Department for
Energy Security
& Net Zero

Whole House Retrofit (WHR) and Social Housing Decarbonisation Fund Demonstrator (SHDF(D))

Outcome and economic evaluation – Technical Annex

Contents

Annex 1: Methodological approach to the final outcome and economic evaluation

This Annex provides an overview of the evaluation scope, analytical approach, analytical and data collection methods, data sources and methodological limitations of the joint evaluation of the Social Housing Decarbonisation Fund Demonstrator (SHDF(D)) and Whole House Retrofit (WHR) programmes.

A.1.1: Evaluation scope

The research conducted for this joint outcome and economic evaluation covers the programmes' inception, delivery, project closure and post-closure activities over the period February 2021 to 30 June 2023.

This report has focussed on the outcome evaluation questions listed in the matrix in Table A1 below. These outcome evaluation questions were first developed by the Department for Energy Security and Net Zero (DESNZ, formerly BEIS), as part of the initial evaluation scoping stage. Ipsos then refined the questions in early 2022, in collaboration with DESNZ, and as part of the outcome evaluation scoping stage. The evaluation questions interrogate the causal hypotheses underpinning both programmes, so as to generate evidence demonstrating (or disproving) the plausibility that the programmes contributed to the measured outcomes. Process evaluation questions have been fully covered in the process evaluation report (June 2023).[1]

Table A1: Final outcome and economic evaluation scope (evaluation matrix)

Evaluation questions	Aspect of the ToCs covered	Where covered in the Report
Are occupants satisfied with the retrofits?	Resident understanding of how to use the retrofit Resident satisfaction with the retrofit process Improved home aesthetics Less damp, draughts, and mould Healthier occupants Energy efficient occupant behaviour	Chapter 6 (resident outcomes)

---

[1] Joint Process Evaluation Report - Whole House Retrofit (WHR) and Social Housing Decarbonisation Fund Demonstrator (SHDF(D)), BEIS/DESNZ Research Paper Series Number 2023/008

Evaluation questions	Aspect of the ToCs covered	Where covered in the Report
How has resident behaviour changed post-retrofit?	Resident understanding of how to use the retrofit Resident satisfaction with the retrofit process Less damp, draughts, and mould	Chapter 5 (building performance)
Are residents paying less on their energy bills post-retrofit?	Energy bills are lower than they would have been without retrofit Fuel poverty reduction	Chapter 5 (building performance)
Have projects affected non-participating residents, and if so, how?	It was not possible to finally assess this evaluation question, because data was not collected from non-participating residents (see limitations section). The process evaluation provides some insights into non-participating residents' views and experiences of the programmes.	N/A
How much have whole house retrofits improved energy performance and why?	Improved energy performance Less damp, draughts, mould Healthier homes post-retrofit Carbon emissions reductions Fuel poverty reduction	Chapter 5 (building performance)
What level of PAS 2035-compliance and build quality was achieved and why?	Less damp, draughts, mould Improved home aesthetics Healthier homes post-retrofit Quality of retrofit improved compared to baseline	Chapter 5 (building performance)
Have the programmes contributed to retrofit market growth?	Increased supply chain confidence Supply chain skills development and business growth Improved supply chain capabilities for retrofit at-scale	Chapter 7 (market outcomes)
To what extent have the programmes supported green jobs?	Job support (for SHDF(D), post-Covid) Reduced unemployment compared to counterfactual	Chapter 7 (market outcomes)

Evaluation questions	Aspect of the ToCs covered	Where covered in the Report
Have cost reductions for retrofit been achieved and why?	Increased understanding of costs and cost reduction methods	Chapter 8 (cost reduction)
Which delivery models have been most successful?	Know-how on what works to support project selection, improved project delivery and programme design	Chapter 9 (learning outcomes)
How much have the programmes helped develop landlord capability for delivering future retrofit?	Increased capacity for PAS2035/2030 delivery and fabric first approach Improved ability of the supply chain	Chapter 9 (learning outcomes)
How much have the programmes helped DESNZ develop their policy portfolio for retrofit and capability to support social housing decarbonisation?	Learning & know-how feed directly into ongoing and future BEIS programmes to make them more effective and efficient Partnerships, systems and communities created Buy-in from Ministers / Treasury, with funding made available for following / related programmes in future Effective and efficient systems ready to use in future energy efficient programmes	Chapter 9 (learning outcomes)

A.1.2 Analytical approach

A.1.2.1 Overarching approach

For each anticipated outcome of this outcome evaluation, we assessed: (a) actual change – i.e. whether anticipated outcomes occurred, and (b) whether these outcomes were caused by the programme (attribution / contribution). This is reflected in the structure of Chapters 5 to 9.

To support our analysis, and to ensure as robust an analysis as possible, we applied a five-step approach to the outcome evaluation.

Step 1: Development and refinement of the ToCs. ToCs existed for WHR and SHDF(D) prior to the start of the evaluation. At the outset of the evaluation, the evaluation team ran a workshop with DESNZ to probe on key components (assumptions, expected outcomes) of the ToC – this information fed into the development of the overarching Evaluation Plan (produced April 2021). Based upon evidence collected through the process evaluation, the evaluation team updated and refined the ToC diagrams and validated these with DESNZ. These updated ToCs were published in the process evaluation report.

Step 2: Refinement of the evaluation questions and research themes. We then developed outcome evaluation questions that would enable us to assess whether the outcome pathways established in the updated ToCs occurred. The questions were developed into frameworks for research (including those in Figures A1 and A2), that set out the additional assumptions to be tested, lines of inquiry and data collection methods. On this basis we also developed research tools.

Step 3: Data collection. We collected evidence to support / refute the hypotheses through interviews, survey and ethnographic work and collated and cleaned monitoring data (final and interim project reports), thermal efficiency and cost data.

Step 4: Data analysis and hypothesis testing. We employed different analytical techniques to draw conclusions on programme outcomes, as set out below. We selected these analytical techniques depending on what was the most appropriate for the nature of and the data available to assess each outcome area. These different techniques enabled us to test and draw conclusions on the plausibility of the causal hypotheses. For all outcomes, whichever technique used, the evaluation investigated both whether there was evidence to support the hypothesis and evidence to refute it / support an alternative hypothesis. However, as there has been no counterfactual analysis conducted for the evaluation, the absence of evidence supporting an alternative hypothesis (or refuting / disproving the causal hypothesis) does not mean necessarily that the causal hypothesis is proven.

Step 5: Development of findings and conclusions. As a final step, we synthesised the findings per outcome area into a single narrative of performance and outcomes relative to the ToC. To do this we held an internal analysis meeting with the fieldwork leads to discuss salient and interesting findings emerging. We then held a further analytical meeting once the main

stage of analytical activity had finished to discuss findings for each outcome area and plan our narrative.

A1.2.2 Theories of Change

A Theory of Change (ToC) is an analytical tool which maps the logical chain of events under which a policy or programme leads to its intended effects, and other contextual factors which may affect change.[2] ToCs set out the structure of an intervention, the outcomes and impacts that it intends to achieve, how these fit within the wider policy and societal context, and how the inputs and activities are intended to achieve them.

ToCs were developed for WHR and SHDF(D) prior to the start of the evaluation, as part of the programme's assurance processes. At the outset of the evaluation, the evaluation team ran a workshop with DESNZ to probe on key components (assumptions, expected outcomes) of the ToC – this information fed into the development of the overarching Evaluation Plan (produced April 2021). Based upon evidence collected through the process evaluation, the evaluation team updated and refined the ToC diagrams and validated these with DESNZ. These updated ToCs were published in the process evaluation and are presented overleaf in Figures A1 and A2.

---

[2]
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879438/HMT_Magenta_Book.pdf

Figure A1: ToC for WHR programme

Buildings Mission: At least halve the cost of renovating existing buildings to a similar standard as new buildings, while increasing quality & safety

Clean Growth (increased energy efficiency & increased employment in green jobs)

More cost-effective retrofit projects are taken forward by BEIS (at-scale)

More cost-effective retrofit projects are taken forward by others (at-scale)

Reduced Fuel poverty

Fewer new homes needed

Supply chain is able to retrofit at-scale, to quality & at speed

Increased demand for whole house approaches to retrofits

Energy bills lower than would have been without retrofit

Health & comfort of occupiers improved

HM Treasury & BEIS confident to support future programmes

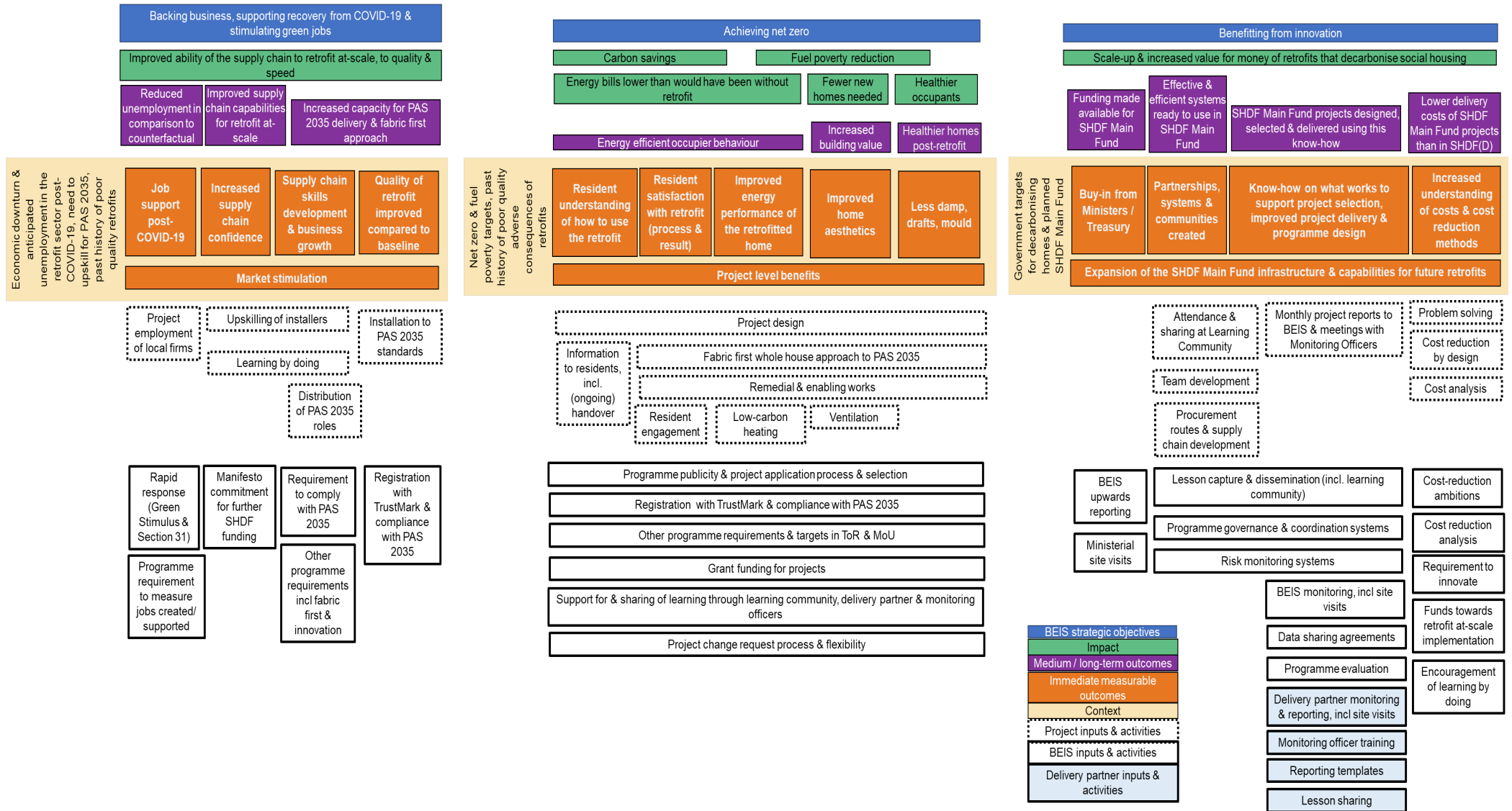Learning & know-how feeds directly into ongoing & future BEIS programmes to make them more effective & efficient

Industry is motivation & capability increases

Delivery costs of newly-designed projects are lower than they were in WHR

Occupier behaviour is energy efficient

Retrofitted home is healthier

Building value increases

Reduced unemployment compared to counterfactual

Supply chain gears up to deliver retrofits at-scale

Increased capacity to deliver to PAS 2035 & fabric first approach

Ministers & Treasury aware of, underst& & can see benefits of WHR

Know-how generated within BEIS on what works to support project selection, improved project delivery & programme design

Know-how is shared / generated beyond BEIS

Increased underst&ing of costs & how to reduce these

Residents underst& how to use retrofit

Resident satisfaction with retrofit (process & result)

Significant energy dem& reduction achieved

Less damp, drafts, mould

Improved home aesthetics

Jobs supported / created

Increased supply chain confidence

Supply chain skills developed & business growth

Quality of retrofit improved compared to baseline

Generating learning about how to do whole house retrofit at-scale & at reduced cost

Improving the energy performance of dwellings

Market stimulation

Attendance & sharing at Learning Community

Problem solving

Project design

Projects employ skilled workers

Upskilling of installers

Installation to high quality

Monthly project reporting to BEIS & meetings with Monitoring Officers

Cost-reduction by design

Information to residents,

Fabric first whole house approach

Learning by doing

Cost analysis

Remedial & enabling works

BEIS upwards reporting

Lesson capture & dissemination (incl. Learning Community)

Cost-reduction ambitions

Resident engagement

Low carbon heating

Ventilation

Ministerial site visits

Programme governance & coordination systems

Cost reduction analysis

Risk monitoring systems

Requirement to innovate

Programme publicity & project application process & selection

BEIS monitoring, incl site visits

Funding to enable retrofit at-scale

Programme requirements & targets stated in ToR & MoU (e.g. around space heating)

Data sharing agreements

Encouragement of learning by doing

Grant funding for projects

Programme evaluation

Support for +sharing of learning through Learning Community, Delivery Partner & Monitoring Officers

Delivery Partner monitoring & reporting, incl site visits

Project change request process & flexibility

Monitoring Officer training

Reporting templates

Lesson sharing

Legend:
- BEIS strategic objectives
- Impact
- Medium / long-term outcomes
- Immediate measurable outcomes
- Project inputs & activities
- BEIS inputs & activities
- Delivery partner inputs & activities

Figure A2: ToC for SHDF(D) programme

A.1.2.3 Analysis of individual outcomes

Building performance: This outcome is covered in Chapter 5 of the main report. To assess building performance, we triangulated evidence from the following strands of analysis:

- Descriptive statistical analysis of:
    - Pre- and post-installation EPC ratings taken from project reporting or modelled where the retrofit was not yet complete or EPCs were missing from reporting.
    - The pre- and post-installation space-heating-requirement of retrofitted properties taken from project reporting or modelled where the retrofit was not yet complete or the data was missing from reporting.

- Subsequent modelling of estimated energy savings, energy bill savings and carbon emission reductions using analysis of changes in space-heating-requirement. The methodology for energy modelling is described in Annex 2 of this technical report.

- Descriptive analysis of data from the resident survey on perceived changes to the warmth, comfort and aesthetics of the property, as well as whether problems (damp, draughts, condensation) had been resolved post-retrofit.

- Thematic analysis of residents' perspectives from qualitative research with residents on the warmth and comfort of the property pre- and post-retrofit, the existence (or not) of problems (damp, draughts, condensation), as well as their views on the quality of the retrofit.

- Thematic analysis of findings on post-installation energy use behaviour from qualitative research with residents.

Outcomes for residents: This outcome is covered in Chapter 6 of the main report. Findings and conclusions are derived from thematic analysis of the perspectives of residents on benefits and disbenefits of the retrofits drawing on evidence from the resident survey, depth interviews, mobile diary, and site visits.

The methodology for data collection with residents is described in this Annex 1 of this technical report.

Market outcomes: This outcome is covered in Chapter 7 of the main report. Assessed through a contribution analysis approach which draws on data from project reporting (e.g. number of full-time equivalent (FTE) persons employed on the projects), a market analysis conducted before projects reached installation stage (in 2021) and in 2023 when most projects were post-installation, and interviews with project teams, as well as interviews with the wider supply chain. The methodology for the contribution analysis is described in Annex 3 of this technical report.

Cost reduction outcomes: This outcome is covered in Chapter 8 of the main report. We triangulated evidence from the following strands of analysis:

- A thematic analysis of project reporting on cost reductions – i.e. the extent to which projects were able to reduce the costs of delivering whole house retrofit at scale, as

evidenced through a reduced final cost per property of the retrofit compared to the counterfactual or 'baseline' costs estimated at project application stage.

- A systematic analysis of enablers and barriers to cost efficiency, which drew on management information and project reporting, and built upon the findings of the process evaluation.[3]

- The modelling of actual costs reported by projects (at a project and property level) as compared to a modelled 'counterfactual cost' (of costs had cost reduction methods not been applied). The methodology for this costs analysis and modelling is described in Annex 4 of this technical report.

- A qualitative comparative analysis (QCA) aimed at assessing which projects were most / least successful at managing costs and the enablers and barriers to this. The methodology for the QCA is described in Annex 5 of this technical report.

Learning outcomes: This outcome is covered in Chapter 9 of the main report. The analysis in this chapter triangulates findings from the QCA, a thematic analysis of the findings from project team interviews and DESNZ policy team interviews, and the overall findings of the evaluation, in order to assess the extent to which the programmes fulfilled their objectives (as set out in the ToC) of generating learning that could be used by social housing landlords and DESNZ to scale up whole house retrofit.

A.1.2.4 Data Collection Overview

This evaluation drew upon:

- Qualitative data collected from residents, project teams, the wider supply chain, DESNZ policy and delivery teams, the Delivery Partner and Monitoring Officers via depth interviews, workshops, site visits, ethnographic research, and a survey (of residents only).

- Qualitative secondary data from programme management information and project reporting, as well as literature.

- Quantitative secondary data from project reporting, as well as proxy data on costs, EPCs and thermal efficiency where necessary.

For projects, the data available through these sources by project varied. Table A2 presents the data that was available per project by data source. This is to give an indication of the volume of data available for some projects as compared to others and to demonstrate why there remains some uncertainty as to some outcomes (see limitations section).

---

[3] Joint Process Evaluation Report - Whole House Retrofit (WHR) and Social Housing Decarbonisation Fund Demonstrator (SHDF(D)), BEIS/DESNZ Research Paper Series Number 2023/008.

Table A2: Further information on sample per project and available information

Project name	Interim reports (narrative)	Final reports (narrative)	Final reports (numeric data)	Project lead interviews	(Wider) project team interviews	Resident interviews	Resident Survey
SHDF(D) Projects							
National Net Zero Retrofit Accelerator	Y	N	Y	2	6	0	16
Northampton Whole House Retrofit	Y	Y	Y	1	2	6	29
Warmer Homes Argyll & Bute	Y	N	Y	2	5	6	30
Alva Community Regeneration through Decarbonisation	Y	Y	Y	0	2	3	1
Nottinghamshire Net Zero Carbon Housing Demonstrator	Y	N	Y	0	4	0	8
Xtra-Z	Y	N	Y	1	0	0	13
Leeds Whole House Retrofit	Y	Y	Y	0	0	5	24
DORIC	Y	N	N	0	0	0	8
Destination Zero II	Y	N	Y	0	0	5	12
Social Housing Retrofit Accelerator Cornwall	Y	N	Y	3	8	0	12

Project name	Interim reports (narrative)	Final reports (narrative)	Final reports (numeric data)	Project lead interviews	(Wider) project team interviews	Resident interviews	Resident Survey
Gloucestershire SHARe and CaRe Demonstrator	Y	Y	Y	2	3	6	5
Orbit Housing Incremental Whole House Retrofit Programme	Y	Y	Y	3	5	6	24
Clarion Housing Group advanced retrofit project	Y	N	Y	2	1	0	18
Retrofit of Electrically Heated Homes	Y	N	Y	6	8	6	44
WHR Projects							
Energiesprong Sutton	Y	N	Y	4	6	6	5
Destination Zero I	Y	Y	Y	2	6	7	7
TOTAL	**16 / 16**	**6 / 16**	**15 / 16**	**28**	**56**	**56**	**256**

A.1.3 Primary data collection - qualitative data

Qualitative data collection for the outcome evaluation was carried out with three key audiences:

- Residents who had measures installed as part of the programmes;
- Project leads and project teams;
- Wider market stakeholders (e.g. whole house retrofit experts and industry leads); and
- DESNZ delivery team members.

This section details the approach to engaging these audiences and research activities carried out.

A.1.3.1 Resident depth-interviews

Overview

Depth interviews were identified as appropriate for this research, enabling residents to describe their individual experiences in their own words. Interviews explored experiences of being engaged in the programme, having measures installed, and living with the measures.

A total of 56 depth interviews were carried out with residents across both programmes. Interviews were undertaken in three tranches, conducted between 29th of November 2022 and 23rd of March 2023.

Each interview lasted up to 60 minutes to allow residents time to explain their experiences. Interviews were carried out using a semi-structured topic guide. Participants were invited to take part via telephone.

Interviews were carried out by six interviewers based in Ipsos' energy and environment team, briefed by members of the core project team.

Recruitment

Recruitment was carried out using a range of outreach methods depending on the contact details available in the sample. The sample was provided by DESNZ from project delivery data. It included addresses of properties receiving works as well as phone numbers and/or email addresses, where residents had provided additional consent for these to be shared for the purposes of evaluation.

As a first point of contact, potential participants were sent a 'Reassurance Letter' in the post. This letter detailed the research that was taking place and provided reassurance that it was bona fide. It invited recipients to directly contact the evaluation team if they were interested in taking part, and also detailed that the evaluation team would be in touch to invite them to take part.

Depending on the contact details available in the sample, potential participants were then contacted via telephone or email to invite them to take part in a depth interview. To support residents in taking part, we sought to offer a range of flexible timeslots for interviews so that residents could choose when would best suit them to participate in an interview.

Recruitment protocols comprised:

- **Carefully designed recruitment materials**: We designed a recruitment screening questionnaire which clearly covered the sample criteria in a succinct way to avoid the risk of deterring potential participants from taking part in the research. We also produced a tailored reassurance letter to demonstrate that research was bona fide and to outline what taking part would involve. This letter was tailored for each project locale to ensure place-based messaging and branding, including named contacts local to the project that recipients could reach out to for further reassurance. Copies of the qualitative recruitment materials used can be found in Annex 8: Qualitative data collection tools.

- **Clarity around the purpose and value of the research**: we developed participant facing recruitment materials that clearly explained why we were collecting the data and why taking part would be worthwhile.

- **Ensuring informed consent**: we provided a Participant Information Sheet which explained the voluntary nature of involvement, the process for withdrawing consent if they changed their mind, and data confidentiality.

