stoke.

8.2.4 The views and experience of auditors

Nine auditors were interviewed for this evaluation. They reported that they had encountered installation issues while undertaking site audits for GHGVS. The most common types of issues encountered comprised inadequate ventilation when installing fabric measures and sub-par installation of external wall insulation (for example not extending the roof lines or moving out windows) and, more generally, all types of insulation. Auditors considered these to be relatively frequent but not hugely problematic.

8.2.5 Applicant experiences

Applicants participating in qualitative interviews for this evaluation had mixed experiences of GHGVS installations. Most wave 2 survey participants (72% or more of those responding to this question, by measure) were satisfied with the quality of their installation. However, feedback from some qualitative interviews with applicants suggest that poor quality installations were still able to pass by the scheme's quality systems. These findings were presented in the interim outcome evaluation,[71] and they indicate that some households faced problems, including accidental damage and mess left by installers, poor finishings (e.g., plastering), and perceived damp problems resulting from the installation of internal wall insulation. Other applicants interviewed for the evaluation were very satisfied with their installation and reported positively on the installation's quality.

Applicants to the wave 2 survey who had had at least one measure installed through the scheme were asked how satisfied they were with the installation in terms of:

- Whether the installation was free of defects or health and safety issues,
- The effectiveness of the improvement (e.g., whether it worked as expected),
- The suitability of the measure, and
- The extent to which the installation was visually appealing.

Table 3.1 presented these results and illustrated that there was no significant variation between measures in terms of how households experienced satisfaction, except in relation to aesthetics and (less so) effectiveness. A little over three quarters of survey participants (77%, 136) were satisfied with the amount of noise their heat pump generated, compared to 13% (24) who were dissatisfied. This varied little between different profiles of applicant, although satisfaction with the level of noise increased in line with income, with higher income groups tending to be more satisfied.

Table 8.2 presents wave 2 survey responses to the question of whether participants had experienced any difficulties or faults, or had complained, about the measures they had installed at their property. Significantly higher proportions of survey participants who had had air source heat pumps, external solid wall insulation and solar thermal installed reported that they had experienced difficulties or faults with the measure than those who had had cavity wall insulation, loft insulation and pitched roof insulation installed. Due to the technical nature of solar thermal and air source heat pump apparatus, it is possible that the issues that some of these participants experienced occurred after the audit inspection, during the equipment's

[71] Chapter 7 in the Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Interim Outcome and Economic Evaluation Report. BEIS, 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131112/green-homes-grant-vouchers-phase-2-interim-outcome-report.pdf

operation, resulting in a difference between participants' satisfaction and the Trustmark audit data.

It is also possible that the performance of the systems, while technically good, did not match up to the recipients' expectations. Air source heat pumps are usually set up to operate at lower temperatures and for longer periods than gas central heating, and it is not uncommon for householders to express disappointment when at the temperature of the radiators despite the temperature of the home being just as high as before. Some householders may also have attempted to use their heat pump in the same way they used to use their boiler, leading to poor performance. Solar thermal has fewer perception issues, but it does provide a relatively small contribution to total heating requirements, which some recipients may have found disappointing.

Table 8.2: Experience of post installation issues

	Air source heat pump	Cavity wall insulation	External solid wall insulation	Loft insulation	Pitched roof insulation	Solar thermal
Yes (experienced difficulties or faults, or complained)	64 (40%)	11 (9%)	76 (27%)	22 (9%)	16 (12%)	74 (33%)
No (did not experience difficulties or faults, or complain)	91 (57%)	111 (87%)	183 (65%)	252 (88%)	105 (79%)	144 (64%)
Don`t know	1 (1%)	5 (4%)	15 (5%)	4 (2%)	9 (7%)	7 (3%)
Prefer not to say	4 (2%)	0 (0%)	8 (3%)	9 (3%)	3 (2%)	1 (1%)
TOTAL	160 (100%)	127 (100%)	282 (100%)	287 (100%)	133 (100%)	226 (100%)

8.3 Exploring contribution

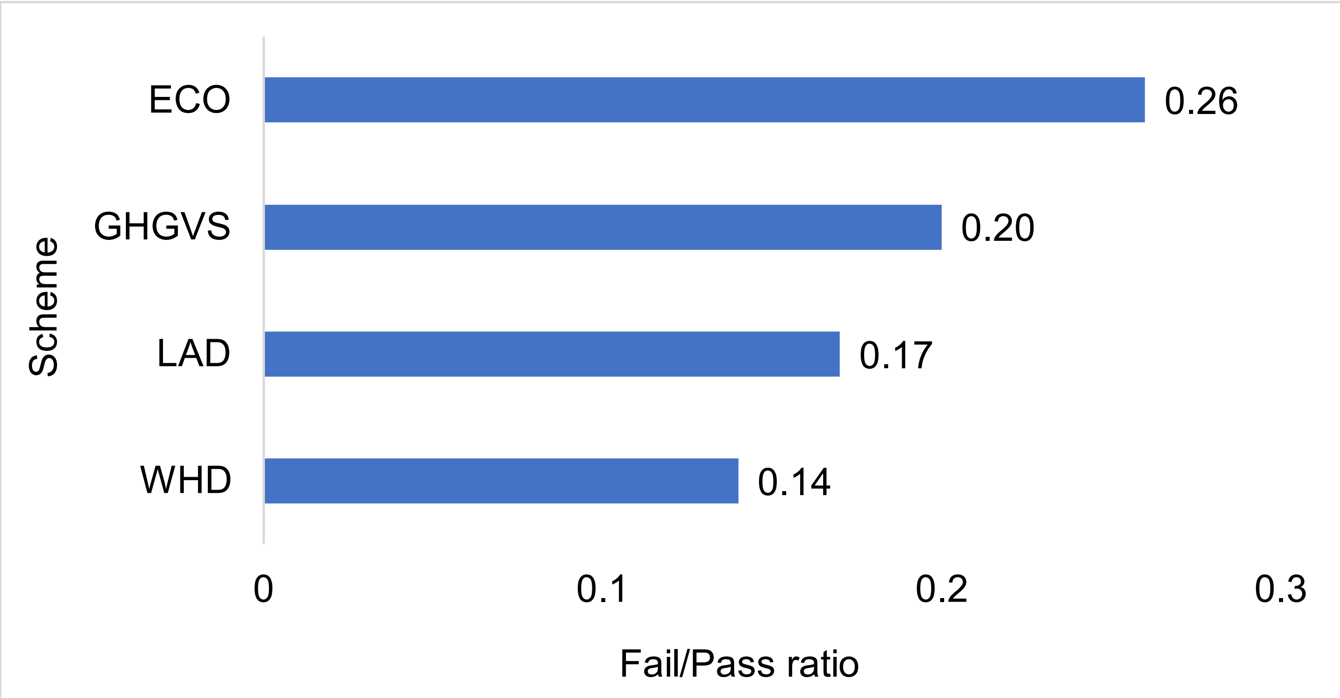
8.3.1 Quality under GHGVS compared to other schemes

TrustMark collected audit data for four schemes: GHGVS, Energy Company Obligation (ECO), LAD and Warm Homes Discount (WHD). The average fail/pass ratio for all measures across the four schemes is 0.25. As shown in Figure 8.4, ECO had the highest fail/pass ratio (0.26), followed by GHGVS (0.20), LAD (0.17) and WHD (0.14 – note that WHD only replaced gas boilers). Property characteristics are missing for ECO and WHD in the Trustmark audit data and therefore a scheme comparison of property age, tenure and type cannot be made.

None of the specific measures under GHGVS had a higher fail/pass ratio than the average fail/pass ratio for the same measures in all four schemes. Since ECO comprises the majority of inspections in the audit data (88%), the comparison with all schemes predominantly compares against ECO data, and therefore typically reflects failures identified by inspections conducted for ECO. GHGVS (0.20) had a higher fail/pass ratio than LAD (0.17) due to the high fail/pass ratios of two insulation measures: suspended floor insulation (1.8; LAD: 1.0) and external wall insulation (0.3; LAD: 0.1). However, GHGVS and LAD's fail/pass ratio were the same for 38% of their common measures (park home insulation (0.1), loft insulation (0.1) and cavity wall insulation (0.1)). Moreover, GHGVS had a lower fail/pass ratio for internal wall insulation (0.2; LAD: 0.3), double/triple glazing (0.1; LAD: 0.2) and room-in-roof insulation (0.1; LAD: 0.2).