- **Ensuring accessibility of our research**: we worked with our recruiters to ensure people could participate in our research comfortably and ethically, reflecting individual needs. For example, at screening, we checked whether participants had any needs to support their participation.

- **Offering incentives:** As a gesture of appreciation for participating in the research we offered a £50 financial incentive provided via BACS or high-street e-voucher.

- **Providing support:** We produced a signposting leaflet to share with participants providing details of organisations that they could contact should taking part in the research and discussing energy use raise any concerns. For example, organisations related to finances, such as The Money Advice Service and the Household Support Fund, were listed.

Sampling

The qualitative research was not intended to be representative of all residents taking part and therefore cannot be read as representative of all resident experiences in the SHDF(D) and WHR programmes.

The projects covered through the qualitative research were determined by the available sample for recruitment (i.e. convenience sampling). In some instances, projects were carrying out their own evaluative research (for example, this was the case for the three Royal Borough of Kensington and Chelsea projects which were later withdrawn from the SHDF(D)) and

therefore, given the likely overlap and risk of participant burden, these were not included in the qualitative research. In other instances, there was mixed availability of sample depending on the extent of resident consent, and resident contact details beyond their postal address. Additionally, the research preferentially included projects where works had completed, or nearing completion, so residents would be able to discuss their experience of works as well as living with them post-completion. A total of 10 projects were finally included in the qualitative sample. Table A2 above further details the data sources by project.

We aimed to achieve a total of six resident interviews for each project in the sample. In some cases all potential participants for a project (residents for which contact details were available) were invited to take part and in others, a random selection were contacted to avoid generating greater interest than scope for interviews.

At recruitment, participants were also asked for information regarding their gender and age. Whilst quotas were not placed on this, collecting this information enabled us to understand the range of residents taking part in the research.

Achieved sample

The qualitative research sample achieved is set out (by project) in Table A2. Tables A3 and A4 set out the profile of residents interviewed by age and gender.

Table A3: Sample profile of qualitative interviews with residents, by gender

Gender	No. interviews
Female	36
Male	20
Other/prefer not to say	-
TOTAL	**56**

Table A4: Sample profile of qualitative interviews with residents, by age

Age bracket	No. interviews
20 to 39	13
40 to 59	24
60 to 79	16
80 to 99	3

TOTAL	56

Topic guides

A copy of the topic guide is provided in Annex 8: Qualitative data collection tools. Depth interviews with residents were designed to explore and address the following evaluation questions, with interviewers allowing residents to go into more or less depth per question / topic (in line with a semi-structured approach).

1. Evaluate residents' experiences of the retrofitting process.

    - Specifically, exploring resident experiences of how local authorities have delivered the projects.

2. Report the residents' perspective on project outcomes, regarding comfort, bills, wellbeing, aesthetics, install quality, and overall environment post-retrofit.

    - Specifically, exploring resident satisfaction with the retrofits (individual and environmental).

3. Understand their energy behaviours pre- and post-retrofit, in particular those that undermine or validate energy or bill savings modelled in SAP.

    - Specifically, exploring resident behaviour and how, if at all, this has changed post-retrofit.
    - Supporting a theory-based effectiveness analysis as part of the economic evaluation, and comparative analysis of outcomes under different projects.

Analysis

With participant permission, interviews were securely digitally audio recorded. One participant did not consent to audio recording their interviews. Using transcripts and interview notes, the evaluation team populated a thematic analysis framework. This framework was designed in Excel, and aligned to the topic guide question areas, and overarching evaluation questions. Once completed, the coding framework enabled the evaluation team to explore the data, looking for themes and patterns in resident experiences and views. This was supplemented by a mid-point analysis session and two subsequent internal analytical workshops following completion of fieldwork. These sessions brought the interviewing team together to discuss interviews and support ongoing analysis.

Findings from the qualitative interviews report on participant perceptions and experiences as they described them to researchers. It was not viable to validate or assess the reliability of participant responses in the context of this research.

Data limitations

Limitations in the qualitative data collected are discussed under A.1.7.

A.1.3.2 Resident mobile diary task (AppLife) approach

To further understand experiences of having measures installed, and living with the measures, 10 residents were recruited from across six projects to take part in a mobile diary task.[4] This involved residents completing six tasks over the course of two weeks. The tasks were designed to:

- Enable researchers to see participants describing their experiences in their own words, and whilst showing measures and their home via video and/or photograph.

- Ask residents to report on living with measures, including how they interact with these, and behaviours they would follow in potential scenarios (e.g. if heating stopped working). These were included to explore the extent to which residents understand their measures.

A list of the diary tasks sent to participants is included in Annex 8: Qualitative data collection tools.

The diary task was carried out using the Ipsos proprietary app, AppLife, which residents downloaded to their mobile device. When a task was available for completion, residents received a notification, and they were able to respond to tasks using video, audio, photograph or text.

The mobile diary task took place between the 20th of March and the 2nd of April 2023. Participants who completed the mobile diary (AppLife) task received a £125 financial incentive and were given the choice to receive this via BACS or high-street e-voucher.

As part of the mobile diary task, participants took part in a short pre- and post-telephone call to explain the task to them, gather their informed consent to take part, and subsequently, follow-up on any queries, or incomplete tasks. These calls also provided clear information about how data shared on the app would be used during reporting. More information on the process of gathering consent is below, and the privacy policy can be found in Annex 8: Qualitative data collection tools.

The mobile app responses were monitored and moderated by three members of the evaluation team also working on the depth interviews with residents.

Recruitment

Residents taking part in the mobile diary task were recruited from those who had taken part in a depth interview. During the depth interview phase of the research, participants were asked if they were willing to being asked about taking part in the mobile diary task. To ascertain this, interviewers provided a quick overview of what the mobile diary would involve, and the financial incentive.

---

[4] As the sample for AppLife was very small, we have chosen not to identify which projects the AppLife participants were part of, to ensure that they are kept anonymous. More information on the recruitment of AppLife can be found below.

A separate Participant Information Sheet was developed for this strand of the research to ensure that participants were informed about this research activity and how data would be used. This is provided in Annex 8: Qualitative data collection tools.

Sample

A total of 38 interview participants agreed to be recontacted about the mobile diary (AppLife) research. Given the small sample frame for this strand of research, the key quota placed on sampling was to include residents from a mix of projects. Secondary to this, the team set out to include a mix of gender and age.

As noted above, participants were recruited from across six projects, including WHR and SHDF(D). As with the qualitative research, the mobile diary (AppLife) task was not intended to be representative of all residents taking part and therefore cannot be read as representative of all resident experiences in the SHDF(D) and WHR programmes.

Achieved sample

Residents included in the sample were from across six projects. The tables below show the spread of gender and age of those taking part. A total of 15 residents agreed to participate in the mobile diary task, but only 10 completed all tasks. This drop-out was anticipated given this type of data collection is a greater commitment when compared to a one-off depth interview.

The qualitative research sample achieved is set out (by project) in Table A2. Tables A5 and A6 set out the profile of residents by age and gender.

Table A5: Sample profile for mobile diary (AppLife) research with residents, by gender

Gender	No. mobile diary (AppLife) participants
Female	6
Male	4
Other/prefer not to say	-
TOTAL	**10**

Table A6: Sample profile for mobile diary (AppLife) research with residents, by age

Age bracket	No. mobile diary (AppLife) participants
20 to 39	5
40 to 59	3
60 to 79	2

80 to 99	-
TOTAL	**10**

Analysis

Participants responses including verbatim from video responses and text comments were written into an analysis spreadsheet in Excel. This analysis framework was structured thematically by the mobile diary tasks. This enabled the evaluation team to explore responses to understand the different experiences reported and themes within this. Findings from these tasks were discussed as part of the final analysis sessions carried out for the resident depth interview stage and added richness to overall findings regarding resident experiences and behaviours.

Outputs

The findings from the mobile diary (AppLife) have been presented in the main report along with the findings from the qualitative depth interviews, and the quantitative survey findings. In addition, where consents allowed, some of the mobile diary (AppLife) entries have been collated into a video which can be found separate to this report. This video summarises the overall findings from the mobile diary (AppLife) task.

Consent gathering

Before taking part in the mobile diary (AppLife) task, participants were provided with a privacy statement (this can be found in Annex 8: Qualitative data collection tools), which stated that the content uploaded as part of this research would be shared with the research team and DESNZ.

At the end of the mobile diary (AppLife) task, participants were asked whether they would consent for their uploads to be shared publicly. Eight of the 10 participants agreed to having their content shared publicly.

To ensure continued and informed consent, participants were recontacted by researchers to let them know which clips would be included in the final video, reminded that the video would be shared publicly, and given the option to contact the research team if they had changed their mind.

Data limitations

Limitations in the qualitative data collected are discussed under A.1.7.

A1.3.3 Qualitative research with project leads and project team members

Depth interviews were identified as suitable for this research, enabling team members to speak individually and to provide in-depth insights into their projects. These interviews explored experiences of delivering the programme, as well as captured lessons learned.

A total of 96 in-depth interviews were carried out with project leads (total: 33) and project team members (63) (project team members represented a range of supply chain actors involved in the projects) across 15 local authorities. A further breakdown is provided in Table A7 overleaf. Interviews with both groups were conducted between April to June 2023. Each interview lasted up to 60 minutes. Interviews were carried out using a topic guide, structured around relevant evaluation questions. The primary evaluation question of interest in the project lead interview was:

- How much have the programmes helped develop landlord capability for delivering future retrofit?

As the process evaluation interviews[5] took place before many of the projects had completed works, some process evaluation questions were also asked, including:

- **Portfolio development/ design:**
  - What were the key facilitators and barriers to success?
  - How do local authorities deliver the projects?
  - What innovative products and methods have been introduced in projects?

- **Delivery:**
  - What are the barriers and enablers to programme delivery?
  - How do LAs engage installers?
  - How do LAs engage clients?
  - How do LAs deliver the projects?

The primary evaluation question of interest in the project team member interviews was:

- How has participation in the programme(s) impacted their organisation and their future role in the whole house retrofit sector?

Participants were invited to take part via email invitation. Interviews were carried out by 12 interviewers sub-contracted by Ipsos. All interviewers were briefed by the Ipsos core project team and communication with Ipsos was maintained throughout the process.

Recruitment and sampling approach

The qualitative research set out to include project leads and participants from a range of project teams – which included employees of companies who were involved in project delivery, such as installers, project management organisations and architects – to help capture diversity of experiences of delivering the programmes. The sample was provided by DESNZ and contacts were categorised as 'priority' and 'non-priority', determined by the level of

---

[5] See: Joint Process Evaluation Report - Whole House Retrofit (WHR) and Social Housing Decarbonisation Fund Demonstrator (SHDF(D)), BEIS/DESNZ Research Paper Series Number 2023/008.

involvement, familiarity and likelihood of availability. A total of 15 projects were included in the sample, and these are listed in Table A8.

The key sampling criteria for the qualitative depth interviews was to include a good spread of projects, to ensure the research captured a range of experiences in delivering the programme across different geographical localities and project contexts. Recruitment aimed to achieve a total of 10 project leads and project team leads from each project. However, it was not always possible to achieve 10 interviews per project where insufficient contact details were available.

Interviewers were responsible for contacting first the 'priority' contacts, and subsequently the 'non-priority' contacts. Up to three follow-up emails were sent to the 'priority' contacts before moving on to the 'non-priority' contacts. To ensure progress, interviewers provided updates twice per week on the number of interviews booked and the number of interviews completed.

Achieved sample

The qualitative research sample achieved is set out (by project) in Table A2. Table A7 presents the sample of project team members interviews by type of company / role in the project.

Table A7: Breakdown of company types by number of participants

Company type	Number in sample	% in sample
Construction Company	18	29%
Retrofit Consultants	10	16%
Contractor	9	14%
Supplier	4	6%
Architect	4	6%
Charity	3	5%
Housing association	3	5%
Property services Company	3	5%
Public body	3	5%
Surveyors	3	5%
Communications agency	1	2%
Procurement solutions provider	1	2%
Project management	1	2%
TOTAL	**63**	**100%**[6]

Analysis

All interviews were either recorded, or in the instance where the participant did not consent to recording, notes were taken. Recordings were then transcribed. Following completion of the interview, the researcher responsible for conducting the interview used the transcription and notes to complete a thematic analysis grid based on the questions of the topic guide. For the analysis of market outcomes, the transcriptions were separately coded against the contribution analysis framework. Further details of this are provided in the analysis section in Annex 4.

Data limitations

Limitations in the qualitative data collected are discussed under A.1.7.

---

[6] Percentages do not add up to 100% exactly due to rounding.

A1.3.4 Qualitative research with DESNZ delivery staff

We conducted depth interviews with 12 members of the policy and delivery teams within DESNZ who were involved in the implementation of both the SHDF(D) and WHR programmes. The aim of the interviews was to provide evidence across the three areas of:

- Programme Outcomes: to understand to what extent the programmes had achieved their key objectives (including cost and energy demand reduction), the challenges experienced across the programmes, the viability of the whole house approach and any impacts of the programmes on the retrofit market.

- Project Outcomes: this section was centred on providing detailed data on success factors and challenges experienced at the project level. This section was mainly for DESNZ representatives who worked more intimately with specific projects, such as in a monitoring capacity.

- Lessons learnt and policy legacy: to understand the learnings that had been established through delivery of the programmes and to what extent these were being implemented on the ongoing waves of SHDF.

The sample was based on the list of policy and delivery team members recommended by DESNZ colleagues. Whilst no specific sampling approach was taken, the sample contained a mixture of professional expertise and grades across both programmes to ensure a diversity of views.

A1.4 Primary data collection – quantitative data

The resident survey consisted of a quantitative questionnaire designed to gather quantified evidence (in the form of responses to closed option questions) from residents on their experiences of the programme.

Recruitment and sampling approach

The sample for the resident survey was provided by DESNZ on a 'public task' legal basis. To implement the survey, DESNZ first sought agreement from social housing landlords participating in the programmes for resident addresses to be shared with Ipsos. Through this process, landlords were able to share a total of 1,335 addresses across both programmes, covering 14 SHDF(D) projects and two WHR projects.[7]

With an anticipated response rate of around 20%, the sample was not stratified further and a census approach was taken, resulting in all 1,335 residents receiving an initial written invitation.

Project residents were sent a warm-up letter in December 2022 (see Annex 8) signalling the intent to contact residents in early 2023 with a survey regarding the works being carried out on the property, with a £10 voucher offered to those completing it. Residents were given the opportunity to opt out of receiving further invitations to participate in the survey at this stage, either by calling a freephone number or sending an email to the project team at Ipsos.

In January 2023, a pilot survey was conducted with two projects (Xtra-Z (SHDF(D)) and Destination Zero I (WHR)). A total of 144 survey invitations were sent to residents and fieldwork ran from 16th of January to 13th of February 2023. Residents were sent a covering letter (see Annex 9) outlining the aim of the research, how to complete the survey, contact details for any questions related to the survey, or if the resident wanted to opt out of further contact.

The survey adopted a 'Push-to-Web' approach, which entails sending out paper invitations to participate in an online survey via an URL printed onto the survey invitation. For this evaluation, however residents were also given the option to complete the survey on paper and return via post. Fourteen pilot surveys were returned via post or online (10% response rate). Data was analysed to ensure that the survey questions were fit for purpose. Following the pilot, no changes were recommended to be made for the mainstage fieldwork.

The mainstage fieldwork ran from 6th of March to June 2023. Invitations were sent to all remaining qualifying residents (1,191). A reminder letter was also sent to residents in the pilot phase who did not respond to the initial invite and did not opt out of further contact, and a further reminder was sent to mainstage participants on 31st of March 2023.

---

[7] As the survey was conducted before the Royal Borough of Kensington and Chelsea projects were removed, some residents participating in the survey were part of these projects.

Questionnaire

The questionnaire was developed by Ipsos, in consultation with DESNZ and the evaluation's consortium partners (to ensure that the survey data met the needs of different parts of the evaluation, including the cross-cutting evaluation).

It included questions on household composition, demographics, questions specifically related to the property, as well as overarching sections on resident satisfaction during the work, post installation and the perceived impact the work has had on the property and those living in it.

Questions were 'closed' (i.e. absent of open text responses) and consistent of a mix on single code, multi code options and 5-point scales. A copy of the questionnaire can be found in Annex 7: Quantitative data collection tools.

Achieved sample

Including responses received in the pilot phase, a total of 256 surveys were returned (19% response rate). The breakdown of completed surveys by project can be found in Table A8 below.

Table A8: Survey response rate, by project

Project	No. invitations sent	No. completes	Response rate
SHDF(D) Projects			
Orbit Housing Incremental Whole House Retrofit Programme	69	24	35%
Warmer Homes Argyll & Bute	130	30	23%
Retrofit of Electrically Heated Homes	174	44	25%
Gloucestershire SHARe and CaRe Demonstrator	28	5	18%
Destination Zero II	62	7	11%
Nottinghamshire Net Zero Carbon Housing Demonstrator	25	8	32%
Northampton Whole House Retrofit	169	29	17%
Xtra-Z	93	13	14%
Leeds Whole House Retrofit	178	24	13%
Clarion Housing Group Advanced Retrofit Project	104	18	17%
DORIC	29	8	28%
National Net Zero Retrofit Accelerator	145	16	11%
Alva Community Regeneration through Decarbonisation	15	1	7%
Social Housing Retrofit Accelerator Cornwall	40	12	30%
WHR Projects			
Energiesprong Sutton	23	5	22%

Project	No. invitations sent	No. completes	Response rate
Destination Zero I	51	12	24%
TOTAL	**1,335**	**256 (195 paper, 61 online)**	**19%**

Due to the limited sample size and anticipated response rate, it was not possible to set quotas to gain a representative sample of social housing residents in the UK. The survey has therefore not been weighted and it is not representative. It is also not necessarily representative of the whole population of the residents supported through the programmes, as some projects were able to provide a much larger number of resident addresses than other projects due to different consent protocols being embedded in the projects.

To mitigate this limitation, analysis of the social housing population has been conducted using data collected for the English Housing Survey[8] and when compared to this survey there is good representation of age, those in employment and those with one or more of households with long-term illness or disability – see Table A9 below.

Table A9: Profile breakdown, survey data vs English Housing Survey and Scottish Household Survey

	Resident survey	English Housing Survey 2021-2022 (social housing data)	Scottish Household Survey 2019 (social housing only – local authority and housing association)
18-64	68%	69%	77%
65+	31%	28%	20%
Lone occupiers	38%	43%	47%[9]
Full-time employment	33%	29%	26%
Part-time employment	16%	15%	11%
Unemployed	17%	8%	8%

---

[8] *data drawn from English Housing Survey 2021-2022: https://www.gov.uk/government/statistics/english-housing-survey-2021-to-2022-headline-report/english-housing-survey-2021-to-2022-headline-report#section-1-households
[9] Comprises single adults, single pensioners, and excludes single parents.

	Resident survey	English Housing Survey 2021-2022 (social housing data)	Scottish Household Survey 2019 (social housing only – local authority and housing association)
Retired / other	30%	49%	55%[10]
One or more of household with long-term illness or disability	53%	54%	59%[11]

Analysis

Responses received via the online survey and paper returns were aggregated in a single data set. The collected data was cleaned to ensure its validity and reliability. This involved eliminating incomplete responses to specific questions (for example where an answer has not been provided on the paper questionnaire) and coding the responses. A table specification was drawn up to include specific analysis points, including demographic data, satisfaction measurements and other key questions identified. Statistical significance testing was applied to a confidence level of 95%. Finally, the tabulated data was interpreted considering the evaluation and research objectives related to the programmes. Not all data cited in the report are statistically significant; in some cases bases are too small or is intended to be indicative to the results only. Data that is statistically significant is noted as such within the analysis.

Data limitations

Despite achieving the anticipated survey response rate, the design of the survey with small sample sizes limited the ability to conduct sub group analysis due to low base sizes. In particular, analysis by project was not possible as in most cases the sample size per project was below 30 cases, limiting the ability to draw any statistically significant differences. The survey data has not been weighted; to carry out a weighting (i.e., representative sample) of the UK social housing population a larger sample size would have been required, as well as a better understanding of the profile of the population affected by the two programmes.

---

[10] Includes self-employed, training scheme.
[11] Whether any of the people in the household has any physical or mental health condition or illness lasting or expected to last 12 months or more.

A1.5 Site visits

Five site visits covering nine projects were conducted for the process evaluation.[12] A further three site visits were conducted for the outcome evaluation. Relevant findings from both sets of site visits fed into the resident, supply chain and learning outcome analysis. These sites were selected because, for Leeds and Fenland, documentation review and project team interviews had indicated that these projects might be good practice examples of outcomes being achieved, suggesting that there would be benefit in the evaluation team observing these sites in person. For Ealing, the purpose was to attain an understanding of progress in the delivery of the large multi-site National Net Zero Retrofit Accelerator building on the project site visit conducted (in Hammersmith) for the process evaluation.

Table A10: Site visits conducted as part of the evaluation

Location	Project name	Date
Leeds	Leeds Whole House Retrofit	15/05/2023
Ealing	National Net Zero Retrofit Accelerator	23/05/2023
Fenland	Clarion Housing Group Advanced Retrofit Project	16/06/2023

The site visits provided the opportunity for the evaluation team to gain an improved understanding of how the programmes were being implemented on-the-ground and to discuss project level outcomes, delivery challenges, and lessons learnt with members of the project team. In some cases, the site visits also provided the opportunity for the evaluation team to conduct in-person research with residents on-site, to supplement findings from the resident qualitative research strand.

The site visits consisted of being taken round the sites by members of the project teams or project managers to showcase the different properties that had various measures installed. During the site visit the evaluation team member(s) conducting the visit recorded detailed notes. Data collection during site visits was unstructured meaning that the evaluation team allowed the project team to lead discussions, with the evaluation team using a site visit template. The template was completed following the completion of the site visit containing sections on project progress, key success factors and innovations – as a guide only. The site visit template can be found in Annex 8: Qualitative data collection tools.

The site visits supported the evaluation of: building performance (quality), market outcomes (skills developed through the retrofit), resident outcomes (resident perspectives on the

---

[12] Joint Process Evaluation Report - Whole House Retrofit (WHR) and Social Housing Decarbonisation Fund Demonstrator (SHDF(D)), BEIS/DESNZ Research Paper Series Number 2023/008.

retrofits), and learning outcomes (the extent to which projects were generating and utilising learning).

The outcome and economic evaluation also incorporates insights collected through site visits for the process evaluation.[13]

Analytical approach

Following completion of the site visits, the member(s) of the evaluation team who conducted the site visit compiled their notes into a site visit template. This was used by Ipsos to standardise the questions asked to the project officers included in Annex 8. The data from the templates fed directly into the contribution analysis for market outcomes and the thematic analysis of resident outcomes.