One key reason why ECO had a higher fail/pass ratio than other schemes was due to its high rate of failures for suspended floor insulation and solid floor insulation, which had fail/pass ratios of 2.7 and 1.3, respectively. For suspended floor insulation, there were more than two and a half instances of failures for every one instance of pass under ECO, far higher than that of GHGVS (1.8) and LAD (1.0). There were no solid floor insulation inspections conducted for any of the schemes other than ECO. The reason for these high fail/pass rates in ECO most likely relates to inspector difficulties in verifying hard to access underfloor insulation; this is discussed in more detail in section 8.2.1. ECO also had a higher than scheme average fail/pass ratio for park home insulation (0.3; scheme average: 0.2) and room-in-roof insulation (0.3; scheme average: 0.1).

Figure 8.5: Fail/Pass ratio by scheme



When asked about the quality of installations in the scheme compared to those in other schemes as well as those outside any scheme, six (out of nine) auditors and six (out of eight) certification bodies stated that there was ultimately no major difference in quality of PAS installations across any scheme, including GHGVS, or outside of schemes. These participants considered PAS 2030 as an important tool to maintain this equivalency. They argued that TrustMark has a comparable monitoring regime across all installations, and the standard has the same focus on addressing recurring issues such as a lack of ventilation and mould growth in any PAS installation. Aside from PAS, auditors also considered that the general level of skill in the market also played an important role in determining quality levels.

8.3.2 The role played by GHGVS in promoting and rolling out government-endorsed quality standards

GHGVS played an important role in increasing the number of PAS 2030-compliant and TrustMark-registered installations undertaken. Most auditors interviewed for this evaluation stated that PAS had played a critical role in improving the quality of installations across the market. Whilst it did not do this to the scale of ECO installations, in terms of the number of installations impacted, it still contributed to a higher guarantee of quality installation than would have otherwise been possible had the scheme not required these standards.

> *"Green Homes Grant Voucher Scheme had to follow PAS 2030:2017, so in theory there was a set of standards that every install should be installed to, which is good because it gives confidence that the consumers are getting quality work and all work should be done to the same standard." – Auditor, interviewed 2022*

In June to July 2021, 218 installers were surveyed as part of the evaluation. Most (59%) had MCS certificates prior to participating in the scheme, and 43% were already registered with TrustMark. Around one in ten installers (9%) did not have any of the listed certifications prior to participating.

61% of all installers completing the survey said they had gained at least one registration/certification to enable them to participate in GHGVS, indicating that the scheme contributed to businesses increasing their certified quality. Among these participants, only 8% stated that they were planning to obtain the registrations/certifications anyway, while 86% were incentivised by the scheme. This would indicate that the scheme doubled the number of installers registered with TrustMark (amongst those participating in the scheme).

The installer survey results strongly indicate that GHGVS played a role in installer uptake of quality standards, which auditors consider to have played a role in improving installation quality over the last few years. In this way the scheme contributed to quality.

8.3.3 Aspects of scheme design which may have affected quality

The interim outcome evaluation presented views from GHGVS auditors about aspects of the scheme that might have enabled instances of non-compliance:

- Three auditors noted scheme delays led to a later-than-planned start date which, when coupled with a tight deadline, led installers to complete jobs as quickly as possible to fit within the timelines to be able to draw as much funding as possible. Auditors reported that this caused some neglect toward the quality of their work. Instances of 'rushed jobs' driven by the scheme's announcements of closure are also recalled in qualitative interviews with applicants.

- Two auditors described instances of installation designs which were not the most appropriate for the customer's needs (e.g., pitched roof insulation in a property which did not have a room-in-roof and already had standard loft insulation). They surmised this to be a result of installers pushing for designs based on commercial interests rather than suitability to the customer and property. Had the installations been subject to PAS 2035 standards, then a Retrofit Coordinator would have been required to advise on the suitability of the installation.

- Two auditors claimed that some installers were not being properly vetted by the GHGVS administration or scheme providers (certification bodies), leading to some new inexperienced installers as well as new businesses established to take advantage of the scheme. However, these claims are likely based on a limited number of cases and reported evidence which the evaluation was not able to verify.

Auditors made a couple of recommendations for improving the quality of future installations:

- Some mentioned requiring PAS 2035 in all future schemes to provide a consistent overview and monitoring throughout. A few specifically recommended making the role of the retrofit coordinator independent of the installer before they can be fit-for-purpose.

- The majority mentioned implementing routine monitoring of installations, with a few specifically recommending including mid-point inspections, would improve quality because installers would be aware that their work will be regularly inspected. Mid-point checks act as a preventative step to identify any mistakes early in the process which can be rectified more easily compared to when the measure has been completed. This is most useful for suspended floor insulation, as mistakes cannot be identified nor rectified after installation.

8.4 Summary and conclusions

The GHGVS quality assurance systems were effective at (a) preventing cases of poor-quality installations; and (b) detecting them in cases where they occurred. However, research with auditors, certification bodies and applicants has shown that – nonetheless – some instances of poor-quality installations still occurred. Qualitative interviews with applicants provided some examples of installations that may not have been carried out to PAS or TrustMark standards (particularly where households were not given sufficient information on aftercare and maintenance of the installation). However, TrustMark audit data indicates that – overall – the volume of quality issues identified were proportionate to the scale of the scheme.

In terms of the scheme’s contributions to these outcomes, GHGVS contributed to the quality of installations observed to the extent that it integrated systems of quality improvement in the sector (TrustMark, PAS, MCS and other certifications) that were established and evolved under previous policies such as the Each Home Counts Review and ECO. In this way, scheme design was coherent with existing policy, and economic in utilising existing tools rather than ‘reinventing the wheel’ for quality. The scheme contributed to quality by encouraging installers wishing to participate the scheme to seek certification and register with TrustMark, which auditors believed raised quality standards across the retrofit profession. However, the evaluation also found some evidence to suggest that in some instances scheme design may have been negatively affecting the quality of installations due to the short timescales of the scheme and/or the pressure to complete installations and redeem vouchers within tight deadlines.

9 Benefits to market

This chapter presents the effects of the scheme on installers and the upstream supply chain (training providers, auditors, certification bodies, and manufacturers). It brings together the evidence from the interim outcome and economic evaluation report delivered in March 2022, with additional quantitative analysis of the GHGVS employment and growth effects, using administrative data. This chapter answers the following evaluation questions:

- How effectively has the scheme supported the creation or preservation of full-time-equivalent (FTE) jobs involved directly and indirectly in delivering?
- Did the scheme contribute to the creation of long-term growth in the energy efficiency/ low-carbon heating supply chain?

In addition to the evaluation questions above, the chapter reports further findings on how far (a) GHGVS led to any further productivity gains by encouraging firms to redeploy furloughed workers in a productive capacity and (b) the net economic effects of GHGVS (by examining impacts on local unemployment levels). A detailed description of the methodology used and the full analysis are included in Annex 7.

9.1 How the scheme was intended to bring market benefits

It was anticipated that, by raising the demand for energy efficiency and low-carbon heat measures, the scheme would help increase employment within the home improvements sector. As a result, businesses would have been able to retain staff or bring in new employees recruited from elsewhere in the industry. The idea was that there were people working within other areas of the construction and home improvements industry that could be brought into the energy efficient and low-carbon heating industry. There was an intention that measures that required many hours of labour (including heat pump installations and external wall insulation[72]) would be supported through the scheme and that this would increase the amount of labour required (thus increasing job security). Whilst no specific objectives around increased profits or turnover were established, there was an explicit objective to grow the low-carbon heat sector and to sustain the wider home improvements sector.