Data limitations

To reduce participant burden on project teams and because a critical mass of evidence for the outcome evaluation was already being collected through other research strands, the number of site visits for the outcome evaluation was reduced from original plans. This change in approach delayed conducting site visits until the later stages of the outcome evaluation, once analysis had begun. In practice, this reduced the value they generated for the outcome evaluation. For example, the two internal analytical meetings for the report had already passed once the site visits were conducted meaning that site visit findings were only integrated at the drafting stage by team members responsible for specific strands / outcome areas.

A.1.6 Secondary data analysis

A.1.6.1 Overview

The key secondary data that was analysed for this Outcome and Economic Evaluation were:

- **Narrative final reports**: These reports were completed by project leads following project completion. They provided details on the number of properties completed and the energy demand and cost reduction achieved. They also provided details of project successes and challenges, in addition to descriptions of the lessons learnt for the project lead organisation.

- **Numeric data provided in final reports**: These annexes contained quantitative data on the length of installation period, number of properties completed, number of employees across the different organisations participating in the project (local authority, contractor, and supply chain) and measures implemented.

---

[13] Joint Process Evaluation Report - Whole House Retrofit (WHR) and Social Housing Decarbonisation Fund Demonstrator (SHDF(D)), BEIS/DESNZ Research Paper Series Number 2023/008.

- **Interim reports**: These contained similar details to that of the final reports, but with significant data gaps given that few to no projects had completed retrofits by that stage of project reporting.

- **Project management information** e.g. project change requests.

- **Programme management information** including monthly project-level monitoring reports and site visit write-ups produced by the project teams and delivery partner (Ricardo).

A.1.6.2 Analytical approach

The monitoring data were used for the energy analysis, market outcomes analysis, costs analysis, and economic evaluation as described in Annexes 3 to 6 respectively. The monitoring data covered the period up to June 2023 for SHDF(D) and June 2023 for WHR, and are reflective of project status at this point in time.

A.1.6.3 Methodological challenges and limitations

The analysis of programme documentation is subject to the following limitations.

Final narrative reports were not available for 10 out of 16 projects, as these projects were still ongoing as of June 2023. This meant that data on project achievements, enablers and barriers from the perspective of these projects were either incomplete or potentially inconsistent. Data gaps were filled from the data in interim reports or gathered through project team interviews (where these were undertaken for the project).

Limitations with project reporting rendered the QCA, in particular, less robust than initially planned / desired. As it was not possible to analyse complete and final data on project costs (including matched funding), cost reduction strategies and innovations, and achieved scale of retrofits, for all projects, the findings from the QCA are heavily caveated. Further detail on the approach to QCA taken, and relevant limitations, are covered in Annex 5.

Variation in reporting by project also risks self-selection bias in the findings; as the projects that were ongoing and had not yet completed final reports at the time of analysis (June 2023) can be reasonably expected to have faced greater challenges in delivery.

Numeric data on the properties retrofitted was also subject to limitations, as not all properties had completed retrofits at the time of reporting and some of the data was of poor quality (data fields incomplete, inconsistencies in reporting, data reported (e.g. heat pumps with no thermal controls) being non-credible). Where relevant for analysis, this was mitigated through a modelling approach to complete data gaps.

A1.7 Overarching methodological strengths and limitations

The evaluation was designed to be as robust as possible within the parameters of the data available, the timeframe for evaluation delivery, and the principle of proportionality. The outcome and economic evaluation strengths are as follows:

Utilisation of the rich project reporting and management information available through the programmes, thus increasing consistency of the evaluation with programme data and reducing research participant burden: We have utilised qualitative and quantitative data captured through the programmes for the analysis of almost all of the outcome areas. Use of this data has required systematic data cleaning, mapping into several analytical frameworks, comparative analysis and interpretation.

Triangulation: We have triangulated several sources of analysed findings for each outcome area and, in doing so, have provided a much fuller picture and robust analysis of the outcomes and value for money achieved and not achieved.

Selection of distinct methods for distinct outcome areas: As stated in A1.2.1, we employed different analytical techniques to draw conclusions on programme outcomes. We selected these analytical techniques depending on what was the most appropriate for the nature of and the data available to assess each outcome area.

Several limitations to the analytical and data collection approaches have been discussed throughout the annexes in this document. The overarching limitations are outlined below.

There is no counterfactual case: It was not possible to identify or construct a counterfactual group against which to compare how participants in the programmes changed in each of the outcome areas. The counterfactual scenario in evaluation is what would have happened anyway in the absence of an intervention. It can be assessed or estimated by comparison of what happens in a 'treatment group' (i.e. amongst those receiving or participating in an intervention) and a group which shares very similar characteristics to the treated group but which did not receive the intervention.

As per the Terms of Reference of the evaluation, a counterfactual, or control group, approach was considered non-feasible for this research. Whilst it may have been possible, in theory, to generate a counterfactual group of residents (to assess property-level and resident-level benefits) from within the local authority areas that applied for funding under WHR and SHDF(D), it would have been challenging to collect data from non-participating residents at such scale, as it would have been highly dependent on the engagement of local authorities, and the consent of the residents to share their contact details, despite not receiving installation benefits. As has been demonstrated through this evaluation, it is highly challenging to engage both non-participating local authorities and non-participating residents.

Further, when the programmes were designed, there was uncertainty about the extent to which different factors (external and internal to the programmes and the funded projects) would be the predominant driver(s) of results. This uncertainty meant that an exploratory theory-based

approach was more appropriate. For the market outcomes, it is very difficult to create a counterfactual group (as has been found in other evaluations for DESNZ)[14] due to the nature of how installers and the wider retrofit supply chain operate nationally and across regional boundaries. The lack of counterfactual analysis does, however, reduce certainty around the extent to which the programmes caused the observed change. The perspectives of participating projects on this additionality of the programmes was covered in the process evaluation[15] and is summarised in Chapter 4 of the main report.

Coverage: As set out in Table A2, there are some projects for which there is less data available (through any of the data sources) than others – in particular, data relating to information on final expenditure (including matched funding), final measures installed and the baseline fabric and heating in retrofitted properties. In some cases this was because some projects had only recently closed or were still in progress when data was being collected and reported for the outcome evaluation. This has affected data availability and the extent to which conclusions on final outcomes can be drawn, particularly at a project level.

As data gaps have tended to be most prevalent for the projects, which progressed slower in their delivery, we were able to make useful judgements, assumptions or exceptions based upon management information and/or findings from interviews with DESNZ. Further, whilst this evaluation used QCA, which is a case-based approach, the majority of the outcome and economic evaluation methods used relied on aggregate data.

In terms of stakeholder group coverage, the evaluation was not able to consult with non-participating residents, except for in the case of two of the site visits conducted for the process evaluation.[16] This has limited the extent to which we could evaluate wider community effects. The evaluation was also only able to speak to two non-participating local authorities (who did not apply to either programme) as part of the process evaluation. Further consultation with non-participating local authorities would have strengthened the analysis of additionality.

The effects of these data gaps is discussed in relevant sections of this Technical Annex (e.g. above in A1.6 on secondary data, and in Annex 2 on energy data analysis and Annex 4 on costs analysis).

Self-reported data: The evaluation is dependent on the self-reported views of the beneficiaries and stakeholders of the programmes and on the data reported by project teams. It was not possible, for example, within the timelines and delivery constraints of SHDF(D) and WHR to carry out pre- and post- monitoring of energy consumption or building performance. To mitigate this, we drew data from a range of primary and secondary sources of data, triangulating these and validating our findings with DESNZ.

---

[14] WE WILL ADD THE LINKS TO THE GHG LAD AND GHGVS FINAL EVALUATION REPORTS ONCE PUBLISHED HERE.
[15] Joint Process Evaluation Report - Whole House Retrofit (WHR) and Social Housing Decarbonisation Fund Demonstrator (SHDF(D)), BEIS/DESNZ Research Paper Series Number 2023/008.
[16] Joint Process Evaluation Report - Whole House Retrofit (WHR) and Social Housing Decarbonisation Fund Demonstrator (SHDF(D)), BEIS/DESNZ Research Paper Series Number 2023/008.

Reduced delivery window for research / due to research ethics around participant burden: To reduce any potential burden on residents and on the projects in which they were participating, we conducted research with residents in one wave only. Whilst pre- and post-installation analysis of change would have been more robust, the four-strand approach (surveys, interviews, mobile diary (AppLife), site visits) to data collection with residents means that we have been able to triangulate the perspectives of residents through different channels, and also validate this with independent modelling of building performance, and with the views of project teams and the wider supply chain. This has mitigated the impact of this limitation.

The primary data collected was subject to the overarching limitations:

Self-selection bias: Participants with particularly negative or positive experiences of the programmes may have felt more inclined to participate in fieldwork than those with more neutral experiences. It is not possible to gauge to what extent self-selection bias is prevalent or not. The quantitative and qualitative research with residents is largely mutually reinforcing and aligns well with what we would expect given the status of projects and information on implementation challenges and successes set out in project reporting.

Temporal effects: The timing at which the interviews were conducted is likely to have had an effect on interviewees' perspectives. This is particularly the case for the residents, as not all participants in the resident research had had their retrofits completed by the time of the interview (and both the evidence collected for this research and for other Ipsos evaluations for DESNZ[17] has shown that residents are more likely to talk positively about retrofits and installations if the works are complete).

Wider context effects: The sharp increase in energy prices and the associated collapse of domestic energy providers that occurred in the winter of 2021-2022. This may have impacted consumer energy behaviours and their perspectives on energy consumption and therefore shaped the findings of the research with residents.

---

[17] [Evaluation of the Green Homes Grant Voucher Scheme (GHGV) - Interim Outcome and Economic Evaluation Report](), BEIS Research Paper Series Number 2022/028

Annex 2: Energy and thermal outcomes

This Annex describes the analytical approach taken to modelling energy and thermal outcomes using quantitative data provided through project reporting, pre- and post-installation EPC records where available, and/or estimates by Energy Saving Trust.

Analysis of thermal performance and energy savings was designed to provide evidence to answer the following evaluation question:

- How much have the whole house retrofits improved energy performance and why?

To answer this question, the evaluation explored the following sub-questions:

- What energy efficiency improvements did projects report?

- What were the fabric improvements for the building, as measured by changes in overall space heating demand?

- What were the energy savings per building and archetype associated with these improvements?

- What were the carbon and cost savings associated with the improvements?

- What were the summary statistics on the number of missing properties after all data filling?

The analysis took a step-by-step approach to model the estimated a) EPC change, b) space heat demand improvement and c) energy savings, carbon emission reductions and energy bill savings, per property retrofitted. The approach can be summarised as follows:

1. Assessed scheme data provided in project reporting to identify the extent of pre- and post-installation data per property for the following key metrics: floor area, occupancy, space heating requirements, heating system type and EPC rating. Project data was also assessed to identify the measures installed per property. This identified key data gaps per property to be filled in step 2.

2. Filled data gaps per property, using the data sources and assumptions outlined Table A11.

   a. Where it was not possible to complete space heating requirements and EPC ratings using scheme data, the Dynamic Engine model was used to replicate an EPC assessment, using archetype-level assumptions (such as similar property age).

   b. Where it was not possible to complete data gaps using the Dynamic Engine model, these properties were excluded from the analysis.

3. Estimated the change in EPC rating per property, to analyse the extent to which properties retrofitted within both programmes had reached an EPC C rating post-retrofit.

4. Estimate the change in energy demand per property, using the Standard Assessment Procedure (SAP) methodology. This included calculating the change in space heating demand pre- and post-retrofit to analyse the extent to which properties retrofitted within both programmes had reached the target space heating requirements (50 kWh/m2 or below).

5. Modelled the estimated energy savings per property retrofitted, again using the SAP methodology. The evaluation team then used appropriate cost and carbon factors for each fuel type, as provided in HMT guidance, to estimate the carbon and energy bill savings per property.

6. Explored results from steps 3 to 5 by measure package to generate learnings for future energy efficiency schemes.

These steps are described in more detail below.

To note the 20 communal spaces from the Wychavon Retrofit of Electrically Heated Homes project, as building performance estimates are based on assumptions that apply to domestic properties only. The total number of properties referred to in this chapter is therefore 1,293 (SHDF(D)) and 74 (WHR) properties (1,367 properties overall), which was correct at the time of analysis (April 2023).

Step 1 – Data cleaning and data gaps identification

Relevant data on retrofits planned and completed was available through project reporting for 15 out of 16 of the projects funded through WHR and SHDF(D), but data was not consistently complete or of adequate quality for all projects. The data provided by projects had the following limitations:

- **Gaps in measures data**: 7% of properties recorded in project reporting, did not have any measures data reported. For a further 14% of properties, it was assumed that the measures data reported was incomplete, as only one measure per property was reported, when this is unlikely to have been the case within whole house retrofit programmes. It has not been possible to quantify the number or type of missing measures. To note a further 8% of properties only had two measures reported, however it is difficult to establish whether this is due to missing data or not.

- **Inconsistencies within project reporting**: For some projects, data presented in the data annexes ('Annex 1') which accompanied the narrative final reports differed from that presented in the reports themselves. While each difference had to be treated on a case by case basis, priority was generally given to the more complete source of data (usually Annex 1).

- **Data not available for all properties due to extensions in project delivery**: Not all projects had completed all retrofits for all properties when the analysis took place in June 2023. It was not possible, on the data available, to ascertain at a property level if the retrofit was ongoing or complete, so the measures reported for a property were considered installed or would be installed, for the purposes of the model. However, based upon information on project completion rates (as set out in Chapter 4 of the main report), it is highly likely that some reporting included incomplete retrofits, where the final number/type of measures may still change. Results from the model can therefore only be considered an estimation - if the final number/type of measures change from the latest reports, this will affect the final modelled energy savings.

- **Discrepancies in how projects reported on key metrics**: Some projects gave space heating requirement (SHR) as the yearly total, instead of the required kWh/m2 unit. In this case the total space heating demand was divided by the total property floor area on a property-by-property basis to standardise.

- **In some cases, the heating system description both before and after retrofit was not sufficiently detailed for model purposes** (for example, if a property was recorded as having a 'gas boiler', but it was not specified as a combi or system boiler) and was not standardised across projects. Where these issues arose, assumptions were made to select the most likely options (see Step 2 for more details).

Table A11 shows the number of properties within each project that had data available by data type. These gaps had to be filled using assumptions outlined in Step 2.

Table A11: Data completeness of variables required for thermal analysis

Project	Pre-installation data				Post-installation data		
	Floor Area	SHR	Heating Type	EPC rating	SHR	Heating Type	EPC rating
SHDF(D) projects							
Alva Community Regeneration through Decarbonisation	15/15	15/15	0/15	15/15	15/15	15/15	15/15
Clarion Housing Group advanced retrofit project	84/116	85/116	0/116	81/116	72/116	56/116	31/116
Destination Zero II: The Next Step	65/65	65/65	0/65	65/65	0/65	14/65	0/65
Gloucestershire SHARe and CaRe Demonstrator	46/46	46/46	45/46	46/46	43/46	45/46	18/46
Leeds Whole House Retrofit	193/193	193/193	41/193	192/193	171/193	192/193	171/193
National Net Zero Retrofit Accelerator	112/129	100/129	0/129	111/129	100/129	109/129	126/129
Northampton Whole House Retrofit	149/149	149/149	134/149	149/149	149/149	149/149	149/149
Nottinghamshire Net Zero Carbon Housing Demonstrator	25/25	25/25	0/25	25/25	0/25	0/25	25/25

Project	Pre-installation data			Post-installation data			
Orbit Housing Incremental Whole House Retrofit Programme	69/69	69/69	36/69	69/69	69/69	39/69	69/69
DORIC	48/50	48/50	1/50	48/50	48/50	29/50	48/50
Retrofit of Electrically Heated Homes	173/176	176/176	176/176	176/176	176/176	176/176	176/176
Social Housing Retrofit Accelerator Cornwall	0/40	0/40	0/40	40/40	0/40	40/40	40/40
Warmer Homes Argyll & Bute	0/130	126/130	0/130	126/130	0/130	0/130	0/130
Xtra-Z	90/90	90/90	0/90	90/90	0/90	59/90	0/90
SHDF(D) total	**1069/1293 (83%)**	**1187/1293 (92%)**	**433/1293 (33%)**	**1233/1293 (95%)**	**843/1293 (65.2%)**	**923/1293 (71%)**	**868/1293 (67%)**
WHR projects							
Destination Zero I	50/51	0/51	0/51	50/51	0/51	1/51	0/51
Energiesprong Sutton	23/23	23/23	0/23	23/23	23/23	23/23	23/23
WHR total	**73/74**	**23/74**	**0/74**	**73/74**	**23/74**	**24/74**	**23/74**
Overall total	**1142/1367 (84%)**	**1210/1367 (89%)**	**433/1367 (32%)**	**1306/1367 (96%)**	**866/1367 (63%)**	**947/1367 (69%)**	**891/1367 (65%)**

Source: Project final report data annexes

Step 2 – Filling data gaps with proxy data

Where data gaps in project reports existed (see Table A11), fields were completed using the logic detailed in Table A12.

It should be noted that the 130 properties retrofitted through Warmer Homes Argyll & Bute are excluded from the analysis due to significant data gaps and challenges applying standardised archetype-level assumptions to a project with a majority of non-standard housing archetypes.

Table A12: Data source, process and logic for filling data gaps in project data returns

Data Gap	Source of proxy data (if numbered, this indicates the order in which data filling was carried out)	Rationale	Limitations
Total floor area	1. EPCs lodged on the EPC registers (where available). 2. Where not available, the average of other similar property archetypes in project was taken and applied.[18]	EPC data is considered a reliable source as it requires a physical site visit from a trained assessor. Similar properties were assumed to have similar floor areas (a trend which can be seen in the projects' reported data) and (therefore) similar EPCs.	Averaging may omit outliers in individual properties. Sensitivity analysis on the properties where floor area was reported in project data showed some discrepancies. It was possible to compare the floor area reported in project data with that reported in the property EPC for 927 properties (68% of 1367 properties treated in both programmes). The reported floor area in both project data and the relevant EPC was the same for 309 (33%) of these. The

---

[18] A similar property is one with the same house type (e.g. semi-detached), number of bedrooms and in some cases geographic proximity. This was done on a case-by-case basis by examining the project data returns where similar properties had similar EPC scores, bands, floor areas and space heating requirements.

Data Gap	Source of proxy data (if numbered, this indicates the order in which data filling was carried out)	Rationale	Limitations
			reported floor area was different in the remaining 618 (66% of those compared); the mean difference was 1.2 m2 between the two sources (with a standard deviation of 15m2). In the instances where project reports and EPC certificates provided different values, reported values were given priority. In total, EPC data was used for 88 properties.
Occupancy	Where occupancy data was not available in project reports, the occupancy was derived from property floor area (either reported or as filled above) using the SAP methodology.	SAP formula is a standard used across the industry for estimating occupancy.	The occupancy reported by projects in their property level reporting is higher than the SAP estimates based on total floor are data. This is likely because projects are reporting the actual occupancy figures of the properties, whereas the SAP methodology infers an average figure based on the floor area based on the wider housing stock. This will lead to potential overestimation of the hot water demand at high occupancies (4/5+) as the formula is then inaccurate. When the SAP

Data Gap	Source of proxy data (if numbered, this indicates the order in which data filling was carried out)	Rationale	Limitations
			occupancy formula is inverted, a house with an occupancy of 5 would result in a total floor area of over 1700 m2. This is clearly an overestimation for the average social housing property.
			For these reasons, where data was available, the occupancy as reported by projects was used. This was the case for 7% (101) of properties in the sample. For a further 7% (103) of properties, occupancy could be derived from project reports from the floor area provided in the property EPC. For the remaining 86% of properties, occupancy was calculated through the SAP methodology.
			Sensitivity testing shows that on average, the reported occupancy was 19% lower than the value calculated by SAP (with a standard deviation of 45%). This means occupancy may be overestimated for over four-fifths of properties in the model, with corresponding overestimating effects on hot water demand for these properties.

Data Gap	Source of proxy data (if numbered, this indicates the order in which data filling was carried out)	Rationale	Limitations
Heating system type pre-installation	If properties are reported as on-grid, it is assumed they have a gas boiler. If property is under 150m2 and on-grid, it is assumed the gas boiler is a combi boiler, otherwise it is assumed to be a system boiler. If properties are recorded as off-grid, it is assumed they have electric heaters.	The most common form of heating for off-gas grid properties in this programme was electric heating. Most properties retrofitted were not urban making them more likely to have electric heating as suggested in the 2021 census data. Data from the 2021 census indicates that in English and Welsh households, without gas, electric heating is the three times more common form of heating than oil (74% gas, 9% electric and 3% oil). [19] On gas grid properties are most likely to have a gas boiler as suggested by the high prevalence of gas heating in the 2021 census data (74% of households use mains central heating). Smaller properties are much more likely to have a combi boiler, the most common boiler type in the UK.[20]	If it is not specified whether a gas boiler is a system (with a hot water cylinder) or a combi-boiler, it is assumed to be a combi boiler when the total floor area is less than 150m2. Combi boilers are the most common type of gas boiler in the UK and would be a more obvious choice in a smaller property. In a larger property, which might have more than one bathroom, a hot water cylinder and a system boiler is more likely as typically properties with multiple bathrooms require hot water cylinders to ensure sufficient water pressure to allow multiple showers at once. For the 902 on-gas grid properties, 705 were assumed to be combis, 16 were assumed to be system boilers and the rest did not require any assumptions to be made.

[19] Constituency data: Central heating, 2021 census, https://commonslibrary.parliament.uk/constituency-data-central-heating-2021-census
[20] English Housing Survey 2021 to 2022: headline report, https://www.gov.uk/government/statistics/english-housing-survey-2021-to-2022-headline-report/english-housing-survey-2021-to-2022-headline-report

Data Gap	Source of proxy data (if numbered, this indicates the order in which data filling was carried out)	Rationale	Limitations
			For the 314 off-gas grid properties, 56 were assumed to be electric heating. The rest did not require any assumptions. There are 151 properties which were unknown if they were on- or off-gas grid.
Post installation heating system	Where no new heating system was indicated in project reporting, this was assumed to be the same as the pre-retrofit heating system.	Where there is no mention of a heating type upgrade, retrofit was assumed to be fabric-only (which was permissible under both WHR and SHDF(D)), meaning that energy savings only come from improvements to SHR.	Measure data was inconsistent with the thermal property summary data given in the data annexes of property reports. Where this inconsistency arose, the summary property level data provided by the project was given priority as this had the fewest data gaps and the most consistent format across projects.
Space heating requirement	1. We averaged values from similar property types[21] in the same project (where possible). 2. We modelled SHR by archetype using EST's Dynamic Engine model, taking property data from EPCs and	Generally, projects retrofitted similar properties in similar locations and of similar sizes (e.g. a row of terraced houses). These properties are likely to have similar floor areas, space heating requirements and EPC ratings, given they will have very similar inputs to any SAP	Averaging across comparable properties can boost the data completeness in cases where just the space heating requitement is missing. This approach, however, omits any outliers which may skew the results. For the Dynamic Engine approach, where property areas, U-values, materials,

---

[21] A similar property is one with the same house type (e.g. semi-detached), number of bedrooms and in some cases geographic proximity. This was done on a case-by-case basis by examining the project data returns where similar properties had similar EPC scores, bands, floor areas and space heating requirements.