9.2 Evidence of market benefits and other changes

9.2.1 Employment

Early qualitative research suggested that at the onset of the scheme, installers had faced challenges allocating their staff to installations under the Voucher scheme due to the significant delays in voucher approvals. This meant that installations were also scheduled with delay, and installers were prioritising non-Vouchers work. However, evidence collected from qualitative interviews later in the evaluation (once the scheme had been ongoing for a longer period) showed evidence that the scheme was having a positive effect on participating firms' employment, with most interviewees reporting having hired additional staff in preparation for

[72] By contrast, solar thermal installations are expensive because of the product cost; they require fewer hours of labour than other measures.

the scheme in various roles (particularly administrative roles and subcontractors). Businesses also reported having used subcontractors in periods of high demand. This pattern was more common among large or medium sized businesses while small firms, in general, did not take on additional staff. In support of this, early findings from the interim outcome evaluation report suggested that the scheme contributed to pockets of employment. However, there was no evidence of the scheme driving employment within the sector at large.

An econometric analysis of employment within the firms participating in the scheme (based on quarterly data compiled from the Interdepartmental Business Register (IBDR)[73]), and of unemployment rates in the localities in which participating firms were based, was conducted to provide a more detailed and robust analysis of the scheme's impact on employment. The analysis found that:

- GHGVS directly created or safeguarded a lower and upper bound range of 550 to 1,700 jobs in the firms participating in the scheme.[74] Owing to the timeframes for which the data was available, it was not possible to determine how far those jobs might have been sustained for a long period.
- The results also suggested that the scheme led to a short-term reduction in unemployment levels in the Mid-Layer Super Output Areas (small areas for the purpose of reporting Census statistics) in which installers were based. It was estimated that the delivery of each measure reduced the number of unemployed claimants by around 0.018 claimants for a period of one quarter. This would imply a total reduction in the number of unemployed claimants of just over 900 claimants.

9.2.2 Effects on demand for quotes

Installers participating in qualitative interviews for the interim outcome evaluation reported that one of the immediate effects of the scheme was a sharp increase in demand for quotations. Businesses were *"utterly swamped",* though many quotes did not lead to actual installations, because customers did not know what they wanted in the first place, and they called simply to understand what they could have done in their property. A few installers however recognised a positive effect from this increase in quotes, either because it increased the pipeline of work, or because it raised awareness among customers about the specific services offered. Despite the issues related to vouchers approval, the general attitude of installers participating in the later wave of (outcome evaluation) qualitative interviews was much more positive towards the scheme than that of those participating in the process evaluation research (which was conducted at the height of the scheme's delivery challenges – e.g., delays in redeeming vouchers). However, it should be noted that a much larger sample of installers were

[73] The Inter-Departmental Business Register (IDBR) is a comprehensive list of UK businesses used by government for statistical purposes. The two main sources of input are Value Added Tax (VAT) and Pay As You Earn (PAYE) records from HMRC, The IDBR covers around 2.7 million businesses in all sectors of the economy, but since the main two tax sources have thresholds, very small businesses operating below these will, in most cases, not be included.

[74] This pertains to the favoured estimates for direct jobs effects. Several different ranges of estimates are presented in Table A7.6 in Annex 7. The widest possible range is from 455 to 3,864 direct jobs. Deeper explanation and discussion is provided in Annex 7.

interviewed for the process evaluation and therefore the two datasets cannot be compared like-for-like.[75]

9.2.3 Effects on turnover

The evaluation has not been able to reach robust conclusions around the scheme's effects on turnover. Evidence collected through two waves of qualitative interviews with installers suggested that whilst the delays to application processing and voucher redemption had an initial negative effect on firms' cash flows, this was offset over time with most firms interviewed seeing an increase in turnover over the scheme's duration.

Turnover was also assessed as part of the econometric analysis of scheme effects on participating firms. However, it was not possible to gather robust evidence on turnover, due to lags in relevant data being available in the publicly available databases used.

9.3 Exploring contribution

To assess GHGVS effects on employment, the evaluation used econometric modelling to isolate the effect of the scheme. The results suggest that the scheme had a small positive impact on employment, as well as on unemployment rates. This finding is supported by the qualitative evidence from interviews and the results from the quantitative survey of 218 installers conducted just after the scheme's closure, where 44% of respondents declared that they did not register a change in their staff levels since the start of the scheme). Further, the survey indicated that most new employment generated through the scheme (directly) was in administrative posts and subcontracting roles. The econometric analysis was not able to assess effects on subcontracting, so it may be that effects on subcontracted employment were greater.

9.4 Summary and conclusions

Overall, the effects on employment were quite small. With respect to other business outcomes, the quantitative analysis on GHGVS firms did not support the existence of considerable effects on firms' profits. However, it found that some specific measures impacted positively on turnover (benefitting the firms providing those installations).

Evidence from qualitative interviews with different groups (for both process evaluation and this outcome and economic evaluation) within the home improvement supply chain indicates that GHGVS contributed to increased employment and turnover at least in the short-term. This finding was supported by the quantitative analysis conducted on GHGVS participating firms, although the impacts on turnover were limited to specific measures.

[75] It should be noted that there was no overlap in the installers sampled for interview in the two phases of qualitative research. Two installers who took part in the survey also took part in the outcome evaluation research, but this number is too low to make reliable longitudinal analysis.

10 Value for money of GHGVS

This chapter presents an analysis of the value for money of the programme in response to the following evaluation question:

- To what extent did the scheme deliver energy efficiency installations which represented good value for money (VfM)?

Of the two most widely used VfM methods, social cost-benefit analysis (CBA) and social cost-effectiveness analysis (CEA), this chapter adopts the CBA approach as it allows for monetisation of short-term and long-term benefits where data is available.[76] In doing so it also answers the following evaluation question:

- What is the average cost of installing measures in homes applying and redeeming vouchers under the scheme? How does this vary by measure, tenure, or property type?

The analysis considers the costs and benefits of the scheme to society (social CBA[77]), calculated as a net benefit/cost,[78] as well as the benefits and costs of the scheme to participating households (private CBA) in order to assess the benefit to cost ratio (BCR) at property level. In this respect, it provides responses to the following questions:[79]

- What benefits have been achieved by the voucher scheme?
- What costs are incurred by the different actors involved in the scheme?
- Have there been any differences in costs and benefits between the different subgroups of participants/ installers?

Annex 2 provides a detailed description of the methodology along with the list of benefits and costs included in the analysis.

[76] The CEA is normally adopted when benefits cannot be monetised or the cost to do so is very high. Inability or intrinsic difficulty in monetising benefits limits the value of CEA compared to CBA as described in the Magenta Book: Central Government guidance on evaluation, HM Treasury, 2020: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879438/HMT_Magenta_Book.pdf

[77] Social Cost Benefit Analysis quantifies in monetary terms the effects on UK social welfare. Costs to society are given a negative value and benefits to society a positive value. Costs to the public sector are counted as a social welfare cost. It generates measure of social value. When combined with an appropriate public sector cost measure a BCR is produced which provides a social unit cost measure.

[78] Social value (or public value) is based on principles and ideas of welfare economics and reflects the overall social welfare efficiency, not simply the economic market efficiency from an individual perspective (see The Green Book : Central Government Guidance on Appraisal and Evaluation. HM Treasury, 2022, Chapter.2) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1063330/Green_Book_2022.pdf

[79] The analysis has incorporated all measures for which estimates of expected energy savings per measure and property type as calculated for ECO3 by Ofgem were available. These estimates were available for about 60% of all measures installed as part of the scheme. See Annex 2 for further details.

10.1 The theoretical framework behind the economic evaluation

10.1.1 Societal value of energy use

The GHGVS had the dual aim of facilitating post-pandemic economic recovery and decreasing carbon emissions towards the UK's target for net zero by 2050. Valuing energy use was therefore a key component to understanding the monetary benefits of the scheme. The valuation of energy use is based on HM Treasury (2022) and BEIS supplementary guidance of 2021.[80] Net changes in energy use, associated with energy efficiency measures installed as part of the GHGVS, were calculated using GHGVS evaluation findings on energy efficiency per measure (as presented in Chapter 6 and Annex 4) triangulated with analysis undertaken for the interim outcome evaluation using Ofgem estimates for similar ECO3 measures.

Net energy changes have been valued in this evaluation based on the social cost of energy, the long run variable cost (LRVC) of energy supply. The LRVC reflects the production and supply costs of energy which vary according to the amount of energy supplied.[81] The supply costs vary over time and according to the type of fuel and the sector being supplied (Data Tables 9-13 of the accompanying spreadsheet to BEIS (2023).[82]

By including the value of energy savings in the VfM analysis, one can capture societal benefits both in the long run and short run. In the short run, they release energy for alternative uses. In the long run, costs can be reduced due to decreased energy demand.[83]

10.1.2 Value of increased comfort (direct rebound effect)

Policy interventions increasing energy efficiency and facilitating heat decarbonisation frequently have an impact on energy consumption and related costs. However, financial savings from increasing energy efficiency might be used to raise consumption and increase comfort in the home, with associated welfare gains (as discussed in Chapters 6 and 7). Net energy changes in this case are obtained by subtracting the rebound effect from the expected savings from the intervention. In this evaluation, the comfort-taking effect has been estimated at 15% of energy savings,[84] and its valuation is based on the retail price of energy, as this captures the gain in welfare.

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[80] Valuation of energy use and greenhouse gas (GHG) emissions: Supplementary guidance to the HM Treasure Green Book on Appraisal and Evaluation in Central Government. BEIS, 2023. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1129242/valuation-of-energy-use-greenhouse-gas-emissions-for-appraisal.pdf

[81] The valuation of energy use is based on the LRVC instead of retail fuel prices, as the latter includes fixed costs, carbon costs and taxes which reflect transfers.

[82] The data can be accessed from https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

[83] Energy Company Obligation ECOd: 2018 – 2022: Final Stage Impact Assessment. BEIS, 2018. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/749638/ECO_3_Final_Stage_IA__Final.pdf

[84] A survey of academic research on the scale of the direct rebound effect suggests a range between 10% to 30%. See for example, Azevedo, I. M. (2014). Consumer end-use energy efficiency and rebound effects. *Annual Review of Environment and Resources*, *39*(1), 393-418; Jenkins, J., Nordhaus, T., & Shellenberger, M. Energy emergence: Rebound & backfire as emergent phenomena (2011). We used 15% in this evaluation as done in similar evaluation (e.g ECO3). The Green Deal and Energy Company Obligation Impact Assessment. DECC, 2011. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/43000/3603-green-deal-eco-ia.pdf

10.1.3 Societal value of changes in GHG emissions

The quantification of GHG emissions changes has been based on net energy changes and emissions factors. The valuation of changes in GHG emissions has been calculated by multiplying the changes in GHG (CO2e) by the value of carbon. Carbon prices have been retrieved from Data Table 3 of the accompanying spreadsheet to BEIS' 2023 supplementary guidance on Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal.[85]

10.1.4 Societal value of air quality

Air pollution can have adverse health impacts, and direct long-term environmental impacts. As policy interventions targeting the reduction of emissions have an impact on air pollution, changes in air quality are expected to be part of the appraisal work and incorporated in the value-for-money analysis. Air quality effects have been estimated for this evaluation by applying 'activity costs' given the estimated changes in fuel. Activity costs or damage costs (2021 p/kWh) for specific types of fuel can be found in supplementary guidance to the HMT Green Book.[86] Data Table 15 of BEIS 2023 guidance[87] provides air quality damage costs from primary fuel use – both in terms of national averages and domestic values (inner conurbation, small urban, medium urban, big urban, rural).

A detailed description of the VfM methodology can be found in Annex 2.

10.2 Value for money of the scheme to society (social CBA)

Overall, the evaluation has found that the benefits generated by the scheme to society outweigh its costs, suggesting good value for money from a social welfare perspective. However, this tended to vary across technologies installed: Whilst benefits resulting from the installation of cavity wall insulation and loft insulation always outweighed their cost, external solid wall insulation and air source heat pumps appeared to be some of the most inefficient technologies from a VfM perspective due to their relatively high installation cost. Nevertheless, when the most cost inefficient measures (i.e. external solid wall insulation installed in mid-terraced and semi-detached properties) are excluded from the analysis, a higher benefit-to-cost ratio for society is produced. Table 10.1 overleaf presents the costs and benefits and BCRs for each of the five measure types considered in this cost-benefit analysis. Table 10.2 overleaf shows the contribution of the individual benefits to the total social benefits for those

[85] Valuation of energy use and greenhouse gas (GHG) emissions: Supplementary guidance to the HM Treasure Green Book on Appraisal and Evaluation in Central Government. BEIS, 2023. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1129242/valuation-of-energy-use-greenhouse-gas-emissions-for-appraisal.pdf

[86] Green Book supplementary guidance: air quality. Defra and HM Treasury, 2013. https://www.gov.uk/government/publications/green-book-supplementary-guidance-air-quality

[87] Valuation of energy use and greenhouse gas (GHG) emissions: Supplementary guidance to the HM Treasure Green Book on Appraisal and Evaluation in Central Government. BEIS, 2023. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1129242/valuation-of-energy-use-greenhouse-gas-emissions-for-appraisal.pdf

measure types for which statistically significant findings on energy savings was available (see Chapter 6 and Annex 4).[88]

For the sample of 303 air source heat pump installations used in the analysis, the findings demonstrate that the cost associated with their installation outweighed the societal benefits. This was partly due to high installation cost.

It is worth noting that the main input into the computation of the benefits are energy estimates based on a sample of households who consented to provide UCL with access to their smart meter data. While the composition of measures installed in these households are similar to those of the full population (see Annex 2), the sample was not drawn randomly. Thus, the findings of the CBA may not be representative of the full population of GHGVS installations.

[88] This is limited to households with gas central heating because all the results for electricity and gas usage for households with electric central heating are statistically insignificant. Also, the CBA was limited to only the sample of households from which smart meter data was collected because the scheme data does not have information on the type of central heating.

Table 10.1 Societal costs and benefits, appraisal period 2021-2063 (2021–prices) - Net benefit/cost

Measure Type	N	Lifetime	Benefits (£)	Costs (£)	Value of benefits compared to costs (£) (Net benefit/cost)	Benefit-to-cost ratio (BCR)
Cavity wall insulation	310	42	647,590	641,700	5,890	1.01
External solid wall insulation	308	36	989,912	3,804,108	-2,814,196	0.26
Loft insulation	458	42	698,450	682,420	16,030	1.02
Pitched roof insulation	306	42	443,700	1,707,174	-1,263,474	0.26
Air source heat pump	263	15	2,112,942	3,772,472	-1,659,530	0.56

Table 10.2 Percentage of individual benefits to total social benefits by measure

Measure Type	Energy savings (% of total benefits)	NHS spending savings (% of total benefits)	Carbon savings (% of total benefits)	Air quality improvements (% of total benefits)
Cavity wall insulation	23.1%	2.5%	44.8%	29.6%
External solid wall insulation	24.2%	1.7%	44.5%	29.6%
Loft insulation	23.5%	0.8%	45.5%	30.1%
Pitched roof insulation	23.5%	0.9%	45.5%	30.1%
Air source heat pump	2.8%	0.4%	57.2%	39.6%

10.2 Costs and benefits to participating households

Table 10.3 shows the cost and benefits from the household's perspective for the five measures. Loft insulation provided the greatest benefit-to-cost ratio for households followed by cavity wall insulation and pitched roof insulation. The lowest benefit-to-cost ratio resulted from the installation of air-source heat pumps. This is partly due to the observed increase in electricity consumption associated with the installation of this technology and the high installation cost.

Table 10.3 Private benefit-to-cost ratios by technology

Measure type	Count	Main benefits £ (bills savings + comfort taking)	Main costs £ (household contribution + hassle cost)	Value of benefits compared to costs £ (Net benefit/cost)	Benefit-to-cost ratio (BCR)
Cavity wall insulation	309	335,265	185,709	185,709	1.8
External solid wall insulation	307	532,952	767,500	-234,548	0.69
Loft insulation	458	369,148	186,864	182,284	1.98
Pitched roof insulation	306	234,396	179,010	55,386	1.31
Air source heat pump	263	154,644	1,247,146	-1,092,502	0.12

10.3 Considerations of value for money of GHGVS as an economic stimulus scheme

Employment benefits were not assessed as part of this cost-benefit analysis. Inclusion of these benefits normally depends on the extent to whether they can be precisely quantified, and the opportunity cost of labour can be reliably computed.[89] It is more straightforward to evaluate such an effect for targeted employment programmes compared to programmes with a wider focus on environmental objectives and economic stimulus, as in the case of GHGVS. However, as part of the analysis undertaken to assess the effects of the scheme on jobs and businesses, the evaluation considered the extent to which the scheme provided value for money in terms of the jobs directly and indirectly supported.