Data Gap	Source of proxy data (if numbered, this indicates the order in which data filling was carried out)	Rationale	Limitations
	project reporting. The Dynamic Engine approach is discussed in further detail below.	model. In properties of a given archetype within reported data, the majority had comparable floor area, space heating demand and EPC ratings and it was therefore reasonable to say they could be grouped into an archetype and their average used to fill gaps in properties with missing data.	construction type were not reported this increased the uncertainty of the results as assumed values had to be used. This was particularly relevant for properties where there was limited data to match to (see method in section proceeding this table for how outputs were matched to the available data). Potential missing reported measure data compounded this issue, with properties potentially not being modelled with all the measures that were actually installed. This limited input data results in some uncertainty in the outputs from this approach.

Data Gap	Source of proxy data (if numbered, this indicates the order in which data filling was carried out)	Rationale	Limitations
EPC band	For pre-retrofit EPCs, we took typical values from similar properties in the same project.[22] For post-retrofit EPCs, we modelled the EPC per archetype using Dynamic Engine, taking property data from initial EPCs and project reporting. The Dynamic Engine approach is discussed in further detail below.	As above.	As above.
EPC score	EPC score was estimated by averaging values from similar property types within the same project. The Dynamic Engine approach is discussed in further detail below.	As above.	As above.

---

[22] A similar property is one with the same house type (e.g. semi-detached), number of bedrooms and in some cases geographic proximity. This was done on a case-by-case basis by examining the project data returns where similar properties had similar EPC scores, bands, floor areas and space heating requirements.

45

Table A13: Data gap prevalence within the full sample of 1367 properties across both SHDF(D) and WHR

	Reported	Filled using EPC data	Calculated using SAP	Estimated using archetype assumptions	Calculated using Dynamic Engine	Unable to fill and excluded from analysis
Total floor area	1137 (83%)	88 (6%)	-	141 (10%)	N/A	1 (1%)
Occupancy	101 (7%)	90 (7%)	1164 (85%)	2 (1%)	N/A	10 (1%)
Heating system type pre-installation	425 (31%)	-	-	793 (58%)	N/A	149 (11%)
Heating system type post-installation	939 (69%)	-	-	277 (20%)	N/A	151 (11%)
Space heating requirement pre-installation	1210 (89%)	-	-	47 (3%)	102 (7%)	8 (1%)
Space heating requirement post-installation	886 (63%)	-	-	82 (6%)	282 (21%)	117 (9%)
EPC band pre-installation	1306 (96%)	-	-	35 (3%)	12 (1%)	14 (1%)

	Reported	Filled using EPC data	Calculated using SAP	Estimated using archetype assumptions	Calculated using Dynamic Engine	Unable to fill and excluded from analysis
EPC band post-installation	891 (65%)	-	-	24 (2%)	217 (16%)	235 (17%)
EPC score pre-installation	1087 (80%)	-	-	-	12 (1%)	268 (20%)
EPC score post-installation	856 (63%)	-	-	-	257 (19%)	254 (19%)

Modelling missing property data using Dynamic Engine

Dynamic Engine, a calculator based on the Standard Assessment Procedure (SAP) methodology, was used to provide missing thermal data (i.e. space heating requirement pre- and post-retrofit) at a property-level for individual projects, where no other data was available (as detailed in Table A12).[23] If the EPC rating/band was also missing, this could also be estimated using this approach.

The properties were modelled pre-retrofit using archetypes for the different housing categories (e.g. two bedroom semi-detached property). It would have been disproportionate to include property-level modelled inputs as it required a large number of data fields that were not readily available in the project reporting (e.g. wall construction types, heating system efficiencies, insulation levels). To generate assumptions at the archetype level, EPC certificates for a random selection of the properties within the archetype and specific project were examined to extract appropriate building parameters (e.g. wall construction, age, total space heating demand, EPC rating) for the properties pre-retrofit. Combined with the data provided through project reporting, these properties were modelled to match the parameters given in EPC certificates and project reporting.

To model post-retrofit properties, the relevant variables (e.g. component U-values) for the measures reported were updated from the pre-retrofit values. These values were obtained using project reported values where possible (e.g. projects reported new U-values for the new walls in some cases) and otherwise using standard values for the measure installed. Several iterations of the model were run, using ranges of possible variable values to best match any values in the project reporting.[24] It should be noted that using standardised assumptions at an archetype level limits the ability to account for project outliers within these archetypes.

Step 3 – Analysing changes in EPCs

EPCs formed an integral part of the SHDF(D) and WHR programmes outcomes with a target of achieving a minimum of EPC band C post-retrofit. As part of the energy and thermal outcomes analysis, changes in EPC ratings were therefore also modelled at a property level for each project using the data sources presented in Table A12 (apart from occupancy). Data prevalence for the EPC data is reported in Tables 13 (at a programme level) and 13 (at a project level). Table A14 presents, per project, the number of cases where:

- Property data were complete,

---

[23] Dynamic Engine is a SAP based modelling tool which enables assessment of a property's energy use. https://www.solsticeassociates.com/#/Dyanmic-Engine This tool can replicate the calculations done on a typical EPC assessment based on manual user input, allowing fine tuning of variables such as property dimensions, material U-values, heating systems and controls. This produces an estimate of the space heating demand, EPC rating, and other energy uses which are required for this analysis.
[24] This included EPC rating, EPC band, space heating requirement in the data annexes provided

- Completeness issues were addressed by averaging similar properties[25] within the same project,

- Completeness issues were addressed by modelling using the Dynamic Engine (DE) approach,

- Properties remained with unfilled data gaps, which were therefore excluded from the EPC analysis (only).

The following projects - Destination Zero I, Destination Zero II and Xtra-Z - had to have all their post-retrofit EPC scores modelled using Dynamic Engine using a limited number of archetypes due to missing data in their project reporting. Results from these projects should be treated with caution.

Following the process above, it was possible to estimate the change in EPC band for 1,132 properties (83% of total properties treated across both programmes, as of April 2023); 235 properties were excluded (17%).

---

[25] A similar property is one with the same house type (e.g. semi-detached), number of bedrooms and in some cases geographic proximity. This was done on a case-by-case basis by examining the project data returns where similar properties had similar EPC scores, bands, floor areas and space heating requirements.

Table A14: Data completeness and inferred data for EPCs (data received February to April 2023). *EPC band inferred from similar properties within the same project.

Project	Pre-installation data				Post-installation data			
	Report by project	DE model	Filled using archetype average*	Unable to fill	Report by project	DE model	Filled using archetype average*	Unable to fill and excluded from analysis
SHDFD Projects								
Alva Community Regeneration through Decarbonisation	15/15				15/15			
Clarion Housing Group advanced retrofit project	81/116	12/116	19/116	4/116	31/116	12/116		73/116
Destination Zero II: The Next Step	65/65					65/65		
Gloucestershire SHARe and CaRe Demonstrator	46/46				18/46			28/46
Leeds Whole House Retrofit	192/193			1/193	171/193		22/193	

Project	Pre-installation data				Post-installation data			
National Net Zero Retrofit Accelerator	111/129		16/129	2/129	126/129		2/129	1/129
Northampton Whole House Retrofit	149/149				149/149			
Nottinghamshire Net Zero Carbon Housing Demonstrator	25/25				25/25			
Orbit Housing Incremental Whole House Retrofit Programme	69/69				69/69			
DORIC	48/50			2/50	48/50			2/50
Retrofit of Electrically Heated Homes	176/176				176/176			
Social Housing Retrofit Accelerator Cornwall	40/40				40/40			
Warmer Homes Argyll & Bute	126/130			4/130				130/130
Xtra-Z	90/90					90/90		

Project	Pre-installation data				Post-installation data			
SHDF total	1233/1293	12/1293	35/1293	33/1293	868/1293	167/1293	24/1293	234/1293
WHR projects								
Destination Zero I	50/51			1/51		50/51		1/51
Energiesprong Sutton	23/23				23/23			
WHR total	73/74			1/74	23/74	50/74		1/74
Total	1306/1367 (96%)	12/1367 (1%)	35/1367 (3%)	34/1367 (2%)	891/1367 (65%)	217/1367 (16%)	24/1367 (2%)	235/1367 (17%)

Source: Project final data annexes, evaluation team analysis

Step 4 - Calculating energy demand

Energy savings for each property were also estimated and analysed to explore property characteristics and regional/project trends. The evaluation of the total energy savings was split into three parts, which are covered in steps 4.1 to 4.3:

- Space heating demand,
- Hot water energy usage and, where applicable,
- PV generation.

The total energy demand for each fuel type was calculated for both pre- and post-retrofit using the following equation:

$$EnergyDemand_{perfuel} = \frac{SH_{Demand}}{SH_{Efficiency}} + \frac{HW_{Demand}}{HW_{Efficiency}} - GenerationUsed\ OnSite_{ElecOnly}$$

Where space heating demand and hot water demand are the energy demands (in kWh) for space heating and hot water, respectively, and space heating efficiency and hot water efficiency are the respective efficiencies 'GenerationUsedOnSiteElecOnly' is the total energy used on site from any generation (only Solar PV in this case) and only applies to electricity as covered under Step 4.2.

Lighting and appliance electricity use was not calculated as it was assumed there was no change in lighting/appliances pre- and post-retrofit and there would therefore be no difference between pre- and post-retrofit usage (and therefore no impact on savings figures). The only exception is where it was required to calculate any generation self-consumption values for solar PV, covered under Step 4.3.

Step 4.1 - Calculating space heating demand

The pre- and post-retrofit space heating demand was required to calculate two outcomes: calculating the fabric improvements of the property and for the overall energy savings.

Data for this were obtained from the final reports submitted by participating projects or filled using the methods detailed in Step 2 (for this calculation, area and space heating demand were required – the prevalence of each per property are provided in Table A8). The projects reported these were calculated using either SAP, rdSAP and PHPP which would result in minor variations in the space heating demand.[26]

---

[26] SAP (Standard Assessment Procedure) is the standard method for generating an EPC certificate. It models a building based on inputs describing the building material (e.g. areas, u-values). RdSAP is the Reduced SAP for use in existing dwellings. It generates a set of input parameters for the SAP calculation methodology based on various inferences about the building type made by the assessor. It is likely that any properties that indicated they were using SAP used RdSAP as this is for existing dwellings. PHPP (Passiv Haus Planning Package) is a similar building modelling procedure but is developed by the Passiv Haus Institute. An article comparing the SAP and

The total energy demand for space heating in kWh was calculated using the formula:

$$\text{SpaceHeatingDemand}_{\text{total}} = \text{SpaceHeatingDemand}_{\text{per m2}} \times \text{Area}$$

Space heating demand per m2 is the space heating demand in kWh per year per square metre reported by the projects. Area represents the total floor area in square metres.

This value was calculated at a property level for pre- and post-retrofit and compared to give the space heating demand savings from fabric improvements. This can be used as a proxy for the fabric improvements as it is a measure of the absolute amount of energy required to heat the building (i.e. it is fuel agnostic).

The total fuel requirement for pre- and post-retrofit was calculated by dividing the respective total space heating demand by the space heating efficiency of the heating system. The difference between the pre- and post-retrofit values gave the total fuel saved on space heating. Heating system efficiencies are determined from Energy Saving Trust research detailed under Step 6.

Step 4.2 - Calculating water heating demand

Water heating demand was not provided by the projects in their reporting so was calculated by the evaluation team to fully assess the total energy savings in the cases where there was a change to the heating system. Where there was no change to the heating system, the hot water demand and associated fuel requirement was assumed to be the same between pre- and post-retrofit and therefore would not effect changes in energy savings.

The hot water demand was calculated using the methodology provided in the latest version of SAP (SAP 2012 9.92).[27] This is given by SAP equation (62):

$$WaterHeatingDemand = (0.85 \times HotWaterEnergy) + DistributionLoss + StorageLoss + PrimaryCircuitLoss$$

Where hot water energy is the energy content of the hot water that property occupants would use, distribution loss is energy lost through the pipework between the hot water tank or boiler and taps/showerheads, storage loss is any losses associated with storing hot water (e.g. in a hot water cylinder) and primary circuit loss are the losses sustained between the boiler and the hot water cylinder. These variables are described in more detail below.

PHPP concluded that the core of the two models is very similar with PHPP providing more clarity around thermal bridges. This would lead to some deviation between thermal performance, however, it is not possible to quantify this given the wide range of archetypes and assessors used across this programme.

Stuart Fairlie, August 2020, 'So which is best – Passivhaus or SAP?', *Architectural Technology Journal*, Issue 135, p22-23, URL: https://architecturaltechnology.com/static/a7b2892f-67cf-48e6-bfaed594b4cab2b1/AT-135.pdf
[27] The Government's Standard Assessment Procedure for Energy Rating of Dwellings, BRE, 2014; https://files.bregroup.com/SAP/SAP-2012_9-92.pdf

The calculations follow the SAP methodology. The approach is thus:

- Calculate the total hot water demand in litres per day ('volumedaily' in the equation below) using occupancy of the property and the SAP equation (43). From this, calculate the energy content for each month of the year using SAP equations (44) and (45).

$$HotWaterEnergy = \ 4.18 \ \times \ \text{Volume}_{daily} \ \times \ NumberOfDays \times \Delta Temperature \ / \ 3600$$

- Calculate distribution losses, assuming all properties have systems without instantaneous water heating at point of use, using SAP equation (46):

$$DistributionLoss = 0.15 \times HotWaterEnergy$$

The calculation of storage and primary circuit losses requires many input variables and its calculation is detailed on page 182 of the SAP methodology. Since the project data did not contain detailed information on the hot water system installed, assumptions were made for inputting cylinder sizes and heating system particularities (such as whether the cylinder is placed in an airing cupboard or not). The calculations detailed in the SAP methodology depend on the following assumptions (see Table A14 in the additional information section for the values used):

- Size of hot water cylinder (where required) for ASHP, GSHP, gas system boilers and electric cylinders – required to estimate storage losses.

- Insulation levels on the cylinder – this determines the heat loss rate of the cylinder. Where there was limited data, generic insulation thickness appropriate to the heating system type/age was used. For example, when there is a note of an insulating jacket being added, this is taken into account.

- Combi losses – for combi boilers there is a facility to keep a small amount of water warm and ready for use.

- Combining water energy content, distribution losses and storage losses gave the total energy required for hot water.

The efficiency of the different heating systems was applied to the total energy to give the total amount of fuel required for hot water heating. Data sources for efficiencies are given as part of the description of Step 6.

Step 4.3 - Calculating generation from solar PV

The use of solar PV panels decreases the volume of electricity that needs to be imported from the grid and is therefore required when assessing total energy and bill savings.

The SAP methodology for solar PV has several limitations, as summarised below:

- SAP assumes a constant self-consumption rate for all properties of 50%. In reality, this varies greatly, for example: a property heated by electricity and one heated by gas will exhibit very different self-consumption rates. This is the key limitation in the SAP methodology and the main reason for finding an alternative approach.

- SAP generation figures are based on 21 regions across Great Britain. This approach fails to account for any local variation arising from local topography. This limitation is less severe as there are still a number of unknowns which would affect the results further. For example the panel slope angle and azimuth (which direction the panel is facing) play a significant role in solar PV generation and is unknown for all properties.

The evaluation team decided to take an alternative approach which uses more accurate self-consumption figures from MCS[28] as well as location data down to a resolution of 5 km2 from the Photovoltaic Geographical Information System (PVGIS).[29] This tool, developed by the European Union, provides more accurate location generation figures than the SAP treatment. It is also used by MCS to generate their PV generation lookup tables, which enabled better consistency when incorporating batteries into the systems. This approach provided more precise savings estimates for individual properties, especially those with a battery installed and is described below.

To determine the contribution of Solar PV to property-level energy savings, the following steps were taken:

1. Fill missing capacity values: In the UK, the maximum inverter size before needing planning permission is 3.68kW. The following fields are options in the project data annexes: solar PV flag, number of panels, peak generating capacity. All properties with PV installs have systems of similar size and therefore it was possible to fill any gaps in the capacity using the following methodology:

a. Where the existence of a PV installation measure is noted, the number of panels is supplied, but the total power of the system is missing, the average of the peak power capacity across properties with the same number of panels was used.

b. Where the number of panels was also unavailable, the capacity was averaged across all other PV installations within the programmes. As expected, the average across all projects corresponds to the typical array size for a 3.68kW inverter. If data is missing the mean value of 3.5kW was assumed.

2. Calculate total generation: Total generation (before self-consumption) was estimated using the PVGIS tool. Geospatial coordinates were obtained from the postcodes of the properties to get an accurate estimate of the PV irradiance. PVGIS considers GPS location, land overshadowing and weather data, all of which are not possible in as much detail on a property-by-property basis in SAP, as SAP simply divides the 21 distinct regions and gives an estimate of generation for a given part of the country.

---

[28] MCS, 2022, Solar PV Self-Consumption: A method to determine the Electrical Self-Consumption of Domestic Solar PV Installations with and without Storage, https://mcscertified.com/wp-content/uploads/2022/04/MGD-003-Solar-PV-Self-Consumption-Issue-2.0-Final.pdf

[29] Huld, T., Müller, R. and Gambardella, A., 2012. "A new solar radiation database for estimating PV performance in Europe and Africa". Solar Energy, 86, 1803-1815.

3. Calculate total electricity demand: To calculate the self-consumption of the raw generation from solar PV, it was necessary to estimate the total electricity demand, including appliances and lighting. These are otherwise excluded in savings calculations as they are assumed to remain unchanged pre- and post-retrofit. Where applicable, electricity consumed by electric heating was also added. As lighting and window-size data is unavailable in the project data, the default values for SAP were assumed. This method was then scrutinised against two other available sources: tables published by Ofgem[30] and a paper from the University of Ulster.[31] Results were broadly consistent to the accuracy needed for the self-consumption calculation. This approach would not be suitable to estimate the electricity use on its own.

4. Calculate self-consumption rate: Using the estimated total electricity consumption per year, the raw PVGIS generation and, in the case of one project, a Tesla battery of 13.5 kWh, lookups obtained from MCS were used to estimate the self-consumption. The average "in-half-day" archetype was used as suggested by MCS when the occupancy profile is unknown. This assumes residents are present in the property approximately half of the day on average. These lookups give self-consumption as a function of electricity consumption in steps of 300kWh. For most properties this is around 10-20% of the electricity consumption, indicating that the standard deviation of 20-30% in the previous step was acceptable and this method still provides greater accuracy than the flat rate of self-consumption given in SAP.

5. Calculate electricity used in the property: The raw generation calculated by PVGIS was multiplied by the self-consumption value given by the MCS lookups to calculate the total PV electricity used directly in the property. Any generation used in the property is subtracted from the total electricity usage which accounts for it in the total energy, CO2 and costs savings.

6. Calculate export payments: Electricity export was not modelled but it is worth noting that it can provide additional cost savings, using a flat rate for export.

Across all projects, there were 364 properties for which PV was modelled. If electricity export payments of 5p per kWh were counted in, the properties would have saved on average £140 (± £3 at 95% confidence) per year. This would mean an increase to the overall energy bill savings of 16% (± 1% at 95% confidence).

Repeating the same analysis for CO2 savings and assuming the carbon saving associated with PV exports is the same as electricity consumption, i.e. 0.146 kgCO2e/kWh, the mean carbon saving would increase by 409 kgCO2e (± 8kgCO2e at 95% confidence). This translates to an increase of 27% (±3% at 95% confidence).

---

[30] Ofgem, 2023, Average gas and electricity use explained, https://www.ofgem.gov.uk/information-consumers/energy-advice-households/average-gas-and-electricity-use-explained
[31] https://www.sciencedirect.com/science/article/abs/pii/S037877880700223X?fbclid=IwAR0EvlSynHR5rLPImH9YZuxbd-cuccQKORA2mHJuExb0Fp7qDCGYq3EQcug

As these were social housing properties, it was not known if the potential cost savings from electricity export for the 364 relevant properties, would be passed on to the residents or social housing providers. Export savings were therefore not included in the analysis.

Step 5 - Calculating energy savings

Step 5.1 – Fabric savings

Building fabric improvements were assessed by calculating the change in space heating demand between the pre- and post-retrofit properties.

It should be noted that this value is before heating system efficiency is accounted for and is considered a reasonable proxy for fabric savings.

$$FabricSavings = SpaceHeatingDemand_{pre-retrofit} - SpaceHeatingDemand_{post-retrofit}$$

Results of estimated fabric improvements for both programmes are discussed in section 5.3 of the main report.

Step 5.2 - Final energy savings

Energy demand per fuel type (gas, electricity, oil and LPG) is given by summing water and space heating demands and taking appropriate efficiencies (see Table A15) into account.

$$EnergyDemand_{perfuel} = \frac{SH_{Demand}}{SH_{Efficiency}} + \frac{HW_{Demand}}{HW_{Efficiency}} - GenerationUsed\ OnSite_{ElecOnly}$$

These are summed (see equation below) to give the total energy requirement for all fuels pre- and post-retrofit.

$$TotalEnergyRequirement = \sum_{fuel\ type} EnergyDemand_{fuel\ type}$$

PV generation was accounted for in the electricity energy requirement, with any electricity unused on site exported to the grid. Export figures are not accounted for in the total energy savings. The difference between the pre- and post-retrofit values gives the total energy savings:

$$TotalEnergySavings \\ = TotalEnergyRequirement_{\ pre-retrofit} \\ - TotalEnergyRequirement_{\ post-retrofit}$$

Results of estimated energy savings generated from both programmes are discussed in section 5.4 of the main report.

Step 5.3 - Cost and carbon savings

The final energy savings (per property) were converted into cost and carbon savings using appropriate factors given in Table A15 for each fuel type.

$$CostSavings = \sum_{fuel\ type} EnergySavings_{fuel\ type} \times CostFactor_{fuel\ type}$$

$$CarbonSavings = \sum_{fuel\ type} EnergySavings_{fuel\ type} \times CarbonFactor_{fuel\ type}$$

These savings are only accurate at the time of publication and will change when fuel cost and carbon factors change. Any exported PV generation follows the same approach, although in this case is not included in the savings to be consistent with the total energy savings.

Results of estimated carbon and cost savings generated from both programmes are discussed in section 5.4 of the main report.

Table A15: Cost and carbon factors for various fuels

Fuel Type	Cost factor (p/kWh)	Carbon factor (kgCO2e/kWh)	Source[32]
Electricity	41.70	0.146	Carbon - Table 1 2023 Domestic Grid average Import Cost – Table 4 2023 domestic central scenario
Electricity export	0	0	Export cost and carbon savings omitted. Only PV energy used is considered.
Gas	11.30	0.183	Carbon - Table 2a natural gas all GHG emissions (AR5) Cost – Table 4 2023 domestic scenario B
LPG	8.69	0.214	Carbon - Table 2a LPG all GHG emissions (AR5) Cost – rdSAP[33]
Oil	6.57	0.247	Carbon - Table 2a burning oil all GHG emissions (AR5)

---

[32] Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal data tables: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

[33] https://files.bregroup.com/SAP/RdSAP-fuel-prices-from-15th-February-2023.xlsx

Fuel Type	Cost factor (p/kWh)	Carbon factor (kgCO2e/kWh)	Source[32]
			Cost – Table 4 2023 domestic central scenario (converted to p/kWh using scaler of 10.29 kWh/litre)

Results limitations

In addition to the limitations in the data already discussed in Steps 1 and 2, some other limitations also apply that impact the validity of the results.

- All the results from this analysis are based on modelled data (primarily based on the SAP methodology), as no actual energy consumption data was available. Actual energy performance can vary significantly with EPCs on average overpredicting primary energy use intensity by 8% for band C and 48% for bands F&G.[34] However, there are also cases where energy use is underpredicted by EPCs. This is partly due to issues with the EPC process but also largely due to behavioural factors where residents heat their properties differently to how the SAP methodology prescribes (e.g. different temperatures or heating durations). Another limitation of using modelled data is the phenomenon widely called the 'rebound effect', where an increase is seen in the consumption of energy following energy efficiency improvements. In reality this is residents increasing the temperature of their home as it is now cheaper overall to run, however results in lower savings than expected.

- The cost and carbon factors are only valid for the publication year (2023) and may be subject to change in the future. While the cost factors are quite volatile and difficult to predict, we can be more certain about the carbon factors. The carbon factor for electricity is predicted to decrease as the grid is decarbonised, while the gas, LPG or oil boilers which will likely stay fairly constant as it is the same material that is being burned.[35] This will increase the carbon savings for switching from fossil fuel to heat pumps and electric heating systems in the future.

- The lifetime carbon savings for the properties where heat pumps or electric heating were installed is also likely to be higher than suggested in this report as these systems will benefit from a potentially lower carbon factors over their lifetime (typically 10-20 years). It is more difficult to predict how costs for the various fuels will change as they depend on a range of external factors. It is likely that fossil fuel prices will generally increase over time relative to electricity. As with the carbon savings, this would likely increase the savings from switching from fossil fuels to heat pumps making them more

---

[34] Few et al., The over-prediction of energy use by EPCs in Great Britain: A comparison of EPC-modelled and metered primary energy use intensity, Energy and Buildings, Volume 288, 2023, 113024, ISSN 0378-7788, https://doi.org/10.1016/j.enbuild.2023.113024.
[35] The carbon factor for gas may decrease slightly if a gas-hydrogen blend is used, however the relative electricity to gas carbon factors will likely favour electricity over time.

attractive in the long term. This is less likely for direct electric heating given the very large gulf in cost per kWh of usable heat. Therefore, these results may underestimate the potential savings of heat pumps over their lifetime.

Step 6 – Exploring correlations and patterns by project approach and measures package

In the analysis, the results were presented in two ways:

- Aggregated on a programme level across all projects. In some cases projects are shown separately for clarity.

- By the package of measures installed.

The measure packages were obtained from the project final reporting as well as extracts from the Trustmark database. More information on this can be found in Annex 5. The measure categories for the report are described in A15.

Table A16: Description of measures installed

Measure	Description
EWI	External wall insulation
IWI	Internal wall insulation
Cavity	Cavity wall insulation
Windows	New windows (double and triple)
Heat pump	Replacement of current heating system with heat pump
Solar PV	Installation of solar photovoltaic panels
Doors	Replacement of doors with insulated and draught proofed variety
MVHR	Mechanical ventilation and heat recovery units
MEV	Mechanical extract ventilation (i.e. no heat recovery)
Ventilation passive	Passive ventilation units (e.g. ceiling fans)
Loft insulation	Loft insulation top up
New roof	Installation of new roof
Roof insulation	Insulation of flat roof or rafters

Measure	Description
Floor insulation	Insulated under ground floor
Boiler upgrade	Replacement of old boiler with new boiler
Hot water	Installation of new hot water system (i.e. hot water cylinder)
Storage heaters	Installation of electric storage heaters
Infrared	Installation of infrared heating system
Party wall	Insulation of party walls
Draught proofing	Draught proofing of property
Heating controls and repair	Installation of new heating controls
Lighting	Replacement of inefficient lighting with new LED bulbs

Additional information

This section presents additional information used for the energy savings modelling.

Table A17: Description of assumptions used for hot water heating)

Variable	Assumption
Hot water cylinder size	The size will be based on the daily hot water demand. The daily demand is calculated using SAP methodology, and an overhead of 50% added based on EST recommendations and rounded up to the nearest typical cylinder size. Based on market research of a range of online plumbing sources, cylinders come in 7 different sizes between 120 and 500 litres. It is assumed the installer chose an appropriately sized cylinder to accommodate the daily hot water demand + some overhead (e.g for higher demand at certain times of year). This is an approximation, however, this only has an effect on the cylinder losses, which applies to only 72 properties across all projects. The magnitude of cylinder losses compared to the overall hot water and space heating demand is only 6% on average.
Hot water cylinder insulation thickness	Where there is no information on cylinder insulation thickness is given it is assumed that they are factory insulated. Based on cylinders available on the market this is assumed to be 20mm for older gas boilers, 10mm for LPG and oil boilers and 80mm for heat pumps. This is based on internal market research by Energy Saving Trust for older boilers and new heat pump cylinders. If there are measures which change the cylinder insulation (for example an additional hot water jacket) a 20mm factory insulated cylinder is assumed before and 80mm jacketed cylinder is assumed after. Changing from a lightly insulated gas system boiler (assumed 20mm) to a heat pump (assumed 80mm of insulation) results in storage loss savings of 520 kWh per year on average. This is around 7.5% of the total energy saving.
Combi boiler water storage	We assumed that a combi boiler is in eco mode and therefore there is no hot water storage. This is typically how an installer would set up a combi boiler and it is assumed that the occupant does not change the settings.
Heating type set as "gasboiler"	If it is not specified whether a gas boiler is a system (with a hot water cylinder) or a combi, it is assumed to be a combi when the total floor area is less than 150m2. This is appropriate as combi boilers are the most common type of gas boiler and would be an obvious choice in a smaller property. In a larger property a cylinder is more likely. This is because, typically, properties with multiple bathrooms require hot water cylinders to ensure sufficient water pressure to allow multiple showers at once

Heating system efficiencies: gas, LPG, and oil boilers

Heating system efficiencies are required to estimate fuel energy usage from space heating and hot water demand in Step 4 of the methodology. Average efficiencies for gas, LPG and oil boilers are calculated using the following logic:

1. The proportion of condensing and non-condensing boilers were determined:

- A. Proportions of condensing and non-condensing boilers were taken from the English Housing Survey Table DA6101 (SST6.1): Heating – dwellings.[36] This considered all tenure types.

- B. Proportions of A and B rated boilers within condensing and C to G rated boilers within non-condensing were taken from data tables provided to Energy Saving Trust by the Heating and Hot water Industry Council.

- C. These data in combination give the numbers (or percentages) of each boiler rating for both condensing and regular/system boilers.

2. The efficiencies for different boiler ratings were calculated:

- A. The winter and summer efficiencies for each rating were taken as the midpoint between the upper and lower SEDBUK 2009 efficiency that defines each boiler rating category. The upper efficiencies for A-rated boilers were taken as the maximum efficiencies in the Product Characteristic Database.[37]

- B. The efficiency for G-rated boilers was taken to be the upper limit for this efficiency band as there is no data available on the minimum efficiency of older boilers, and there are no boilers below this efficiency in the Product Characteristics Database. This may have the effect of increasing the average performance of G-rated boilers in the calculation, but the effect will be negligible due to the very low proportion (2%) of G-rated boilers in the current housing stock.

- C. Real world correction factors were applied to these efficiencies for condensing boilers, taken from BEIS' In-situ monitoring of efficiencies of condensing boilers and use of secondary heating trial,[38] to give space and water heating efficiencies.

3. A weighted average calculation was carried out to determine an average boiler efficiency based on the proportion of different boiler ratings and their respective efficiencies:

- A. The stock percentage figures for each boiler rating and type are combined with the adjusted mid-range efficiencies for each rating and type to give a weighted average boiler efficiency for the entire housing stock, giving a typical efficiency for each fuel type.

---

[36] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1088661/DA6101_Heating_-_dwellings.ods

[37] https://www.ncm-pcdb.org.uk/sap/pcdbsearch.jsp?pid=26

[38] https://www.gov.uk/government/publications/in-situ-monitoring-of-efficiencies-of-condensing-boilers-and-use-of-secondary-heating-trial-final-report-2009

Heat pump efficiencies

The average Seasonal Performance Factor (SPF) for air source heat pumps was taken from the Electrification of Heat Interim Heat Pump Performance Data Analysis Report.[39]

The median SPFH4 of 2.80 was used as representative of a typical recent installation as part of a funded programme, with the H4 system boundary including all hot water provision. This figure is a combined SPF for both space and water heating, and separate figures for the two efficiencies are not currently available from this source. There are separate figures that could be deduced from older trials, but these sources are not representative of current practice in terms of overall performance and so may not be representative in terms of relative space and water heating performance. Therefore the combined figure for both space and water heating efficiency was used.

Ground source heat pump data is not yet available from the Electrification of Heat trial. Therefore, the relative performance of ground and air source systems in the Microgeneration Certification Programme (MCS) Database was used to calculate an uplift to apply to the Electrification of Heat figure to give an equivalent figure for ground source systems. The uplift is calculated using design seasonal coefficients of performance from all air source and ground source installations recorded in the database over the past five years. The database is not published but the data was made available to Energy Saving Trust by MCS for the purpose of assessing system performance.

Other electric heating efficiency

Other forms of electric heating include infrared panels, storage heaters, electric room heaters and electric boilers. All these forms of heating are assumed to have 100% efficiency as all the electrical energy is converted into heat within these types of systems.

---

[39] https://es.catapult.org.uk/news/heat-pumps-shown-to-be-three-times-more-efficient-than-gas-boilers/

Table A18: Electric heating efficiency assumptions

Water heating efficiency		Space heating efficiency	
Gas system/regular	73.1%	Gas system/regular	85.5%
ASHP	280%	ASHP	280%
GSHP	312%	GSHP	312%
Oil boiler	74.1%	Oil boiler	86.0%
LPG boiler	73.2%	LPG boiler	85.6%
Combi boiler	73.3%	Combi boiler	85.6%
Electric immersion	100%	Electric heating	100%

Detailed results

This section sets out the detailed results of the modelled energy, bill and carbon savings for SHDF(D) and WHR, in a tabular format. The detail is for reference when reviewing the summarised results, as presented in the main report (Chapter 5).

Overall Results

Table A19: Summary of modelled energy, bill and carbon savings for the two programmes

Programme	Combined	SHDF(D)	WHR
Number of properties analysed	1,210	1,137	73
Total Bill Savings (£000's)	1,538	1,492	47
Total Energy Savings (MWh)	12,045	11,493	552
Total Carbon Savings (tonnes CO2e)	2,109	2,011	98
Mean bill savings per property (£)	1,271 ± 56	1,312 ± 59	639 ± 73
Mean energy savings per property (kWh)	9,954 ± 325	10,108 ± 337	7,562 ± 1,083
Mean carbon savings per property (kgCO2e)	1,743 ± 60	1,768 ± 63	1,346 ± 188

Source: Project reporting, proxy data, and modelled estimates. Values are given on an aggregated basis as well as per property (with associated 95% confidence interval).

Comparison of various costs scenarios

Table A20 shows a comparison of the savings for various heating systems for 2021 to 2023 values. Costs for 2023 are given in Table A15 and 2021 costs are given in the footnote.[40]

Table A20: Comparison of annual bill savings from costs from 2021 and 2023. % change shows the decrease from 2023.

Heating system	Annual bill savings – 2021 prices (£)	Annual bill savings – 2023 prices (£)	% change in bill savings from 2023 to 2021 prices
Electric to heat pump	1,540	3430	-55%
Gas to heat pump	170	966	-82%
Unchanged heating system	408	1,137	-64%
Total	424	1,271	-71%

Results by measure package

The energy, carbon and bill savings grouped by measure, as discussed in Chapter 5 of the report, are based on Table A21 given below. The savings are grouped by change in EPC band and are presented with associated sample sizes and 95% confidence intervals. Only measure groupings with more than ten properties were selected in order to minimise the effect of outliers.

---

[40] Electricity cost: £0.1890/kWh (QEP 2.2.4 averaged over payment methods, UK average), Gas cost: £0.0342/kWh (QEP 2.2.4 averaged over payment methods, UK average), Heating oil: £0.0499/kWh (Unpublished prices provided by DESNZ, UK averages), Bulk LPG cost: £0.0676/kWh (Sutherland Tables for October 2021, using Quarterly Energy Prices 2020 Annual Domestic Bills Estimates Supplement for calorific value)

Table A21a: Measures packages and associated energy, carbon and energy bill savings.

*These are grouped by the change in EPC band. For example, the same measure package might have multiple changes in EPC band (e.g. D -> C and D -> B).**

Measure package	EPC change*	#	[kWh] Savings with 95% confidence	[kgCO2e] Savings with 95% confidence		[£] Savings with 95% confidence
EWI, Heat pump, Doors, Ventilation Passive, Roof insulation, Hot water, Infrared, Heating Controls and repair	D->B	17	27,625 (±2,026)		5,154 (±377)	2,312 (±177)
EWI, Heat pump, Solar PV, Doors, MVHR, Loft insulation, Hot water	D->B	30	20,840 (±1,140)		3,665 (±205)	1,575 (±102)
Windows, Heat pump, Solar PV, Ventilation Passive	C->B	13	18,668 (±744)		3,284 (±139)	1,250 (±59)
EWI, Windows, Heat pump, Ventilation Passive, Loft insulation, Roof insulation	E->C	24	16,632 (±844)		3,149 (±156)	1,014 (±97)
Windows, Heat pump, Ventilation Passive, Loft insulation, Roof insulation	E->C	17	15,803 (±1077)		2,991 (±205)	970 (±132)
EWI, Windows, Solar PV, Loft insulation	E->A	11	15,663 (±311)		2,720 (±57)	1,679 (±35)

Measure package	EPC change*	#	[kWh] Savings with 95% confidence	[kgCO2e] Savings with 95% confidence		[£] Savings with 95% confidence
EWI, Heat pump, Solar PV, Loft insulation	D->C	30	14,563 (±415)		2,541 (±77)	816 (±27)
EWI, Windows, Heat pump, Solar PV, MEV, Loft insulation, Draught Proofing	D->C	15	14296 (±1,844)		2,494 (±341)	755 (±168)
EWI, Windows, Solar PV, Loft insulation	D->A	16	14,152 (±2,242)		2,443 (±412)	1,463 (±234)
EWI, Windows, Solar PV	D->A	12	13,363 (±2,395)		2,299 (±437)	1,420 (±270)
EWI, Windows, Loft insulation	D->C	11	11,447 (±3,786)		2,095 (±693)	1,294 (±428)
Heat pump, Solar PV	D->A	24	10,461 (±287)		1,824 (±53)	696 (±24)
EWI, Windows, Solar PV, Doors, Loft insulation, Roof insulation, Floor insulation, Hot water, Draught Proofing, Lighting, Heating Controls and repair, Appliances	D->B	12	10,175 (±654)		1,392 (±122)	860 (±75)

Measure package	EPC change*	#	[kWh] Savings with 95% confidence	[kgCO2e] Savings with 95% confidence		[£] Savings with 95% confidence
EWI, IWI, Heat pump, Doors, Ventilation Passive, Roof insulation, Hot water, Infrared, Heating Controls and repair	D->B	20	9,971 (±499)		1,897 (±94)	533 (±33)
Heat pump	D->B	99	9,868 (±216)		1,858 (±40)	682 (±19)
EWI, Windows, Ventilation Passive, Loft insulation, Roof insulation	E->C	14	9,650 (±989)		1,766 (±181)	1,090 (±112)
EWI, Cavity, Windows, Heat pump, Doors, Loft insulation	D->A	15	9,313 (±778)		1,360 (±114)	3,883 (±324)
EWI, Windows, Doors, MEV, Loft insulation, Roof insulation, Lighting, Heating Controls and repair	D->C	14	9,155 (±1078)		1,675 (±197)	1,034 (±122)
EWI	D->C	67	8,582 (±348)		1,571 (±64)	970 (±39)
EWI, Ventilation Passive, Roof insulation	E->C	26	8,027 (±832)		1,469 (±152)	907 (±94)

Measure package	EPC change*	#	[kWh] Savings with 95% confidence	[kgCO2e] Savings with 95% confidence		[£] Savings with 95% confidence
EWI, Loft insulation, Floor insulation, Draught Proofing	E->C	13	5,208 (±1,586)		953 (±290)	589 (±179)
EWI, Loft insulation, Draught Proofing	E->C	24	5,129 (±939)		939 (±172)	580 (±106)
EWI, Windows, Doors, MEV, Loft insulation, Party Wall	F->C	31	4,906 (±930)		716 (±136)	2046 (±388)
EWI, Windows, Doors, MEV, Loft insulation, Lighting, Heating Controls and repair	D->C	15	4,352 (±801)		796 (±147)	492 (±90)
EWI, Windows, Doors, MEV, Loft insulation	F->C	12	3,809 (±304)		556 (±44)	1,589 (±127)
Cavity, Windows, Solar PV, MEV, Loft insulation, Draught Proofing	D->C	11	3,588 (±469)		546 (±83)	337 (±51)
EWI, Windows, Doors, MEV, Loft insulation, Party Wall, Lighting	D->C	17	3,169 (±531)		463 (±77)	1,321 (±221)
EWI, Windows, Doors, MEV, Loft insulation, Party Wall, Lighting	D->B	17	3,079 (±575)		449 (±84)	1,284 (±240)

Measure package	EPC change*	#	[kWh] Savings with 95% confidence	[kgCO2e] Savings with 95% confidence		[£] Savings with 95% confidence
EWI, Windows, Doors, MEV, Loft insulation, Lighting	D->C	11	2,674 (±708)		390 (±103)	1,115 (±295)
EWI, Windows, Doors, MEV, Loft insulation, Heating Controls and repair	D->C	17	2,238 (±1,204)		392 (±234)	463 (±104)
EWI, Cavity, Windows, Doors, MEV, Loft insulation	F->C	23	2,146 (±311)		313 (±45)	895 (±130)

Source: Measure data from final reports. EPC ratings as reported in final reports or identified by the evaluation team using postcode data from final reports. Results have a 95% confidence interval, ordered by largest energy saving.

The space heating requirement improvements, as discussed in Chapter 5 of the report are based on data set out in Table A21b below. Packages of measures were sorted by greatest SHR improvement and combinations with less than 10 properties were disregarded to maintain statistical significance. Results are presented with 95% confidence intervals and corresponding sample sizes.

Table A21b: Measures packages and associated space heating requirement improvements

Measure Package	#	Difference in SHR	Pre-installation data	Post-installation data
EWI, Heat pump, Doors, Ventilation Passive, Roof insulation, Hot water, Infrared, Heating Controls and repair	20	191 (±0)	240 (±0)	48 (±0)
EWI, Windows, Heat pump, Solar PV, Loft insulation	11	156 (±6)	209 (±3)	53 (±5)
EWI, Heat pump, Solar PV, Doors, MVHR, Loft insulation, Hot water	37	155 (±15)	201 (±15)	46 (±0)
EWI, Windows, Solar PV	14	137 (±18)	196 (±17)	59 (±3)
EWI, Windows, Solar PV, Loft insulation	65	126 (±7)	175 (±7)	48 (±4)
EWI, Windows, Loft insulation	34	117 (±18)	176 (±17)	59 (±2)
EWI, Windows, Doors, MEV, Loft insulation, Party Wall	31	116 (±0)	193 (±0)	77 (±0)
Heat pump	105	109 (±3)	159 (±4)	50 (±1)
EWI, Windows, Doors, MEV, Loft insulation	20	109 (±9)	179 (±10)	71 (±5)
EWI	69	103 (±3)	161 (±3)	58 (±1)
Windows, Heat pump, Ventilation Passive, Loft insulation, Roof insulation	20	102 (±11)	171 (±6)	69 (±8)

Measure Package	#	Difference in SHR	Pre-installation data	Post-installation data
Heat pump, Solar PV	30	102 (±9)	146 (±8)	44 (±2)
EWI, Windows, Heat pump, Ventilation Passive, Roof insulation	12	102 (±8)	174 (±2)	72 (±7)
EWI, Windows, Heat pump, Ventilation Passive, Loft insulation, Roof insulation	27	100 (±6)	172 (±5)	72 (±5)
EWI, Windows, Ventilation Passive, Loft insulation, Roof insulation	18	98 (±8)	172 (±7)	73 (±5)
Windows, Heat pump, Solar PV, Ventilation Passive	16	93 (±0)	136 (±0)	43 (±0)
EWI, Ventilation Passive, Roof insulation	50	91 (±6)	152 (±6)	61 (±4)
EWI, Heat pump, Solar PV, Loft insulation	41	89 (±0)	150 (±1)	61 (±0)
EWI, Windows, Heat pump, Solar PV, Doors, Loft insulation, Draught Proofing, Heating Controls and repair	17	88 (±21)	137 (±24)	49 (±6)
EWI, Ventilation Passive, Roof insulation, Boiler upgrade	14	85 (±12)	149 (±11)	64 (±6)
EWI, Windows, Doors, MEV, Loft insulation, Roof insulation, Lighting, Heating Controls and repair	14	85 (±6)	154 (±5)	69 (±5)
EWI, Windows, Solar PV, Doors, Loft insulation, Roof insulation, Floor insulation, Hot water, Draught Proofing, Lighting, Heating Controls and repair, Appliances	15	85 (±9)	199 (±10)	114 (±7)
EWI, Cavity, Windows, Heat pump, Doors, Loft insulation	31	75 (±7)	119 (±8)	43 (±3)

Measure Package	#	Difference in SHR	Pre-installation data	Post-installation data
EWI, Windows, Heat pump, Solar PV, Doors, MVHR, Loft insulation	13	73 (±10)	131 (±14)	51 (±6)
EWI, Cavity, Windows, Doors, MEV, Loft insulation	23	73 (±0)	135 (±0)	62 (±0)
EWI, Windows, Heat pump, Solar PV, MEV, Loft insulation, Draught Proofing	17	73 (±12)	129 (±14)	56 (±3)
EWI, Windows, Doors, MEV, Loft insulation, Lighting, Heating Controls and repair	18	70 (±11)	149 (±11)	79 (±8)
EWI, Windows, Doors, MEV, Loft insulation, Lighting	27	68 (±12)	137 (±12)	69 (±5)
EWI, Windows, Doors, MEV, Loft insulation, Heating Controls and repair	24	68 (±13)	140 (±13)	72 (±8)
EWI, IWI, Heat pump, Doors, Ventilation Passive, Roof insulation, Hot water, Infrared, Heating Controls and repair	20	64 (±0)	111 (±0)	47 (±0)
EWI, Cavity, Windows, Loft insulation	140	64 (±17)	523 (±39)	54 (±0)
EWI, Loft insulation, Floor insulation, Draught Proofing	18	58 (±12)	129 (±12)	71 (±7)
EWI, Windows, Doors, MEV, Loft insulation, Party Wall, Lighting	47	58 (±7)	120 (±7)	62 (±2)
EWI, Loft insulation, Draught Proofing	32	54 (±8)	132 (±8)	78 (±5)
Cavity, Windows, Solar PV, MEV, Loft insulation, Draught Proofing	12	50 (±10)	120 (±17)	71 (±10)
Cavity, Heat pump, Solar PV, Loft insulation	27	32 (±17)	85 (±15)	53 (±4)

Source: Measure data from final reports. SHR as reported in final reports or calculated based on archetypes using Dynamic Engine. Results have a 95% confidence interval, ordered by largest energy saving.