In relation to jobs directly supported through the scheme, the average number of jobs created or safeguarded per lodgement over the delivery of the scheme was 0.01 to 0.03 jobs[90] (i.e. 42.1 x 0.03 to 42.1 x 0.08). In total, the programme involved the delivery of 48,184 measures.

[89] As stated in section 6.2 of the HMT Green Book, the opportunity cost of labour should include the total value of output produced by the employees.

[90] Calculated as the percentage of jobs created per lodgement as a proportion of the average number of employees per firm.

This implies that the programme may have created or safeguarded a lower and upper bound range of 550 to 1,700 direct jobs[91] (0.01 x 48,184 to 0.03 x 48,184). This implies that the direct employment impacts of GHGVS were relatively modest and that firms were largely able to accommodate additional demand within their existing capacity or reduced (or delayed) other types of work to deliver measures funded via GHGVS. Alternatively, measures delivered via GHGVS may have largely been delivered via contractors (which would not be visible in these results). Evidence presented in the process evaluation from the survey of 218 installers suggests that where firms did take on new staff to deliver the scheme, this was primarily into administrative positions or as subcontractors, with an average of 1 additional subcontractor for every 3 being taken on according to the survey results.[92] In relation to jobs indirectly supported (i.e. the scheme's effects on unemployment during the COVID-19 lockdown period), it found that the scheme had an estimated reduction on unemployment of just over 900 claimants .

The findings imply that there were high levels of deadweight and/or crowding associated with the scheme. The additional GVA associated with the scheme can be approximated based on the average quarterly wage[93] for the construction sector in November 2020 (£8,944)[94] to the reduction in the number of unemployed claimants. This would give an indicative estimate of the additional output associated with scheme of £8.1m. This only represents a small share of total spending on the scheme. This would raise questions around VfM in terms of the effect of the scheme purely as a stimulus measure (although clearly if it diverts spending to energy efficiency measures from other things, then this is an important aspect of effectiveness).

10.4 Summary and conclusions

The CBA conducted for this evaluation suggests that, overall, the scheme generated societal benefits which modestly outweighed the costs of the scheme. The analysis of impacts on employment suggests, similarly, that, overall, the employment benefits monetarily outweighed the spending on the scheme. However, for some households, the costs of participation are likely to outweigh the monetary benefits derived.

[91] Calculated as the total effect over all lag periods (upper bound) or one lag period (lower bound) multiplied by the average number of firms times the number of firms delivering measures. This pertains to the favoured estimates for direct jobs effects. Several different ranges of estimates are presented in Table A7.6 in Annex 7. The widest possible range is from 455 to 3,864 direct jobs. Detailed explanation and discussion is provided in Annex 7.

[92] Analysis conducted by comparing survey responses to the two questions: B13: "In the 12 months before your business's involvement in the scheme, how many staff were involved in the delivery of the measure(s) you are providing through the scheme?" and C10: "Thinking about the staff who were involved in the delivery of the Green Homes Grant Voucher Scheme just before the announcement was made on 27th March 2021 that the scheme would close to new applications on 31st March 2021. How many staff were involved in the provision of [relevant measures]?". Only one wave of the installer survey was conducted. The base of respondents for this question was 209.

[93] On the basis that GVA is approximately equal to the sum of wages and profits.

[94] Annual Survey of Hours and Earnings, ONS.

11 Consumer demand for the scheme and onward consumer preferences

A key part of the ToC for GHGVS was an assumption that demand for the scheme would be sufficient to drive some of the behavioural and market changes that the scheme hoped to create. Longer term, the scheme was expected to contribute to onward demand for energy efficient and low-carbon home retrofits and/or demand for programmes like GHGVS, reflected in an increased interest in/understanding of energy efficiency for consumers outside of early adopters and increased installation of heat pumps, solar thermal, and heat controls.

This chapter explores the expected ToC hypotheses corresponding to the above-mentioned target outcomes further and answers the following two evaluation questions:

- How effectively has the scheme driven consumer demand for home insulation and low-carbon heating measures?
- What have we learned about consumer preferences from the choice of primary and secondary measures in combination with any additional unrelated building work?

11.1 How the scheme was intended to drive and influence consumer demand

Participation in (and consumer demand for) the scheme was expected to be encouraged by (a) scheme publicity and announcements, (b) the scale of financial incentive being offered, and (c) the terms and conditions of the scheme in terms of the measures that were primary vs. secondary, i.e., the (broad) eligibility requirements. GHGVS aimed to encourage demand 'beyond early-adopters',[95] though it also sought to accelerate the uptake of energy efficient measures and low-carbon heat solutions amongst those who would have had the measure completed anyway (but at a later date).

The various assumptions underpinning these causal hypotheses driving and influencing consumer demand are outlined in Chapter 4. Research and analysis for the GHGVS process evaluation[96] led Ipsos to confidently conclude that the assumptions underpinning GHGVS around consumer demand for, willingness to participate in and to contribute to the costs of installations under the scheme were valid.

In terms of onward behaviours, the ToC posited that scheme applicants would seek additional improvements to their homes in future and that other consumers would be encouraged to seek installations through word-of-mouth recommendations from scheme applicants.

[95] See the GHGVS ToC presented in Chapter 4 of this report.

[96] Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Process Evaluation Report. BEIS, 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131110/green-homes-grant-vouchers-phase-1-process-evaluation-report.pdf

11.2 Evidence of consumer demand for the scheme and onward demand for retrofits

11.2.1 Demand for the scheme

As set out in the interim outcome evaluation, the scheme received voucher applications for a much lower number of vouchers (169,430) than the approximately 600,000 for which funding was available. Over half (92,869, 54%) of the voucher applications were withdrawn or rejected, leaving 76,560 vouchers issued. Of these, 64% (49,355) resulted in measures installed, and 36% of all vouchers issued (27,194) expired. Qualitative research with participating households suggests that demand for the scheme was higher than the number of applications, as some (potential) applicants were unable to apply at all due to a lack of suitable installers or due to them missing the timeframe for applications (because of the short window between the closure of the scheme being announced and the scheme closing).