Annex 3: Market outcomes contribution analysis

This Annex provides an overview of how Ipsos applied Contribution Analysis (CA) to assess effects on companies participating in WHR and SHDF(D), particularly in relation to skills development, business growth, and jobs.

A3.1 Introduction

We used CA to address the Evaluation Questions relating to market outcomes of:

- To what extent did the programmes contribute to retrofit market growth?
- To what extent did the programmes support green jobs?

CA is a theory-based method which is employed where experimental or quasi-experimental designs are not feasible or not practical (as is the case with the SHDF(D) and WHR programmes) but there is an interest in assessing whether observed outcomes can confidently be attributed to the intervention. It is an approach for developing, testing and refining a ToC to build a credible, evidence-based story of contribution which can be rigorously assessed. Rather than determining the causal impact of a programme or intervention, CA focuses on understanding the underlying factors that contribute to the attainment or non-attainment of a desired outcome.

To accomplish this, CA relies on the programme ToCs, which outline the expected causal pathways through which the programme activities are anticipated to lead to the desired outcome. By examining these causal pathways, the analysis seeks to uncover the specific factors that have played a role in either facilitating or hindering the achievement of the outcome of interest. This methodology was developed by John Mayne (2001)[41] and constitutes the following steps:

- Setting out of the evaluation question(s) that are to be assessed.
- Development of a ToC.
- Gathering of existing evidence.
- Triangulation of evidence to assess the contribution narrative.
- Gathering of additional evidence to assess the contribution narrative.
- Refinement of the contribution narrative considering the additional evidence.

---

[41] John Mayne (2001). *Addressing Attribution through Contribution Analysis: Using Performance Measures Sensibly. Canadian Journal of Program Evaluation 16.1: 1-24*

By synthesising multiple sources of data, including qualitative interviews, publicly available employment data, and project-level monitoring data, the analysis aims to establish a plausible assessment of the contribution that the programme has made to the observed outcomes. It helps to disentangle the programme's impact from other external factors and provides insights into the potential pathways through which the programme has influenced the observed outcomes. By adopting this approach, policymakers and evaluators can gain a deeper understanding of the programmes' effectiveness and make more informed decisions based on the available evidence.

This approach was the most appropriate for assessing the job and market impacts of the programmes due to several key reasons.

- CA is unique in its ability to provide insight into the contribution of different programme elements to a varied and multifaceted outcome, such as retrofit market growth or supporting green jobs. CA allows for the dissection of contributing factors to provide insight into the different elements of the programmes which facilitated job and market outcomes.

- The iterative nature of CA, such as the ability to revisit and amend the contribution narrative (Steps 5 and 6 above), provided useful flexibility in managing and making use of multiple data sources.

- The novel nature of the SHDF(D) and WHR programmes meant that there was no feasible or easy-to-construct comparison group that could be robustly used to measures programme impacts through a quasi-experimental design (QED).

- We did not have access to comprehensive quantitative data on job and market related outcomes. Instead, CA allowed us to effectively use the significant amount of qualitative data undertaken as part of the outcome evaluation.

A3.2 Framework

We initially formulated a CA framework by reviewing the programme-level ToCs and breaking down the definitions for the two outcomes of interest e.g. contributing to retrofit market growth and support of green jobs. This can be shown in Table A22.

Table A22: Breakdown of definitions

Outcome	Causal pathways
Retrofit market growth	The programmes were anticipated to contribute to retrofit market growth this could be through:
	Improving the size and resilience of the retrofit market
	Increasing the maturity of the technologies, and the skills, capability, and capacity (to deliver whole house retrofit) of companies employed in the programmes.

Outcome	Causal pathways
	Increasing willingness within the retrofit industry to invest in whole house retrofit approaches.
Supporting green jobs	The programmes were anticipated to support green jobs through: Employing people in green jobs,[42] and Increasing skills and capacity in green sectors.

From this initial breakdown of the causal pathways, we then hypothesised contribution claims for each of the separate causal pathways identified for each EQs. For each contribution claim we identified:

- **Assumptions:** that underpin the contribution claim to materialise.

- **Alternative theories:** that could explain any change in the outcome of interest other than the contribution claim.

- **Theory of no change:** identifying, in line with the contribution claim hypothesised, what would be the indicators of a failure to evoke a change in the outcome of interest.

- **Indicators of change and contribution:** what would be expected to be seen in the data if there was a positive change in the outcome of interest and what indicators would provide evidence of contribution.

- **Data sources:** identification of the sources of data that each contribution claim would rely on.

This initial framework identified a total of 12 contribution claims for assessing whether the programmes contributed to retrofit market growth and five related to the question of whether the programmes supported green jobs. Through an iterative review process with DESNZ, we reduced the total to eight and three for the growth contribution and green jobs questions respectively. This reduction was based on the expected strength of evidence and plausibility of the contribution claim against the programmes' ToCs. The finalised CA framework is presented in Table A23.

---

[42] We used the Government's Green Jobs Taskforce definition of a green job as: employment in an activity that directly contributes to - or indirectly supports - the achievement of the UK's net zero emissions target and other environmental goals, such as nature restoration and mitigation against climate risks. Accessed from : https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1003570/gjtf-report.pdf

Table A23: Contribution analysis framework: To what extent did the programmes contribute to retrofit market growth?

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
1. Increasing the size and resilience of the retrofit market	1a. Retrofit companies survived economic shock. DESNZ provides funding > LAs (or the social landlord) contract companies (including retrofit providers and installers) > these companies see their turnover increase > the companies have stable income during economic shock, thus making them more resilient in the short-term.	- Additionality: without the programmes funding the companies would have been affected by shocks driven by COVID-19 lockdowns, inflation, Brexit uncertainty. - The market is not at capacity, and therefore companies are able to acquire new employees and capital. - This assumption applies to all claims under this causal link.	1. The size and resilience of the retrofit market increases, but not as a result of the programmes. For example, turnover of companies within the retrofit industry increases, but due to involvement in other social housing retrofit programmes or private retrofit projects. For businesses who also provide other services, such as construction companies, their turnover could increase due to changes in their other business operations such as new housing projects. The size and resilience of the retrofit	Companies delivering the projects must lay off staff in the face of shocks / face financial challenges OR companies do not report experiencing financial challenges.	Indicator of (positive) change: turnover of the companies involved in the programme. Indicator of contribution: companies employed on the project attribute the change in profit and thus investment levels in capacity to the impact of being employed on the programme.	Project team interviews, Secondary data (Companies House).
	1b. Increased revenue and profits	- External factors (such as COVID-19,		Companies employed on the programmes	Indicator of (positive) change: revenue of	Project team interviews,

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
	allow investment in growth. DESNZ provides funding > LAs (or the social landlord) employ companies (which includes retrofit providers and installers) > these companies have greater ability to invest in new employees/capital.	inflation) do not lead to rising costs for retrofit providers and installers, which could limit their ability to deliver the project profitably. - The projects are profitable for suppliers. - This profit is used to fund investment into employees/ capital within this industry, rather than used for other reasons such as dividends, investment in other sectors or covering losses in other business areas.	market could increase because of changes to private demand of energy efficient heating (heat pumps), or other retrofit components, which increases the turnover of both suppliers and installers.	do not report the project as profitable, so do not report willingness to take on similar projects in the future, and to grow their ability to deliver WHR.	companies employed on the programme increases following the programme, and report that delivery was successful, and costs were managed such that delivery was profitable. These companies also report that they have used the profitability of these programmes to fund investment into new capabilities/capital/ employees. Indicator of contribution: companies employed on the project attribute the change in profit and thus investment levels into capacity to the impact	Project lead interviews.

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
					of being employed on the programme.	
	1c. Increased customer base improves reputation. DESNZ provides funding > LAs (or the social landlord) employ companies (which includes retrofit providers and installers) > these companies build customer base (partners and customers) and add to their track record > their reputation and reach improves > they are able to attract a more sustained pipeline of work.	- The companies publicise their involvement in the programmes / projects. - The companies have the time to effectively network. - The relationships work well - i.e., the projects have a positive experience of working with the company which motivates the project partners / others to seek longer-term or follow-on work with the company.		Companies do not attract a follow-on pipeline of work (and/or their networks are not increased / their track record does not generate follow-on work).	Indicator of (positive) change: Companies involved reporting on an expansion of offering. Indicator of contribution: Companies employed on the project attribute the change in offering to experience gained through delivering the projects.	Project team interviews, Project lead interviews, monitoring data.

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
		-The projects are successful in achieving their objectives and/or generate admirable results in order to enable the companies to use this as evidence of successful delivery.				
2. Increasing the maturity of the technologies, and the skills, capability and capacity (to deliver whole house retrofit) of companies employed in	2a. Technical support increases WHR skills. DESNZ provides technical support (monitoring, knowledge sharing, learning communities) > LAs (or the social landlord) employ companies (which includes retrofit providers and	-The projects are successful in achieving their objectives and/or generate positive results to enable the companies to use this as evidence of successful delivery. - DESNZ support is effective.	2.The size, skills capability and capacity of firms employed in the programmes increases but not because of the programmes. This could be because of gaining knowledge, skills, revenue, or knowledge of PAS compliant WHR delivery, through employment/participati	Companies employed on projects do not take on new skills due to outsourcing to other agencies for retrofit specific roles, or segment delivery with separate subcontractors.	Indicator of change: Employed companies report that the programmes made them take on new skills, and that they have gained knowledge. Management within these companies see the impact of having these new skills as increasing their ability to deliver WHR	Project team interviews, Project lead interviews, monitoring data.

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
the programmes.	installer) with existing retrofit experience (who have not yet utilised whole house approaches) > through delivery of the programme these companies increase skills in whole house retrofit > These companies have a greater capacity to deliver whole house approaches on future projects and evidence of prior experience.	- Companies are motivated to upskill their workforce. - LAs, landlords and companies engaged have an effective learning culture for embedding skills after works are completed.	on on other retrofit programmes. This includes funding programmes such as the Mayor of London's Retrofit Accelerator, or ECO3i Funding, in addition to knowledge gained through participation in private funding programmes. The maturity and technological readiness of suppliers increases but not as a result of the programme. This could be as a result of employment in other retrofit programmes, or through increased demand for retrofit materials and products, such as Heat Pumps or EWI,		retrofit and have a better offering in terms of potential future projects. Indicator of contribution: the skills taken on were specifically because of the conditions under which the programmes were set up, and the requirements/needs of the project to facilitate completion.	
	2b. Funding increases WHR Skills. DESNZ provides funding > LAs (or the	- Companies are motivated to invest in upskilling their workforce.		Projects decide to employ providers with proven experience rather than companies looking to pivot into the industry.	Indicator of change: Companies with no prior experience of retrofit report that they had to upskill their workforce as	Project team interviews, Project lead interviews,

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
	social landlord) employ companies (such as construction companies, architects, consultancies who have not yet utilised (these) whole house approaches) to deliver their projects > these partners upskill to provide (whole house) retrofit > this increases their knowledge, skills and capacity to deliver on future retrofit projects.	- Whole house specific roles are not outsourced to external agencies, or different providers. For example, the construction company undertaking the installations does not hire an external retrofit coordinator, but instead does so in house. - The projects are successful in achieving their objectives and/or generate admirable results in order to enable the companies to use	privately. For example, more consumers may be buying heat pumps privately, separate to government funded retrofit programmes.	This limits the ability for experience to disseminate through the industry and means that companies without prior retrofit experience are unable to gain the skills/knowledge/capacity to enter into the industry.	part of project delivery. Indicator of contribution: Companies report that the skills taken on were specifically as a result of the conditions under which the programmes were set up, and the requirements/needs of the project to facilitate completion.	monitoring data.

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
		this as evidence of successful delivery.				
	2c. PAS2035 increases WHR skills. DESNZ provides funding with conditions of compliance to PAS 2035 > employed retrofit providers adopt PAS 2035 > these providers take on new skills and create new retrofit specific roles within their company in order to comply with PAS 2035 and PAS2030 > companies gain improved understanding of how to successfully	- Requirements for PAS2035 compliance are enforced. - Installers and retrofit providers involved comply with PAS 2030 and PAS2035 during delivery. - PAS 2035 is facilitating upskilling of the workforce and improving delivery more than the programme funding or support alone. - Companies involved feel motivated to		The retrofit providers and installers employed on the projects outsource retrofit specific roles to external providers, rather than gaining the knowledge and skills of how to deliver to PAS 2035 in-house. The companies may also complete the projects, but not be compliant with PAS. The companies may not view PAS2030 or PAS2035 as effective methods or feel motivated to deliver them in future.	Indicator of change: Reported change in skills, TrustMark / other data on compliance and the nature of lodgements. Indicator of contribution: Employed companies (retrofit providers, installers) report that: compliance to PAS 2035 was a contributing factor to improving their ability to deliver WHR; Compliance was maintained; and PAS contributed to upskilling in the workforce.	Project team interviews, monitoring data, Project lead interviews, Market landscape analysis (expert interviews).

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
	coordinate and deliver retrofit projects.	become compliant with PAS 2035, and to invest in skills needed for PAS 2035 delivery. This means delivery under PAS 2035 is seen as feasible and profitable by companies.				
	2d. Maturing of innovative materials and services. DESNZ provides funding and support (monitoring, knowledge sharing, learning communities) > project teams use suppliers for the retrofit components (e.g. construction materials,	- The project treats a sufficiently large number of properties to enable suppliers to test their product at scale. - Lessons are effectively utilised by suppliers in order for participation in the programme to lead to a maturing of the underlying		The projects do not retrofit enough properties. This means that the companies are not able to test their products on a large enough level to gain learnings from delivery. This could be due to issues in project delivery, such as lack of property access, high levels of remedial work, supply	Indicator of change: Tech company turnover. Monitoring data indicates that the project was able to treat a large number of properties. Indicator of contribution: Suppliers report a positive impact of the programmes on enabling their technology to	Project team interviews, Project lead interviews.

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
	technologies such as heat pumps, and specialist services) > By supplying to projects, suppliers are able to sell - and for innovations - test their product at significant scale > promotes development and commercialisation of innovative materials and services > an increase in the maturity of the suppliers and their technologies.	technology being supplied.		chain issues or contract/management problems, leading to a reduction in scope. The projects test the technology, and it is found not to be viable. Learnings from the project are not sufficient to advance the maturity of the technology. Learnings are not stored, shared, or capitalised after projects close.	develop; enabling them to generate lessons; to gain understanding and awareness; positive impact on commercialisation of their product/material. Suppliers identify that the growth/ advancement of their product is due to the programmes rather than alternative sources such as other retrofit programmes, or growth in retrofit materials industries through increased private demand.	

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
	2e. Process innovations in development. DESNZ provides funding with the condition of providing evidence of process innovations > project teams develop process innovations through project delivery > increased knowledge of effective deployment strategies > increased effectiveness and efficiency of retrofit delivery.	- The conditions on the project are such that process innovations can be successfully implemented. This includes the impact of external factors such as COVID-19 and Brexit. - The project context is amenable to innovation (e.g. sufficient number of properties to enact process innovations). - Suppliers are motivated to increase effectiveness and efficiency of delivery to become more competitive.		The projects are not able to test process innovations, which hence limits the ability for employed companies to gain knowledge and understanding of lower cost, more efficient deployment strategies.	Indicator of change: Monitoring data indicates that process innovations are planned and successfully implemented, with lessons being obtained on effective delivery. Indicator of contribution: This is corroborated by evidence from employees of participating companies who state that process innovations had a positive impact on their delivery and capacity to deliver future retrofit projects.	Project team interviews, Project lead interviews, monitoring data.

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
		- Process innovation lessons are disseminated effectively.				
3. Increasing willingness within the retrofit industry to invest in whole house retrofit approaches.	3. Profitability demonstrated. DESNZ provides funding, sets the Ts and Cs / scope of the programmes, and provides technical support (monitoring, knowledge sharing, learning communities) > projects showcase profitability and market potential to retrofit providers, installer and associated businesses to WHR/PAS2035	- Projects are successful. - Evidence of project success is disseminated effectively. - Suppliers are looking to consolidate and not reduce their business. - Perception of long-term security of funding streams for WHR and PAS2035 types of retrofit work.	3.Confidence within the retrofit industry, in terms of investment and businesses, but not as a result of the programmes. For example, this could be as a result of other retrofit programmes, or the expansion of retrofit components. Expansions of these industries could fuel increased demand, with greater incentives for investment in retrofit with cheaper and more easily sourced components. Increased confidence within the retrofit	Companies within the retrofit industry (who were not employed within the programmes) are not incentivised to take on skills/knowledge and invest in building their whole house retrofit offering. This could be due to projects within the programmes not being successful in showcasing profitable ways of delivering whole house retrofit. This could also be as a result of desire in the business to grow, or a lack of capacity	Indicator of change: Participating companies report an improved outlook on the retrofit market; improved confidence and plans on investment in their whole house retrofit capabilities. Indicator of contribution / assumptions: Evidence indicates that projects were successful in achieving their objectives and were profitable for	Project team interviews, Project lead interviews, monitoring data, Market landscape analysis (expert interviews).

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
	specifications > Companies within the retrofit industry not yet delivering this type of work are incentivised to shift to this kind of work (and to invest in order to facilitate employment) in future whole house retrofit projects/ PAS2035.	- The cost of retrofit materials remains constant. This means that there is no effect of external factors including COVID-19 and Brexit. - There is sufficient capacity within the market to facilitate companies to invest in skills and services, for instance having sufficient volume of skilled workers in the industry.	industry could also be as a result of external forces, such as changes to construction materials, easing of COVID-19 restrictions, government regulation on building and net zero, or changes in the ease of trade of retrofit materials internationally.	within the labour market, which means skilled workers are not available to be acquired in order for companies to improve their offering. In addition, small-scale market actors will not be incentivised into investing into their capacity to deliver WHR if the programmes predominantly employ large-scale ("usual suspect") providers across the projects, as knowledge will not be disseminated within the industry.	participating businesses.	

Table A24: Contribution analysis framework: To what extent did the programmes support green jobs?

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
1. Employing people in green jobs.	1a. Green Job Creation. DESNZ provides funding to LAs > LAs (either directly or indirectly through passing the funding onto the social landlord) create green roles as part of the delivery team, or contracted companies within the project create for green roles as part of project delivery > workers are appointed within these roles as part of the delivery team > employment (long	- Green jobs are sustained after contract completion, either through pivoting within the organisation or working on similar projects. - Workers looking to move into the industry have the resources and training opportunities available to do so. - There is surplus in the labour market, therefore employment	1.Employment in Green Jobs increase, but not because of the programmes: - This could be attributed to employment arising as a result of alternative green stimulus funding programmes, such as GHG LAD, GHG Vouchers, or other programmes relating to the Green recovery. - Employment increases due to expansions of either the retrofit industry, or component	1. There is little measurable employment in green jobs in localities where the programmes are implemented. This could be through: - Employment in green Jobs does not increase in the long term. Green jobs created as part of the project are short-term contracts, with employment not lasting past the end of the project. - There are capacity restraints within the labour supply, which mean that projects cannot attract a	Indicator of change: LAs or contracted companies report that green jobs have been created, and report that this can be attributed to being as a result of the programmes. This is triangulated with monitoring data on number of Green jobs created. Indicators of assumptions (to make plausible claims of contribution): - This is reported as continuing beyond contract completion. - Project teams report that there is capacity within the labour market.	Project team interviews, Project lead interviews, secondary data (Companies House).

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
	term) in green jobs increases (within the Local authority, social landlord, or contracted company).	within this green job is a net increase in green jobs rather than a transfer from another green job.	industries, not as a result of the programmes. For example, the expansion of the heat pump industry as a result of private investment in heat pumps, and public funding programmes (such as Heat Pump Ready) which lead to market stimulation in the Heat pump, and subsequent retrofit industry. this leads to an increase in employment.	sufficient number of workers to green jobs within the projects. - Net employment in green jobs does not increase, even in the case of increased employment within projects, due a lack of surplus of labour within the market. Alternative green stimulus programmes, including SHDF(D) and WHR, may compete for workers to take part in their projects, therefore resulting in no net increase in employment.	- Project team report that there was training opportunities available.	
	1b. Retention of workers through economic shock. DESNZ provides funding and support to LAs > New green jobs are created by either the LA, social landlord or contracted company > existing staff are able to be retained in green roles rather than being	- Green roles are not outsourced to external providers, such as outsourcing the retrofit coordinator role.			Indicator of change: Project teams and contracted companies report that the programmes led to new green jobs having to upskill, use of training and specific roles developed, and that this was specifically as a result of the programme. Workers from other industries were able to effectively pivot and improve skills within the retrofit industry.	Project team interviews, Project lead interviews, secondary data (Companies House).

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
	made redundant due to the economic shock > their capabilities within the green sector increases.			- Green jobs are not provided locally, being outsourced to a relatively small number of providers.	- This is corroborated with evidence from monitoring data. Indicator of contribution: Project teams report a perceived contribution.	
2. Increasing green skills.	2. Green skills development. DESNZ provides funding and support (monitoring, knowledge sharing, learning communities) to LAs > the LA, social landlord or contracted company have existing green roles > through project delivery people employed	- Specific retrofit skills are not outsourced to other roles. - Project delivery teams support existing employees to develop their skills and expertise, such as providing opportunities for development and training.	2.The skills and capabilities of workers employed within the programme improve but not as a result of the programmes: - Involvement in other programmes - Development of skills in green sectors outside of retrofit specific skills, for instance training offered by	2. The programmes do not lead to an increase in skills and capabilities within green sectors for those employed within green jobs on the programmes. This could be due to project teams outsourcing retrofit specific skills to external providers, which will not lead to an increase in retrofit specific skills for the project team, and delivery	Indicator of change: Project teams/ installers/contractors report that the programmes led to an increase in skills amongst the workforce, use of training and specific roles developed. Retrofit specific roles were not reported to be outsourced, and effectively utilised training opportunities, and companies were incentivised to upskill their staff.	Project team interviews, Project lead interviews, monitoring data.

Causal pathway	Contribution claim	Assumptions	Alternative theory	Theory of no change	Indicators	Sources
	within these roles have to gain skills in order to fulfil project completion > their capabilities within the green sector increases.		contracted companies to employees outside of the programmes, to improve other green skills, such as in renewable energy.	partners. This could also be due to training opportunities during project delivery may be limited, which could mean that employees do not have the resources to increase their skills, and project teams/delivery partners may be more inclined to use external partners to fill these roles. This is also likely to be impacted by the costs and barriers of upskilling the workforce compared to outsourcing.	Indicator of contribution: Project teams report a perceived contribution.	

A3.3 Data collection

After defining all the contribution claims, the underpinning assumptions, alternative ToCs and theories of no change, we gathered evidence from a number of qualitative and quantitative data sources. The data sources reviewed were:

- Qualitative in-depth interviews (achieved sample of 63) with members of the project teams – including representatives of primary contractors, design partners, management organisations and subcontractors. The project team interviews were the primary source of data to evaluate all the contribution claims. Therefore, the topic guide for these interviews included questions on:[43]

    o Job creation and growth (Green jobs 1a)

    o Stability through COVID-19 (Market growth 1a, Green jobs 2)

    o Skills development: driving factors behind skills development including impact of PAS 2035 (Market growth 2b, 2c)

    o Innovation (Market growth 2d)

    o Revenue and profits from delivery of projects (Market growth 3)

    o Market outlook (Market growth 3)

    o Supply chain development (Market growth 3).

- Qualitative in-depth interviews (achieved sample of 30) with project leads from either the local authority or housing association leading the project. The topic guide included questions on:

    o Job creation (Green jobs 1a)

    o Green skills development (Market growth 2b, 2c, Green jobs 2)

    o Process innovations (Market growth 2d)

    o Job retention through COVID-19 (Green jobs 1a)

    o Market Outlook (Market growth 3)

    o Supply chain development (Market growth 3).

- Qualitative in-depth interviews with experts in the retrofit industry. This included individuals with significant experience of working in the industry who have knowledge of the wider market. The findings of these interviews provided insight into recent developments within the retrofit industry, and therefore were particularly important in providing evidence of the impact of alternative explanations in the contribution analysis.

---

[43] The codes provided against each topic guide question area represent the contribution claim identified in tables 1.8 and 1.9. For example, (Market growth 2a) represents the contribution claim 2a in Table A17.

- Monitoring data – including project-level final and interim reports, project change requests, and monthly reporting (up to July 2022). This also included a review of wider documentation on the state of the retrofit market, including key market developments.

- Companies House records – on the number of employees and turnover reported by participating companies over the period of 2019-2022 on Companies House.

A3.4 Analysis

The analysis process comprised the key steps of:

1. Internal analysis session

An internal analysis session was used to share initial findings from the qualitative data collection for the project teams, project leads and resident interviews.

2. Coding of Primary data

Each transcript for the project team interviews was coded against the contribution claims, assumptions, alternative theories and theory of no change. As the coding process developed, and we started to gain an understanding of the emerging findings, we also added additional coding themes.

All interviewers conducting project lead interviews coded interview transcripts against the questions within the project lead topic guide. This was then reviewed and analysed against the CA framework.

In addition, all of the transcripts of the expert interviews conducted in the Market Landscape Analysis were coded against the CA framework.

3. Analysis of secondary data

This included a review of the final reports, interim reports and project change requests, to analyse findings on green job creation, innovation, cost reduction achieved, and the reasons cited for delays in delivery.

This also included the analysis of revenue and employment data collected from Companies House records for the financial years of 2019, 2020 and 2021,[44]The data provided was used to calculate the average change in employment across the companies who were employed on the programmes. The sample used was the list of participating companies that were provided by the individual projects in final reporting (Data Annexes). Given that these were self-reported, we were unable to verify whether this sample had complete coverage for all participating companies that were employed on the programme. This provided a sample of 60 companies (after excluding duplicates, councils and other public bodies from the initial sample of 90

---

[44] Data for 2022 was not available for analysis as only a small proportion of the sample had published their accounts for the 2022 financial year at the time of analysis (May 2023).

organisations). This was then reduced to a sample of 54 due to lack of availability of employment data on Companies house. We were unfortunately unable to fill these gaps due to the small relative size of the companies where data was unavailable, which meant that there were no publicly available data sources that could be used for triangulation.

4. Data triangulation

We then summarised the key findings for each of the research strands into one document. With the primary data source being the project team interviews, the findings for each of the contribution claims from these interviews were compared against the findings from each of the other data sources.

5. Assessment of contribution claims

Based on this triangulation, we assessed each of the contribution claims for the two EQs of either supported, partially supported or not supported. For each contribution claim, we provided a rationale for the assessment given based on the evidence from across the research strands. We also evaluated each assessment based on the strength of evidence. This strength of evidence test was:

- Strong – Evidence comprises multiple data sources (good triangulation), which are of robust quality. Where fewer primary data sources are available, the supporting evidence provided is of good quality and provides direct evidence of contribution.

- Medium – Evidence comprises multiple data sources (good triangulation) of lesser quality, or the finding is supported by fewer data sources (limited triangulation).

- Low – Evidence comprises very limited evidence (single source, or a limited number of informants or documents within the source) or incomplete evidence.

This assessment framework is provided in Table A25.

Table A25: Contribution assessment framework: To what extent did the programmes contribute to retrofit market growth?

Contribution claim	Interlinks	Assessment	Rationale	Strength of Evidence
1a. Retrofit companies survived economic shock. DESNZ provides funding > LAs (or the social landlord) contract companies (including retrofit providers and installers) > these companies see their turnover increase > the companies have stable income during economic shock, thus making them more resilient in the short-term.	Table A24 1b	Partially supported	There were mixed responses from the project team interviews as to the effect of participation in the programmes on providing stability through the economic shock due to COVID-19. Responses that highlighted a positive impact of the programmes were overall more likely to be involved in the earlier delivery stages (such as design partners, management entities or property surveyors). Companies involved in later stages of the delivery process (such as in installation) were less likely to report any impact of COVID-19 as part of this project, with the majority of projects main installation period being in 2022, when the main impacts of COVID-19 were mostly over. Whilst not providing evidence of causal impact of the programme, data from Companies House across the projects involved indicates a positive increase (31%) in employment over the period of 2019 to 2021.	Medium: Although this relies on three data sources, the secondary data provided through Companies House were not specifically validating the findings of the qualitative interviews, and this data was limited in validity given the lack of data for 2022, during which the majority of projects were in installation.
1b. Increased revenue and profits allow investment in growth DESNZ provides funding > LAs (or the social landlord)	Table A23 3	Not supported	Majority of respondents indicate positive investment plans for the future, but do not cite the revenue received as part of the project as reason for increased investment. Project lead interviews indicated that a number of local authority/housing associations were continuing	Medium: The data only relies on the qualitative data available from the project team interviews and project lead interviews, secondary

Contribution claim	Interlinks	Assessment	Rationale	Strength of Evidence
employ companies (which includes retrofit providers and installers) > these companies have greater ability to invest in new employees/capital.			with future retrofit projects, including wave 1 and 2 of the SHDF.	data was not applicable or available, and project monitoring data was produced by the project leads, so did not provide data on company impacts.
1c. Increased customer base improves reputation. DESNZ provides funding > LAs (or the social landlord) employ companies (which includes retrofit providers and installers) > these companies build customer base (partners and customers) and add to their track record > their reputation and reach improves > they are able to attract a more sustained pipeline of work.		Supported	Evidence from qualitative interviews conducted with members of project teams involved indicates that participation in the programme led to an increase in future work by improving their reputation for delivering retrofit. Participation in the programme helped cement partnerships with housing providers and LAs for SHDF Wave 1 and Wave 2 successor projects and alternative retrofit projects. Majority of respondents cited an increase in the continued onward pipeline of work on future retrofit projects, specifically for providers of more 'niche' services such as retrofit coordinator providers. Project lead interviews provided evidence that participation in the projects helped establish improved relationships between housing associations/local authorities and delivery partners.	Medium: The data only relies on the qualitative data available from the project team interviews and project lead interviews, secondary data was not applicable or available, and project monitoring data was produced by the project leads, so did not provide data on company impacts (e.g. changes in reputation).

Contribution claim	Interlinks	Assessment	Rationale	Strength of Evidence
2a. Technical support increases WHR skills. DESNZ provides technical support (monitoring, knowledge sharing, learning communities) > LAs (or the social landlord) employ companies (which includes retrofit providers and installer) with existing retrofit experience (who have not yet utilised whole house approaches) > through delivery of the programme these companies increase skills in whole house retrofit > These companies have a greater capacity to deliver whole house approaches on future projects and evidence of prior experience.		Insufficient evidence	Insufficient evidence to assess this provided in the qualitative interviews conducted with members of the project teams on any positive impact of the technical assistance provided on skills development. The final reports provided by the projects also do not provide significant detail of any positive impacts associated with skills development as a result of the technical assistance provided. However, the process evaluation did find evidence that technical support had a positive effect on project delivery, with project teams stating that they highly valued the learning communities, with these providing opportunities for peer-to-peer knowledge sharing. However, given the lack of evidence available from research conducted during the outcome evaluation, we are unable to assess this claim further.	Very low: This data relies only on the qualitative data from the project teams and project lead interviews, and final reports. In addition, the topic guide for project teams and project leads did not contain any specific question referencing the technical assistance provided and its impact on capacity development. Further detail is provided in the limitations section (A3.5). This reduces the validity of the project teams as a data source for testing this contribution claim.
2b. Funding increases WHR Skills. DESNZ provides funding > LAs (or the social landlord)	Table A23 2c	Supported	A number of interview respondents for project teams indicated that participation in the programme facilitated green skills development. Whilst the majority of respondents indicated that they had previous experience in retrofit, for	Medium: relies on three data sources, with each providing detailed and specific evidence.

Contribution claim	Interlinks	Assessment	Rationale	Strength of Evidence
employ companies (such as construction companies, architects, consultancies who have not yet utilised (these) whole house approaches) to deliver their projects > these partners upskill to provide (whole house) retrofit > this increases their knowledge, skills and capacity to deliver on future retrofit projects.			some it provided the opportunity to enter the space. For some respondents, participation in the programme provided an opportunity for companies to become accredited on Trustmark, and gain experience delivering to PAS2035 standards. A number of interview respondents indicated that they had undertaken training courses during project delivery through training providers including the retrofit academy. These findings are supported by evidence from the project lead interviews, where the majority of project lead respondents believed participation in the programme led to green skills development. Respondents highlighted that a number of team members had no prior experience of delivering retrofit projects, and participation in the programme led to increased understanding of both project management and technical retrofit skills. However, here was some evidence from the project teams and project leads of primary contractors/LAs outsourcing retrofit specific roles (such as retrofit assessors and coordinators) to external partners, rather than building in house capacity. Project leads all indicated that the extent of green skills development during project delivery was limited by the short timeframe for project delivery.	

Contribution claim	Interlinks	Assessment	Rationale	Strength of Evidence
2c. PAS2035 increases WHR skills. DESNZ provides funding with conditions of compliance to PAS 2035 > employed retrofit providers adopt PAS 2035 > these providers take on new skills and create new retrofit specific roles within their company in order to comply with PAS 2035 and PAS2030 > companies gain improved understanding of how to successfully coordinate and deliver retrofit projects.	Table A23 2b	Supported	Strong evidence from qualitative interviews conducted with members of project teams involved that the requirement of PAS 2035 compliance was a driving factor for skills development. Significant proportion of respondents indicated development of skills relating to the delivery, implementation and management of PAS 2035 compliant WHR projects. This was reported as being of greater significance in some cases than the development of technical WHR skills. Evidence from project lead interviews also indicate the positive impact of the requirement of PAS2035 compliance on skills development, including an increase in the number of people taking on skilled retrofit specific roles (such as retrofit assessor and retrofit coordinator). A number of project leads indicated they had undertaken training courses during project delivery in order to comply with PAS 2035 and to increase their understanding of WHR approaches. The evidence from the Interviews with wider market stakeholders as part of the Market Landscape Analysis (provided in Annex 8) was relatively limited in its assessment of the contribution of PAS 2035 to green skills development, and instead focused on the mainly positive impact of	Strong: Evidence from 4 different data sources, with specific and rich data provided. Both strands of qualitative interviews had dedicated questions relating to PAS2035, which therefore provides rich data on its impacts across the varied sample. Market landscape analysis provided wider insights into the impact of PAS2035 on industry which were used to validate the findings.

Contribution claim	Interlinks	Assessment	Rationale	Strength of Evidence
			PAS 2035 on professionalism and quality of retrofit.	
2d. Maturing of innovative materials and services. DESNZ provides funding and support (monitoring, knowledge sharing, learning communities) > project teams use suppliers for the retrofit components (e.g. construction materials, technologies such as heat pumps, and specialist services) > By supplying to projects, suppliers are able to sell - and for innovations - test their product at significant scale > promotes development and commercialisation of innovative materials and services > an increase in the maturity of the suppliers and their technologies.		Not supported	The qualitative interviews with project teams did not provide sufficient evidence to suggest that there was a significant maturing of the technologies implemented on the projects. One key innovation that was to be tested in delivery of the project was off-site manufactured external wall insulation. Respondents indicated that this technology did not develop significantly as a result of project delivery (with relatively high costs and limited manufacturing capacity in the UK). Relevant respondents indicated that in these cases the projects failed to achieve sufficient scale to stimulate the supply chain. Project lead interviews indicate that there was limited supply chain development as a result of the programme due to the limited size of the projects and insufficient success in delivery.	Low: The evidence is only based from two sources. The project team interviews did not speak to a large number of suppliers of retrofit materials, with the majority of interviews from installers, designers and primary contractors. Therefore, the data provided may not provide significant detail of the extent of supply chain development, such as changes to organisational effectiveness.

Contribution claim	Interlinks	Assessment	Rationale	Strength of Evidence
2e. Process innovations in development. DESNZ provides funding with the condition of providing evidence of process innovations > project teams develop process innovations through project delivery > increased knowledge of effective deployment strategies > increased effectiveness and efficiency of retrofit delivery		Not supported	Evidence from project team interviews indicates that the impact of process innovations in delivery was relatively limited in its impact on knowledge and green skills development. Final reports do not provide significant evidence of successful delivery of process innovations. Similarly for the project lead interviews, the majority of respondents indicated that the projects did not achieve cost reductions as a result of the process innovations implemented.	Medium: the evidence relies on three data sources, with discussion on process innovations discussed in both the project team and project lead interviews.
3. Profitability demonstrated. DESNZ provides funding, sets the Ts and Cs / scope of the programme, and provides technical support (monitoring, knowledge sharing, learning communities) > projects showcase profitability and market potential to retrofit providers, installer and associated businesses to WHR/PAS2035 specifications > Companies within the	Table A23 1b	Not supported	Evidence from project team interviews indicate that a large proportion of companies experienced high costs, challenges in delivery and lack of profitability. A significant proportion of respondents also stated that their company made a loss in delivery of the project. Majority of respondents reported significant increases in costs for materials, labour and supplies. However, a majority of interview respondents indicated a positive market outlook, with increased investment in retrofit potential by companies across the sector. This was not directly attributed to the SHDF(D) and WHR	Strong: relies on evidence from four different data sources. Detailed data provided in project team interviews on the profitability of project delivery, market outlook and future investment plans. This is supported by the data in the project lead interviews. This is also validated through

Contribution claim	Interlinks	Assessment	Rationale	Strength of Evidence
retrofit industry not yet delivering this type of work are incentivised to shift to this kind of work (and to invest in order to facilitate employment) in future whole house retrofit projects/PAS2035.			programmes, but instead as a result of the increased visibility of the future pipeline of work in the retrofit sector with the ongoing waves of the SHDF main fund. Some respondents highlighted that a lack of PAS2035 accredited providers in the market meant that accredited subcontractors could increase their margins, leading to increased costs for contractors. These findings were validated by that of the project team interviews, which found that in general projects experienced high costs, but highlighted plans for ongoing involvement in retrofit projects. Evidence from the Market Landscape Analysis (Annex 8) further indicated that the ongoing pipeline of work in government funded retrofit projects (SHDF main fund) has been a driving factor behind investment into retrofit potential by companies within construction sectors.	the findings in the market landscape analysis and final reports.

Table A26: Contribution assessment framework: To what extent did the programmes support green job?

Contribution Claim	Interlinks	Assessment	Rationale	Strength of evidence
1a. Green Job Creation. BEIS provides funding to LAs > LAs (either directly or indirectly through passing the funding onto the social landlord) create green roles as part of the delivery team, or contracted companies within the project create for green roles as part of project delivery > workers are appointed within these roles as part of the delivery team > employment (long term) in green jobs increases (within the Local authority, social landlord, or contracted company).		Partially supported	Project team interviews gave a mixed response on green job creation. In the cases where there was positive job creation as a result of the project, this was usually relatively modest (~ 2 additional staff). A significant number of projects reported no additional staff being brought on. The vast majority of respondents indicated challenges in recruiting staff for the project, and referenced competition with competing programmes and alternative trades, for both skilled and unskilled positions. This could represent evidence of a lack of surplus in the market, implying a lack of net green job creation. However, Project lead interviews indicated that the programme led to positive green job creation, but similarly highlighted significant labour market shortages. The average company saw an 8% increase in employment over the period of 2019 to 2021, (based on the employment figures provided in publicly available accounts on Companies House). However, the average number of employees across all companies is affected by 5 companies with over 1,000 employees. When these companies are excluded, the change in	Medium: relies on data from three data sources. However, there was a lack of quantitative data submitted by the projects on the number of jobs created during project delivery. Data from Companies House does not provide causal evidence of job creation as a result of participation in the programme, especially for installation companies, who may not have started work on the programme until at least 2022 (which we do not have data for).

Contribution Claim	Interlinks	Assessment	Rationale	Strength of evidence
			employment for the average company is negative at -18%.	
1b. Retention of workers through economic shock. BEIS provides funding and support to LAs > New green jobs are created by either the LA, social landlord or contracted company > existing staff are able to be retained in green roles rather than being made redundant due to the economic shock > their capabilities within the green sector increases.	Table A23 1a	Partially supported	The project team interviews provided mixed evidence of the impact of the programme on retention of workers through the economic shock due to COVID-19. Some respondents indicated that the programmes meant that the businesses could continue work throughout COVID rather than having to shut down operations. This was especially pertinent to companies involved in the design and early development stages of installation. However, evidence is lacking on the extent to which the programme mitigated increased unemployment given the presence of COVID-19 specific job retention programmes (e.g. the Furlough programme). For example, in the absence of the programmes, workers may have been furloughed rather than being made unemployed. Project lead interviews provided very little data on the retention of workers due to COVID-19. The change in employment over the period 2019-2021 was positive on average across the companies involved.	Medium: Relies on data from three data sources. However, qualitative data from project lead interviews is limited in providing detail of the retention of workers during COVID. Companies house data also only provides indication of the number of employees across the companies during the period (2019-2021) and does not provide additional detail.

Contribution Claim	Interlinks	Assessment	Rationale	Strength of evidence
2. Green skills development. BEIS provides funding and support (monitoring, knowledge sharing, learning communities) to LAs > the LA, social landlord or contracted company have existing green roles > through project delivery people employed within these roles have to gain skills in order to fulfil project completion > their capabilities within the green sector increases.	Table A23 2b, 2c	Supported	Evidence from both project teams and leads indicate that participation in the projects led to green skills development. Many respondents indicated that participation led to an increase in understanding of the retrofit processes and how to implement a retrofit project. The majority of project teams indicated that they had completed training courses or become PAS2035 accredited during project delivery. Delivering to PAS2035 was frequently highlighted as being a driver to green skills development, specifically on developing understanding of implementation of retrofit projects. However, a noticeable proportion of project team respondents expressed that either participation in the programmes did not lead to skills development, or that skills development during project delivery was not directly caused by participation in the programme. Project team members were more likely to be employed by providers of a specialist service (such as a specialist supplier or installer of retrofit components). Project lead interviews corroborate evidence of positive impact of programmes on skills development.	Medium: Data relies on data from three data sources.

A3.5 Limitations

The results on market outcomes against the two evaluation questions analysed are subject to the following limitations:

1. **Limited availability of comprehensive financial data on the companies employed on the programmes**: We were unable to use sources such as Pitchbook, the financial database, and the Interdepartmental Business Register (IDBR), the government-recorded register of businesses in the UK, to provide details of market and firm level changes. This was because firms within the retrofit and construction industries were not sufficiently captured within Pitchbook to provide comprehensive data, and due to the time lag with IDBR captured data. This meant that we instead used Companies House data, which was only able to capture employment data. We were unable to collect data on recorded revenue because companies are only obligated to publicly report revenue figures if they are above a certain threshold (£10.2 million in annual turnover). A large proportion of the employed companies in the programme were below this threshold, meaning that revenue data was missing for the majority of companies.

2. **Limited reliability and lack of available employment data**: The sample of companies with available employment data was limited in size. This limits the robustness of the data for verifying the findings of the qualitative data strands. Furthermore, due to Companies House not having comprehensive accounts for 2022, the analysis of changes to total employment is limited to the time period 2019-2021. With a significant number of projects not commencing installation until 2022, this limits the extent to which we can analyse how participation in the programmes contributed to total employment changes for companies involved in later stages of project delivery.

3. **Relatively limited number of suppliers in the sample**: The sample of project team interviews mainly consisted of team members of either the primary contractors, installers, and design partners within a project. The number of suppliers in the sample was relatively small. This was likely due to the fact that the sampling frame was the list of project team members provided by the LA in final reporting, where it was probably less likely to include suppliers engaged during project delivery. This lack of representation may bias our results to be more reflective of the experience of the project team members, rather than suppliers. This also limits the validity of our results for the maturing of the innovations deployed on projects and detailed evidence of the extent of supply chain development.

4. **Lack of quantitative findings on skills development and capacity building**: Given that we largely relied on qualitative evidence, we were not able to provide clear quantitative figures for the proportion of companies who had previous experience in retrofit. A quantitative survey of companies who participated in the programme was not feasible given that the number of companies who participated (~120) would not achieve a sufficient size sample to obtain representative results, assuming historical survey response rates.

5. **Distinguishing whole house retrofit market developments from wider retrofit market changes**: The evaluation team encountered challenges in distinguishing the difference between impacts of both the programmes and wider market factors on developments for the whole house retrofit market specifically. Whilst we were unable to fully mitigate the impact of this on the specificity of the results obtained, we had specific questions in the topic guide on the viability of the whole house approach.

6. **Limited discussion of technical assistance**: The topic guides for project teams and project leads did not include a specific question on technical assistance (market growth 2a). This was because given the time constraints for the interviews it was decided to have a greater focus on more important research strands. This meant that we did not have sufficient evidence to assess this contribution claim.