11.2.2 Onward demand for future measures

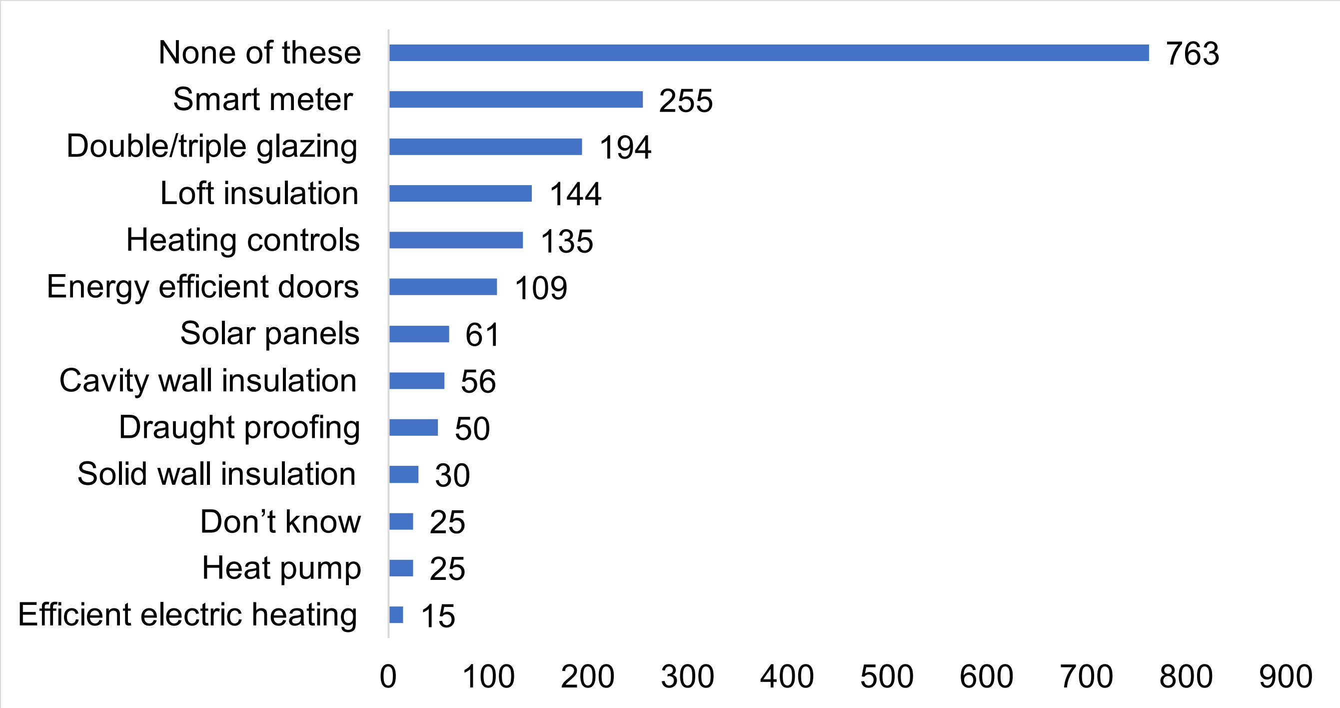
In the wave 1 survey, over half (58%) of applicants said they would be likely or very likely to consider other future measures. Findings from the wave 2 survey were similar. Of those surveyed who had installed a measure under GHGVS, 81% (1,071) said that they were more likely to consider other energy efficient or heating improvements in the future, compared to just 5% (60) who were less likely.[97] Of those who said they would consider making energy efficiency improvements to their home in the future, the most cited[98] by both occupiers and landlords were solar panels (988, 62%), energy efficient doors (852, 54%) and draught proofing measures (826, 52%). Cavity wall insulation was the measure least likely to be considered (211, 13%).

In addition to expressing their intention, 41% of wave 2 survey participants had had at least one other measure installed (to the same property) outside of the scheme since applying for the GHGVS voucher. The most common types of measures survey participants had installed were smart meters, double or triple glazing, loft insulation, heating controls and energy efficient doors. Some had also installed more expensive measures such as solar panels, cavity wall insulation, solid wall insulation, and heat pumps. Most applicants who had had any other energy efficient or heating improvement(s) installed to their property since they first applied for a GHGVS also expressed that they were satisfied with the scheme.

[97] Base: 1,328 (all who had had an installation through GHGVS). Refers to question E5. As a result of having energy efficient or heating improvements installed, would you say you are more or less likely to consider other energy efficient or heating improvements in the future?

[98] Refers to question E6. Which, if any, of the following energy efficiency improvements would you consider making to the property in the future?

Figure 11.1: Other measures installed since applying for a GHGVS voucher



Base: 1,328. Refers to question D9. Aside from the improvements we've been talking about which are listed below, have any other energy efficient or heating improvement(s) been installed to this property since you first applied for a Green Homes Grant Voucher? Wave 2 survey.

11.2.3 Potential for wider demand for measures beyond participants

Amongst survey participants who had had at least one measure installed (whether on GHGVS or outside it), 33% (539 of all of those responding to the question) had already recommended the measure to someone they knew.[99] Proportionally higher shares of heat pump, external wall insulation and heating control customers had already made the recommendations: 54% of all heat pump customers responding to the question (100), 46% of all external wall insulation customers (133), and 42% (21) of all heating control customers. For customers of other measures, the share who had recommended the measure already ranged from 0 to 32%.

11.3 Exploring contribution

11.3.1 Evidence indicating a contribution of the scheme to consumer demand for measures

The quantitative and qualitative work found a consistent theme of consumers reporting that they would not have installed the measure without the scheme. When asked how likely they would have been to have the measures installed if the scheme had not been available, a majority of survey participants (66%) stated that they would have been unlikely to do so. Landlords participating in qualitative interviews also indicated that the scheme influenced them

[99] Base 1,658. Refers to question E8. How likely would you be to recommend the improvement(s) listed below to people you know?

to install measures, with several questioning how they would have been able to finance the necessary improvements in the absence of a government grant.

Applicants for measures which tend to be less expensive and/or require less intrusive work in the home were more likely to state that they would have installed the measure without the scheme than applicants for measures that tend to cost more and/or require more intrusive work in the home. In this way, a large share of those who applied for external solid wall insulation, heat pumps, park home insulation, and solar thermal stated that they would have been unlikely to have these installations without the scheme. Those who applied for loft insulation were almost evenly split between those who would have been likely to install the measure without the scheme and those who would have been unlikely to do so.

Table 11.2: Applicants' likelihood of installing the measure without GHGVS support (results from two waves of applicant survey conducted for this evaluation)[100]

Measure for which application was made	% Likely to have installed without GHGVS – Wave 1	% Likely to have installed without GHGVS – Wave 2	% Unlikely to have installed without GHGVS – Wave 1	% Unlikely to have installed without GHGVS – Wave 2	Cost of measure (relative)	Required level of labour to implement
Loft insulation	39	41	43	48	Low	Low
Double triple glazing	33	25	50	54	High	Medium-high
Flat roof insulation*	30	23	55	74	Low	Low
Biomass boiler*	30	N/A[101]	55	N/A[103]	Medium-high	Medium-high
Energy efficient replacement doors*	30	31	52	54	Medium	Low-medium
Cavity wall insulation	29	35	53	51	Low	Low
Heating controls	26	31	57	67	Medium	Low-medium

[100] The survey results in this table have been presented for completeness and are subject to margins of error which vary with the sample size specific to each question and the percentage figure concerned. This means that not all differences reported are statistically significant.

[101] No applicants for biomass boilers participated in the wave 2 survey.

Measure for which application was made	% Likely to have installed without GHGVS – Wave 1	% Likely to have installed without GHGVS – Wave 2	% Unlikely to have installed without GHGVS – Wave 1	% Unlikely to have installed without GHGVS – Wave 2	Cost of measure (relative)	Required level of labour to implement
Room-in-roof insulation*	26	22	60	62	Low	Medium
Internal solid wall insulation*	25	23	61	61	High	High
Under floor insulation (solid floor and suspended floor*	19	22	63	69	Low-medium	Low-medium
Heat pumps (air source, ground and hybrid)	18	18	72	78	High	Medium-high
Pitched roof insulation	15	16	74	68	Low	Low
External solid wall insulation	14	16	72	75	High	Medium
Park home insulation*	14	17	76	78	High	Medium-high
Solar thermal	9	10	80	80	Medium-high	Medium-high

Bases: Wave 1 survey: 4,979. Summary responses to the question F1. If the Green Homes Grant Voucher scheme had not been available, how likely would you or the people who live at the property have been to have had the following improvements installed to this property anyway?

Wave 2 survey: 1,546. Summary responses to the question E4. If the Green Homes Grant Voucher scheme had not been available, how likely would you or the people who live at the property have been to have had the following improvements installed to this property anyway?

Note: Measures marked with * had low base sizes. Hot water tank insulation, hot water tank thermostats, Secondary glazing and draught proofing are omitted from the table below due to low base size (<100).

Other findings of the survey also indicate that, without the scheme, consumers were generally less likely to pursue additional retrofits: 40% (297) of applicants responding to the wave 2 survey who had applied for a measure that had not led to an installation at the time of the survey (between May 31st and August 11th, 2022) decided not to proceed with the installation altogether. This was proportionally more common where the application was for a low-carbon heating measure, in particular solar-thermal and air source heat pumps (where all survey participants whose applications had not led to an installation had decided to not proceed). Only 15% (114) of these survey participants stated that they had completed their installation outside of GHGVS. This was slightly less likely to be the case when the application was for low-carbon heating. These findings further underline that consumer's willingness to install measures, especially low-carbon heating measures, were driven by the scheme.

11.3.2 Evidence of the relationship between satisfaction with the scheme and whether consumers would recommend it to others

Both the survey responses (see Table 11.3 overleaf) and qualitative interviews conducted for the evaluation indicate that participants were more likely to have already recommended the measure(s) they had installed to others if they were satisfied with the scheme.

Table 11.3: Participants' likelihood to recommend measures to people they know, corresponding to scheme satisfaction

Measure installed	Likelihood to recommend measures to people they know	Very/fairly satisfied with the scheme	Very/fairly dissatisfied with the scheme
Air source heat pump	I have already recommended it to someone	65 (72%)	20 (22%)
Air source heat pump	Very likely	20 (80%)	4 (16%)
Air source heat pump	Quite likely	13 (58%)	7 (32%)
Cavity wall insulation	I have already recommended it to someone	23 (70%)	4 (11%)
Cavity wall insulation	Very likely	40 (77%)	11 (21%)
Cavity wall insulation	Quite likely	11 (41%)	12 (48%)
External solid wall insulation	I have already recommended it to someone	109 (82%)	18 (14%)
External solid wall insulation	Very likely	73 (81%)	15 (17%)
External solid wall insulation	Quite likely	25 (61%)	12 (30%)
Loft insulation	I have already recommended it to someone	47 (60%)	27 (35%)
Loft insulation	Very likely	76 (65%)	35 (29%)

Measure installed	Likelihood to recommend measures to people they know	Very/fairly satisfied with the scheme	Very/fairly dissatisfied with the scheme
Loft insulation	Quite likely	39 (62%)	17 (27%)
Pitched roof insulation	I have already recommended it to someone	30 (70%)	9 (21%)
Pitched roof insulation	Very likely	23 (71%)	6 (19%)
Pitched roof insulation	Quite likely	20 (70%)	6 (23%)
Solar thermal	I have already recommended it to someone	47 (74%)	16 (26%)
Solar thermal	Very likely	53 (78%)	9 (14%)
Solar thermal	Quite likely	20 (58%)	10 (30%)
Under-floor insulation: Suspended floor	I have already recommended it to someone	16 (68%)	6 (25%)
Under-floor insulation: Suspended floor	Very likely	16 (64%)	7 (29%)
Under-floor insulation: Suspended floor	Quite likely	10 (54%)	7 (35%)

Base: 81 – 313, covering question E8. How likely would you be to recommend the improvement(s) listed below to people you know? [per measure], wave 2 survey. Only measures with more than 100 survey participants completing the installations through the scheme included.

11.3.3 Evidence of the scheme's influence on consumer onward behaviour

Applicants' openness to consider installing future energy efficient or heating improvements correlated with overall scheme satisfaction: Three quarters (74%) of those applicants stating that they were more likely to consider future heating improvements in the wave 1 survey had also stated that they were overall satisfied with the scheme, which also applied to 88% of wave 2 survey participants who were asked this question.[102] Evidence from qualitative interviews as to whether applicants would recommend the scheme to others was presented in the interim outcome evaluation report.[103] Most applicants interviewed through the qualitative research for this evaluation stated that they would recommend the measure because they were happy with the result, with several saying that they would also caveat that applications to the scheme would require a significant degree of patience. Those who had experienced issues since the installation did not share this view; they felt that they had not obtained their expected benefits from the scheme and could therefore not recommend it to a friend. This suggests that negative experiences with the scheme would not necessarily deter future participation in government

[102] This correlation has not been tested for statistical significance.

[103] Evaluation of the Green Homes Grant Voucher Scheme (GHGV): Interim Outcome and Economic Evaluation Report. BEIS, 2022, page 42. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1131112/green-homes-grant-vouchers-phase-2-interim-outcome-report.pdf

schemes, but that a negative experience with an installed measure might deter such participation.

Additional measures installed by survey participants outside of GHGVS were mainly paid for from survey participants' own income (in between 52% and 94% of cases, depending on measure type), except in the case of smart meters, which were commonly paid for through other means (most likely through the survey participants' energy supplier) and heat pumps, of which nine (out of 25) had been paid for through the Domestic Renewable Heat Incentive (RHI).[104] Out of a base of 146 survey participants who had had measures installed and funded by other schemes since they first applied to GHGVS, 42 had funded measures through LAD and 40 through ECO, Carbon Emissions Reduction Target (CERT), or Community Energy Saving Programme (CESP). However, this evaluation has not been able to demonstrate any causal link between participation in GHGVS and installation of further measures. (For example, the households concerned could have been renovating lots of aspects of the house and searching for different funding streams to be able to do so). The findings are, however, interesting as they indicate demand for schemes such as GHGVS and the ways through which different households combined different funding options to implement multiple measures, which – as discussed in previous chapters (e.g., Chapter 6) would have a greater positive effect on energy efficiency of the home and home decarbonisation.

11.3.4 Evidence of the scheme's influence on choices around measures

There is clear evidence from the qualitative research with applicants (both waves) that some applicants had not heard about the measures available on the scheme and only learned about them on speaking to installers to see how best they could use the available subsidy. Some applicants wished to have specific installations to resolve specific problems in their home (e.g., cold spots in the home, draughts). Others knew little about the available measures but, on hearing about the scheme, enquired with installers about what measures were available and which would be most appropriate to their personal priorities and circumstances. Other motivations for choosing one measure above the others available included recommendations from family or friends, or the elimination of alternative measures that would not have been appropriate for the house in question (e.g., insufficient space around the home for a heat pump). Others had particular measures in mind but were drawn to install others due to the terms and conditions of the scheme.

Some applicants consulted for the evaluation had chosen not to install secondary measures because their preferred secondary measure would have cost more than their chosen primary measure.[105] This suggests that the price capping policy in place for secondary measures may have discouraged certain formations of application.

11.3.5 Other factors driving the installation of measures (during the scheme)

The primary motivations for applying to the scheme amongst those responding to the wave 1 applicant survey were: a desire to save money on energy bills (86%), an interest in making the property warmer or more comfortable (70%), and a desire to reduce energy for environmental reasons (61%). Particularly prominent amongst applicants participating in qualitative research

[104] As stated in responses to question D11. Which government scheme(s) were the (additional) energy efficient or heating improvement(s) funded by?

[105] The Green Homes Grant Voucher Scheme capped the available subsidy for any secondary measure to the cost of the primary measure.

was an interest in making the home feel warmer or more comfortable, also closely linked to the desire to resolve specific issues in the home.

Landlords were frequently motivated above all by an interest in increasing the EPC rating of the home to ensure it would meet upcoming minimum EPC requirements. They chose measures that they felt would be well-suited to enabling them to achieve this. In choosing measures, some landlords were also concerned about minimising the degree of disruption to tenants during installation. One landlord chose solar thermal for this reason, and another chose loft insulation. An additional motivation for landlords was a desire to increase the comfort of their tenants, with at least one mentioning that their tenants were on low incomes and struggled to pay their fuel bills.

11.4 Summary and conclusion

The scheme's reach was lower than it could have been; the scheme had funding able to benefit around 600,000 homes, but applications were made for only 113,739 properties. Only 49,355 of these applications resulted in vouchers. However, evidence presented in the process evaluation indicates that some demand was not met through the scheme, as some (potential) applicants were unable to obtain vouchers through not being able to find suitable installers at all / within the timeframes of the scheme. As set out in Chapter 3.3 of this Final Outcome Evaluation, withdrawals from the scheme were mainly driven by the process of getting the voucher taking too long, and challenges of getting installers to complete the works within the timeframes of the scheme.

The responses to the wave 2 survey of applicants indicates the majority of demand for measures was catalysed by the scheme: 66% of survey participants indicated that they would have been unlikely to have the measures installed if the scheme had not been available. Survey respondents also indicated that GHGVS accelerated the behaviour of some homeowner-occupiers and landlords who had long-term plans to install measures but who were not seeking to do so before the scheme (due to financial or pragmatic constraints). However, it is not possible to use the quantitative data from a survey that relies on self-reporting to calculate overall deadweight. The lack of an overall robust analysis of deadweight is covered in the discussion of evaluation method strengths and limitations in Annex 1.

There is evidence that the scheme influenced consumers' choice of measures, with some applicants having little to no knowledge of the available measures prior to undertaking research on learning of the scheme. The categorisation of measures into primary and secondary categories caused some whose preferred measure was a secondary measure to also apply for a primary measure.

The survey results from both waves of applicant survey suggest that the scheme may catalyse future demand for energy efficient and low-carbon heating measures, with the majority of survey participants considering future measure installations. Participants in the wave 2 applicant survey state that they would also willing to pay for measures out of their own savings. Both quantitative and qualitative findings indicate that this willingness was frequently dependent on applicants' experience with the scheme and of the measure since installation being broadly positive. Applicants were also likely to recommend the measures they had installed to people they know, although this was dependent to a large extent on their satisfaction with the measure.

12 Conclusions

12.1 Benefits to households and effects on energy use behaviour

GHGVS has generated savings in energy usage, bills, and carbon emissions. However, these impacts have been both small in scale and highly dependent on the measures taken up by participants. The smart meter data analysis conducted for this evaluation observed effects on energy savings in previously gas-heated homes which had installed external solid wall insulation, cavity wall insulation, loft insulation, pitched roof insulation and air source heat pumps.[106]

Given past studies that suggest that comfort taking may explain lower post-retrofit energy savings, it is possible that energy, carbon and bill savings may be lower than they otherwise would have been due to applicants taking the opportunity to improve their comfort rather than realise savings.

Both the findings from the survey, qualitative interviews, and the health impact modelling suggest that GHGVS installations generated modest health benefits (or perceived health benefits) amongst some households installing a measure through the scheme. The combined evidence from the survey and qualitative research indicates that this was mainly the case when the measure led to the occupants being able to better warm their home or heat their water.

12.2 Effects of the scheme on fuel poverty

The modelling conducted for this evaluation estimated that 14% of homes likely to be fuel poor would have been lifted out of fuel poverty as a direct result of the GHGVS (~3,445 households). This is lower than initially anticipated at the outset of the policy. This is likely partly because of the lower than anticipated reach of the scheme, but it may also be because households likely to be fuel poor mostly applied for single measures that brought about only small improvements to the energy performance of their homes. Indeed, the fuel poverty modelling conducted for the evaluation found just 12% of participating energy inefficient homes (regardless of income) were raised above 'band D' as a direct result of the scheme.

It can therefore be concluded that for GHGVS to have made a bigger impact on fuel poverty (according to the LILEE definition) it would have needed to have supported the installation of multiple measures in fuel poor households. In turn, this would have lifted more households out of fuel poverty and lifted them further up their energy performance ratings.

[106] Where no effects were observable, this may have been due to the small numbers of these measures present in the sample, rather than to a non-existent or small observed effect resulting from the measure itself.

12.3 Quality of installation and service

The GHGVS quality systems were effective at (a) preventing poor quality installations; and (b) detecting them where they occurred. The evaluation's independent research with auditors, certification bodies and applicants has shown that – nonetheless – cases of poor-quality installations did occur. Qualitative interviews with applicants provided some examples of installations that may not have been carried out to PAS or TrustMark standards (particularly where households were not given sufficient information on aftercare and maintenance of the installation). However, TrustMark audit data indicates that – overall – quality issues were proportionate to the scale of the scheme.

In terms of the scheme's contributions to these outcomes, GHGVS contributed to the quality of installations observed to the extent that it integrated systems of quality improvement in the sector (TrustMark, PAS, MCS and other certifications).[107] In this way, scheme design was coherent with existing policy, and economic in utilising existing tools rather than 'reinventing the wheel' for quality. To the extent that GHGVS encouraged installers wishing to participate in the scheme to seek certification and register with TrustMark, which auditors believed raised the bar of quality in the retrofit profession, the scheme contributed to quality. However, the evaluation findings also indicate that, in some cases where poor quality of installation occurred, this was due to installations being rushed due to the short timescales of the scheme and/or the pressure to complete installations and redeem vouchers within the deadlines of the scheme. In this way, scheme design negatively impacted on quality.

12.4 Benefits to the market

Overall, the effects on employment were small. An econometric analysis of employment within the firms participating in the scheme and of unemployment rates in the localities in which participating firms were based found that GHGVS directly created or safeguarded a lower and upper bound range of 550 to 1,700 jobs in the firms participating in the scheme.[108] It was not possible to gather robust evidence on other business effects such as turnover and profit. However, evidence from qualitative interviews (within the home improvement supply chain for both process evaluation and this outcome and economic evaluation) indicates that GHGVS contributed to increased employment and turnover at least in the short-term.

12.5 Value for money

The CBA conducted for this evaluation suggests that, overall, the scheme generated societal benefits which modestly outweighed the costs of the scheme. The analysis of impacts on employment suggests that, overall, the employment benefits monetarily outweighed the spending on the scheme. However, for some households, the costs of participation are likely to outweigh the monetary benefits derived from the scheme.

[107] Where these systems were that were established and evolved under previous policies such as the Each Home Counts Review and ECO before being adopted as part of GHGVS.

[108] This pertains to the favoured estimates for direct jobs effects. Several different ranges of estimates are presented in Table A7.6 in Annex 7. The widest possible range is from 455 to 3,864 direct jobs. Deeper explanation and discussion is provided in Annex 7.

12.6 Consumer demand for the scheme

When asked how likely they would have been to have the measures installed if the scheme had not been available, a majority of survey participants (66%) stated that they would have been unlikely to do so. Both waves of applicant survey indicate significant differences in reported additionality of the GHGVS voucher in driving them to install the measure, with the scheme likely to have encouraged large proportions of those installing solar thermal through the scheme, but much smaller proportions of those installing loft insulation, as set out in detail in Table 11.2.

The results of the applicant surveys also suggest that the scheme accelerated the behaviour of some homeowner-occupiers and landlords who had long-term plans to install measures but who were not seeking to do so before the scheme (due to financial or pragmatic constraints). There is also evidence that the scheme influenced consumers' choice of measures, with some applicants having little to no knowledge of the available measures prior to undertaking research on the scheme. The categorisation of measures into primary and secondary categories caused some whose preferred measure was a secondary measure to apply for a primary measure.

Wave 2 applicant survey data indicates that GHGVS applicants would be willing to take advantage of future schemes, but also that they would be willing to pay for measures themselves.

Appendix 1 Measures installed under the scheme (based on final scheme data)

Table Apx1: Measure installations, per type

Measure group	Measure type	Total measures installed	Percentage measures installed
Primary Measures		**45,936**	**93.1%**
Insulation		**33,485**	**67.8%**
Insulation	Cavity Wall Insulation	4,418	9.0%
Insulation	External Solid Wall Insulation	9,855	20.0%
Insulation	Internal Solid Wall Insulation	1,097	2.2%
Insulation	Loft Insulation	7,734	15.7%
Insulation	Pitched Roof Insulation	6,217	12.6%
Insulation	Flat Roof Insulation	861	1.7%
Insulation	Room in Roof Insulation	763	1.5%
Insulation	Solid Floor Insulation	63	0.1%
Insulation	Suspended Floor Insulation	1,864	3.8%
Insulation	Park Home Insulation	613	1.2%
Low Carbon Heat		**12,451**	**25.2%**
Low Carbon Heat	Air Source Heat Pump	3,966	8.0%
Low Carbon Heat	Ground Source Heat Pump	31	0.1%
Low Carbon Heat	Hybrid Heat Pump	963	2.0%
Low Carbon Heat	Biomass Boiler	6	0.0%
Low Carbon Heat	Solar Thermal	7,485	15.2%
Secondary Measures		**3,419**	**6.9%**
Heating Controls		**1,133**	**2.3%**
Heating Controls	Heating Controls	1,133	2.3%

Measure group	**Measure type**	**Total measures installed**	**Percentage measures installed**
Heating Controls	Hot Water Tank Insulation	0	0.0%
Heating Controls	Hot Water Tank Thermostat	0	0.0%
Windows and Doors			**2,286**
Windows and Doors	Double or Triple Glazing	916	1.9%
Windows and Doors	Draught Proofing	15	0.0%
Windows and Doors	Energy Efficient Windows and Doors	1,327	2.7%
Windows and Doors	Secondary Glazing	28	0.1%

Source: Green Homes Grant Voucher Scheme (GHGVS) Statistics (BEIS, October 2022).

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