Annex 4: Costs analysis

This Annex describes the analytical approach taken to aggregating, analysing and validating cost data provided in project reporting, and to modelling estimated baseline costs (were cost reduction strategies not applied) and comparing with endline costs per property and by project.

A4.1 Introduction

As part of the SHDFD and WHR programmes, projects expected to see a reduction in the costs of retrofit due to various cost reduction strategies implemented. This analysis considered the following evaluation question:

- Have cost reductions for retrofit been achieved and why?

For the purposes of this strand of evaluation analysis the following definitions are used:

- **Cost reduction:** The delivery of projects at a lower cost than they would have been delivered at without cost reduction activities. This was assessed by comparing baseline and endline costs at a measure level.

- **Baseline costs**: The estimated cost of retrofit at the commencement of the project (usually at the application stage, but in some cases after the initial property assessment where the information wasn't provided previously). The baseline cost represents the project's estimate of what costs would be prior to applying cost reduction measures being applied within the project.

  As described in this Annex, projects' methods for baseline cost estimation were not detailed in project reporting. Where baseline costs needed to be corrected (to account for changes in measure packages), Energy Saving Trust estimated baseline costs using proxy data on costs (retrieved from industry literature) from as close to the baseline period as possible, and assumptions about the costs of measures based on Energy Saving Trust's own internal expertise.

- **Endline costs**: The actual costs incurred during the project. This would include any savings from cost reduction activities that were achieved throughout the project. These values were checked and, where necessary, corrected for inflation to enable comparison with baseline costs.

In order to conduct a cost reduction analysis, the evaluation team required information on individual measures and their associated costs assumed at the baseline and endline stage, for two reasons: (1) to ensure that the baseline costs provided are comparable between projects; and (2) to adjust the baseline total where measures installed differ from those planned at baseline. The evaluation team therefore created a list of measures installed by each project from other supporting information provided by projects. To generate learnings on cost reduction approaches, qualitative data from project reporting and project team interviews on cost reduction strategies and the extent to which these were applied, was also reviewed.

A4.2 Data Sources

To assess cost reduction this evaluation considered both qualitative and quantitative evidence collected for both programmes. This comprised:

- Completed final narrative reports for nine out of 16 completed projects, in which projects described whether and how cost reductions were achieved. Only six of the nine available final reports included narrative information on whether or not cost reductions had been achieved.

- Information on whether cost reductions were achieved or not (and if not, why not) from project lead interviews. Project leads were asked several questions related to cost reductions.[45] Only nine out of 16 project leads interviewed provided this information.

- Quantitative analysis by the evaluation team to validate whether cost reductions had been achieved for all 16 projects that reached the construction phase of project delivery. The method for this analysis is described in this Annex from A4.3 onwards and is based on the report baseline and endline costs, together with measure data.

 For the quantitative estimation of baseline costs, the following data were used:

- Reported baseline costs from project final reporting. This is an estimate at the commencement of the project of the total cost of each individual property and is not disaggregated into individual measure costs.

- Reported baseline measures – i.e. the measures which projects expected to install and associated costs as presented in project applications, or – where not documented there – in project reporting. This provides a project level cost per measure which is used to compare costs across projects and to correct baseline cost data where applicable (see the subsequent methodology section for details).

- Reported endline (actual) costs per property from final reports, change requests and invoices.

- Reported endline (installed) measures and the actual costs of measures (in some cases) from project reporting or Trustmark data.

- Overall project costs and property retrofit number. These were used to fill any gaps in endline property costs when other data sources were not provided.

- Data on typical retrofit costs for measures from the sources as outlined in Table A26. This included data from SHDF(D) and WHR projects as well as cost research from DESNZ and Energy Saving Trust. This was used to fill any gaps in the data when applying corrections to the baseline costs.

It should be noted that the property-level analysis was based upon property and measure data provided in final reports submitted by projects between February and April 2023. Based upon

---

[45] See topic guide in section A8.5.

information on project completion rates (as set out in Chapter 4 of the main report), it is highly likely that some of reporting covered retrofits that were still ongoing (i.e. where the final number and type of measures was still subject to change). This generates a limitation in the data in that some of the project data may not be final or fully accurate. This is estimated to be as high as a third of properties although we are unable to exactly quantify this exactly due to the differing timing of the various data sources received. Additionally, not all measures may have been reported by projects in their reporting, however, it was not possible to check this with projects and therefore the scale of these potential errors are unknown. Therefore, the results of the following must be treated with caution as it assumes the data provided by projects is fully accurate which is unlikely to be true in all cases.

For all costs data, the endline cost data was adjusted for inflation to match baseline costs using the Construction Price Index for new work on housing.[46]

A4.3 Methodology

For the quantitative cost analysis we applied the following steps.

Step 1. Generate baseline data on expected measures and costs per property

Very few projects provided information on the measures they intended to install per property and associated per measure costs (i.e. baseline measures and costs) at application stage (this was, in many cases, because projects had not yet scoped this out). Where these were provided by projects, it was for a small sample of properties. To establish a baseline of measures intended to be installed, Energy Saving Trust therefore constructed measures data from subsequent early project reporting; and cost data on the basis of the measures data from the data sources listed in Table A27. A caveat to this reconstructed data is that it is agnostic to local supply chains, meaning that it does not account for any potential variation in costs by project / location.[47]

Table A27: Data sources for typical retrofit costs

Data source	Description	Data quality
Project bids and other reporting	Data reported in project applications and interim and final reporting.	Assumed to be accurate for the reporting project (as they

---

[46] ONS, Construction output price indices, 12th May 2023, https://www.ons.gov.uk/businessindustryandtrade/constructionindustry/datasets/interimconstructionoutputpriceindices For baseline costs the average value for 2020 was chosen due to the dates of the competitions and when the bids were submitted. For the *Alva Community Regeneration through Decarbonisation* project, the majority of the spend was in 2021 so this year was chosen for this project. However, for the other projects, the majority of the spend was in 2022, so this year was selected for these other projects.

[47] We know from project reporting reviewed for the process evaluation that costs (for materials, products, labour) did vary from project to project depending on the supplier and on the time at which they were installed, but it has not been possible within the scope of this strand of analysis to account for this systematically.

	For some measures, where costs were not provided in a projects' reporting, averages from across the other projects were used to provide typical costs for those measures.	would be assessing costs as part of procurement). May not be as accurate when used for similar projects as does not account for project-specific cost drivers.
DESNZ commercial insight into retrofit costs	Insight commissioned by DESNZ for sole use on DESNZ projects. Describes retail cost changes from 2019 to 2021 (forecast to 2022) for predominantly insulation measures.	Data collected to be indicative of the range of costs of insulation measures of the market at the time it was collected, but results cannot be generalised.
Energy Saving Trust cost research	Energy Saving Trust proprietary data on the costs of most retrofit measures. Based on multiple sources including loans data for energy efficiency measures in Scotland, published cost data (e.g. SPONS) and other desk based research conducted in 2022 with data from 2021.	Used where other sources did not provide data for specific measures. These sources were also used to sense check the other average cost assumptions.

Step 2. Quality assure baseline costs through benchmarking data between projects

To align cost estimates by project to make it possible to compare them, we cross-compared per project:

- Material costs (by timestamp, region, and volume).
- Overhead costs (e.g. design, management, PAS 2035 costs).

Any differences in costs between projects were analysed if they fell within expected cost ranges for the specific measures based on expert knowledge within the team. Where any costs fell outside this range, these measures were examined further to understand the drivers. For example, insulating below the damp proof course increases the cost of EWI. From this review we did not find any incidences (at baseline) in which anomalous variation in costs by project could be explained by regional differences.

Step 3. Correct baseline costs to reflect changes in the measures actually installed as compared to initial project design

In almost all projects, the measures actually installed at endline differed from those intended at baseline. As discussed in Chapter 8 and Chapter 9 of the main report, the scope of measures was often amended to manage cost escalations in the face of supply chain challenges such as cost increases of particular materials and equipment (e.g. heat pumps). In order to compare baseline and endline costs for the same measures, for all properties (where there was

sufficient data on endline measures), the baseline was 'corrected', which resulted in three sets of baseline costs data, which were labelled according to the analytical method used:

- Method A: Baseline costs data constructed from information on the measures anticipated at baseline, as per steps 1 and 2 above (i.e. no correction for measure changes applied).

- Method B: The values calculated using method A, adjusted to remove the costs of any measures not finally installed and add the costs of any new measures installed not initially planned.

- Method C: Baseline costs constructed by calculating the costs of each measure which is actually installed using assumed baseline costs from project reporting for industry average values (using the approach in Step 1).

Table A28, below, summarises the three methods and their strengths and limitations in generating accurate assessments of cost reduction. The results discussed in Chapter 8 of the main report use cost reductions calculated using method B where possible. For WHR Sutton and National Net Zero Retrofit Accelerator, which took an overarching Energiesprong approach, method A was used as baseline costs and measures were reported in a format which meant it was not possible to apply method B. Method C was considered to produce irregular results (i.e. potentially very large values) and is therefore only presented for completeness in this Annex for comparison.

Table A28: Cost reduction methods considered in the analysis

Method	Strength and limitation
A – per property, reported	**Strength**: Presents per-property baseline and endline costs as observed by projects from start to end of the programme. **Limitation**: Baseline costs were often inaccurate as the baseline measures differed from final ones, limiting the ability to meaningfully compare baseline and endline costs. Baseline measure data was not available in project reporting for 10% of all listed properties.
B – per property reported with adjustment for changes in measures	**Strength**: Provides a more accurate figure than method A in accounting for changes in measures whilst retaining the embedded overhead costs within the calculation. **Limitation**: Assumes that the baseline costs reported at the project commencement were accurate. Could also not be used for Energiesprong projects because these projects did not report baseline measures.
C – per property constructed from endline list of measures	**Strength**: Removes the distorting effect from an especially large or small baseline estimates which were unrealistic.

(using the cost data sources outlined under Step 1)	**Limitation**: Likely to underestimate the baseline, as does not account for embedded overhead costs which are not separately reported in final project reports. When applied to the project data it generated costs which intuitively were unrealistically high.

Step 4. Calculate the endline costs per property

Using the same method outlined under Step 1, the endline costs per property were collated from project reporting where available or constructed using the data sources outlined in Table A26 where not available in project reporting. These were integrated into the same analytical framework where baseline costs (per method) were mapped.

Step 5. Calculate cost reduction

The difference between baseline and endline costs was then calculated as a percentage decrease or increase of the baseline cost. These results were presented in the main report and are copied overleaf in Table A29, alongside the sense check detailed in Step 6. In the table, positive values represent cost increases and values with a minus represent cost decreases. As the calculations in the table show, very few projects achieved cost reductions.

Step 6. Sense check the cost reduction calculations by comparing overall cost per property at project outset and project completion

To sense check the cost reduction calculations, the cost reduction assessments per project were compared to analysis of the average cost of the projects per property as calculated for the QCA by:

1. Dividing the original project budget by the target number of properties to get the originally expected cost per property of the project; and

2. Dividing the final project budget (accounting for any additional funding from DESNZ through change requests and additional match funding) by the final number of properties achieved (using June 2023 data for SHDF(D) and June 2023 data for WHR) to get the final cost per property of the project.

These calculations did not represent actual cost of retrofit per property, as it included the costs of managing the overall project, including administration and reporting to DESNZ, but it provided a useful comparator for sense-checking the calculations derived. This data is presented in Table A29 overleaf.

Table A29: Cost **reductions** for various projects across SHDF(D) and WHR programmes

Project	Cost change from baseline method (%)			
	A – Reported	B – Adjusted	C – Constructed	QCA – Sense check
SHDF(D) projects				
Nottinghamshire Net Zero Carbon Housing Demonstrator	-57%	-55%	67%	0%
Orbit Housing Incremental Whole House Retrofit Programme	-16%	19%	75%	0%
Social Housing Retrofit Accelerator Cornwall	-48%	-42%	83%	44%
Warmer Homes Argyll & Bute	-13%	93%	72%	0%
Retrofit of Electrically Heated Homes	-48%	-33%	19%	35%
Gloucestershire SHARe and CaRe Demonstrator	10%	23%	27%	9%
Destination Zero II: The Next Step	-62%	-54%	-3%	39%
DORIC	94%	72%	184%	100%
Alva Community Regeneration through Decarbonisation	16%	7%	7%	4%

Project	Cost change from baseline method (%)			
Clarion Housing Group advanced retrofit project	6%	26%	102%	37%
Northampton Whole House Retrofit	19%	71%	88%	1%
Xtra-Z	30%	60%	205%	80%
National Net Zero Retrofit Accelerator	19%	NA	304%	90%
Leeds Whole House Retrofit	-3%	109%	139%	0%
WHR projects				
Energiesprong Sutton	14%	NA	198%	63%
Destination Zero I	113%	NA	208%	34%
Across all projects	**-3%**	**12%**	**118%**	**25%**

Table A30: Cost reductions based on budget and property numbers at baseline and endline as of June 2023 (as calculated in the QCA)

Project Name	Baseline			Endline			Cost reductions	
	Budget	Target # properties	Average cost per property	Total spend	Number of properties retrofitted /to be retrofitted	Average cost per property	Value	% change
SHDF projects								
Nottinghamshire Net Zero Carbon Housing Demonstrator	£1,500,000	25	£60,000.00	£1,500,000.00	25	£60,000.00	£0.00	0%
Orbit Housing Incremental Whole House Retrofit Programme	£3,623,382	69	£52,512.78	£3,623,382.80	69	£52,512.79	-£0.01	0%
Social Housing Retrofit Accelerator Cornwall	£4,025,825	75	£53,677.68	£4,025,825.42	52	£77,419.72	-£23,742.04	-44%
Warmer Homes Argyll & Bute	£4,921,639	130	£37,858.76	£4,921,637.00	130	£37,858.75	£0.02	0%

Project Name	Baseline		Endline			Cost reductions		
	Budget	Target # properties	Average cost per property	Total spend	Number of properties retrofitted /to be retrofitted	Average cost per property	Value	% change
Retrofit of Electrically Heated Homes	£7,708,981	236	£32,665.17	£7,708,981.00	175	£44,051.32	-£11,386.15	-35%
Gloucestershire SHARe and CaRe Demonstrator	£2,263,620	50	£45,272.40	£2,263,620.00	46	£49,209.13	-£3,936.73	-9%
Destination Zero II: The Next Step	£5,466,870	104	£52,566.06	£4,733,124.00	65	£72,817.29	-£20,251.23	-39%
DORIC	£5,233,111	100	£52,331.11	£5,233,111.00	50	£104,662.22	-£52,331.11	-100%
Alva Community Regeneration through Decarbonisation	£775,000	15	£51,666.67	£805,000.00	15	£53,666.67	-£2,000.00	-4%
Clarion Housing Group advanced retrofit project	£8,985,354	160	£56,158.46	£8,985,352.76	117	£76,797.89	-£20,639.42	-37%

Project Name	Baseline			Endline			Cost reductions		
	Budget	Target # properties	Average cost per property	Total spend	Number of properties retrofitted /to be retrofitted	Average cost per property	Value	% change
Northampton Whole House Retrofit	£5,612,740	150	£37,418.27	£5,612,740.00	149	£37,669.40	-£251.13	-1%
Xtra-Z	£7,800,424	164	£47,563.56	£7,800,254.00	91	£85,717.08	-£38,153.52	-80%
National Net Zero Retrofit Accelerator	£26,406,422	270	£97,801.56	£21,745,352.00	117	£185,857.71	-£88,056.15	-90%
Leeds Whole House Retrofit	£8,870,477	190	£46,686.72	£8,870,477.00	190	£46,686.72	£0.00	0%
WHR projects								
Energiesprong Sutton	£8,574,195	100	£85,741.95	£3,221,745.77	23	£140,075.90	-£54,333.95	-63%
Destination Zero I	£10,199,303	180	£56,662.79	£3,859,636.84	51	£75,679.15	-£19,016.36	-34%
Across all projects	**£111,967,343**	**2018**	**£55,484.31**	**£94,910,239.59**	**1365**	**£69,531.31**	**-£14,047.00**	**-25%**

A4.4 Data

This section presents the various intermediary data that were used to calculate the cost reductions as per the method presented in A4.3. This includes the typical retrofit costs used in the absence of project reported data and a summary of the data quality issues in the costs data.

Table A31: Typical retrofit costs for social housing retrofit projects.

Table A31 provides more information on the individual sources and the rationale for the use of these. Where possible, the internal DESNZ research was used, followed by the project averages and the Energy Saving Trust research.

Measure	Cost (£)	Unit	Source
EWI	£11,949	per property	Internal research commissioned by DESNZ separate from this evaluation.
IWI	£9,279	per property	Internal research commissioned by DESNZ separate from this evaluation.
Cavity	£2,055	per property	Internal research commissioned by DESNZ separate from this evaluation.
Windows	£446	per m2 glazing	Average of costs from project baselines. Matches reasonably well with Energy Saving Trust cost estimate for typical semidetached house which is £7500. Typical area is 16.9m2 corresponding to total cost of 122 approx. £8500.
Heat pump	£11,116	per property	Average of costs from project baselines. Not too dissimilar to the Energy Saving Trust average cost of £14535 which includes radiators.
Solar PV	£5,999	per system	Average of costs from project baselines. Also matches well with Energy Saving Trust cost estimates for typical 3.5kWp system which is £5449.
Doors	£1,026	per door	Average cost from project baselines. Similar to Energy Saving Trust estimates of £980 and £1300 for PVC and hardwood doors, respectively

SHDF(D) and WHR: Outcome and economic evaluation – Technical Annex

Measure	Cost (£)	Unit	Source
MVHR	£2,956	per property	Average cost from project baselines.
MEV	£2,067	per property	Average cost from project baselines.
Ventilation Passive	£928	per property	Average cost from project baselines.
Loft insulation	£678	per property	Internal research commissioned by DESNZ separate from this evaluation.
Roof insulation	£8,172	per property	Internal research commissioned by DESNZ separate from this evaluation.
Floor insulation	£3,353	per property	Internal research commissioned by DESNZ separate from this evaluation.
Boiler upgrade	£4,200	per property	From Energy Saving Trust research – cost of boiler upgrade.
Hot water	£500	per property	From Energy Saving Trust research – cost of new hot water cylinder.
Storage Heaters	£3,965	per property	From Energy Saving Trust research – typical cost assuming 5 storage heaters per property.
Infrared	£1,920	per property	Assume 10 panels for house (£150 each) and two day install @£210.02 (from SPONS) per day. Approx costs from https://epace.uk/collections/all. Aiming for 500W panels.
Party Wall	£12	per m2	From Energy Saving Trust research – similar to single project's reported figure of £9/m2.

Source: as stated in final column.

Table A32 provides an overview of data completeness by project and by data type.

Table A32: Summary of quantifiable cost issues for analysis

Project	Baseline costs completeness	Endline cost completeness (after gap filling)	Endline cost assumed from TM measures	Endline costs assumed from project average	Endline measure data completeness
SHDF projects					
Nottinghamshire Net Zero Carbon Housing Demonstrator	100%	100%	0%	0%	100%
Orbit Housing Incremental Whole House Retrofit Programme	100%	100%	0%	0%	100%
Social Housing Retrofit Accelerator Cornwall	100%	100%	0%	0%	100%
Warmer Homes Argyll & Bute	100%	100%	0%	100%	99%
Retrofit of Electrically Heated Homes	100%	100%	0%	0%	100%
Gloucestershire SHARe and CaRe Demonstrator	100%	100%	0%	0%	100%
Destination Zero II: The Next Step	97%	100%	100%	0%	100%
DORIC	100%	100%	0%	100%	100%

Project	Baseline costs completeness	Endline cost completeness (after gap filling)	Endline cost assumed from TM measures	Endline costs assumed from project average	Endline measure data completeness
Alva Community Regeneration through Decarbonisation	100%	100%	0%	0%	100%
Clarion Housing Group advanced retrofit project	100%	100%	66%	34%	66%
Northampton Whole House Retrofit	100%	100%	0%	0%	100%
Xtra-Z	100%	100%	0%	100%	100%
National Net Zero Retrofit Accelerator	85%	100%	8%	92%	84%
Leeds Whole House Retrofit	99%	100%	3%	95%	79%
WHR projects					
Energiesprong Sutton	100%	100%	0%	43%	100%
Destination Zero I	100%	100%	0%	0%	100%
Across all projects	**98%**	**100%**	**11%**	**46%**	**93%**

Annex 5: QCA

This annex describes how qualitative comparative analysis (QCA) was applied within the SHDF(D) and WHR programme evaluation. QCA was used alongside a range of other methods (such as Contribution Analysis and energy modelling, described in detail elsewhere in this Technical Annex) to assess the SHDF(D) and WHR programme outcomes defined in the specific ToCs.

A5.1 Introduction

QCA was used to identify the conditions (or combination of conditions) which led to successful project outcomes such as achievement of planned scale and cost efficiency. This analysis considered the following evaluation question:

- Which delivery models have been most successful?

The remainder of this document is structured as follows:

- Section A5.2 explains the rationale for applying QCA in the context of this evaluation.

- Section A5.3 describes the evaluation team's approach and process for designing and carrying out the QCA, including the challenges encountered and how these were tackled.

- Section A5.4 presents the results of the QCA and provides an interpretation of the findings.

- Section A5.5 puts forward some methodological lessons and reflections based on application of QCA to this evaluation.

A5.2 Rationale for applying QCA

As a method, QCA aims to unpack the complex interplay of conditions under which an outcome occurs. By comparing the cases displaying the outcome with those which do not, QCA can help identify:

- The conditions that are necessary or near necessary for the outcome to occur. A necessary condition is a condition that must be present, all or most of the time, for the outcome to occur. The presence of a necessary condition does not mean that the outcome will occur; however, the absence of a necessary condition means that the outcome will not occur, all or most of the time.

- The conditions that are sufficient or near sufficient for the outcome to occur. A sufficient condition is one that when present, causes the outcome to occur all or most of the time

i.e. the outcome always occurs when the condition is present, although the outcome could also result from other conditions.

- The ways conditions combine to produce the outcome (i.e. the different configurations of causal conditions leading to the outcome).

QCA is particularly suited for small-N samples (5 to 50 cases); the ideal number of cases being 15-50. With smaller samples, the number of observations is too small for meaningful comparison, while for larger samples, knowledge of individual cases becomes infeasible.

Due to the above characteristics of QCA, the SHDF(D) and WHR programmes lend themselves well to this method. The two programmes were essentially testing how different approaches to whole house retrofit at scale could work – with each of the projects representing a WHR 'testbed' or case. These programmes were thus good examples for exploring and understanding the conditions (or combinations of conditions) under which projects delivered the desired outcome(s).

A5.3 Methodology

As illustrated below (Figure A3), a step-by-step and iterative process was followed to apply the QCA methodology. These steps are explained in subsequent (sub-sections).

Figure A3: Steps involved in QCA
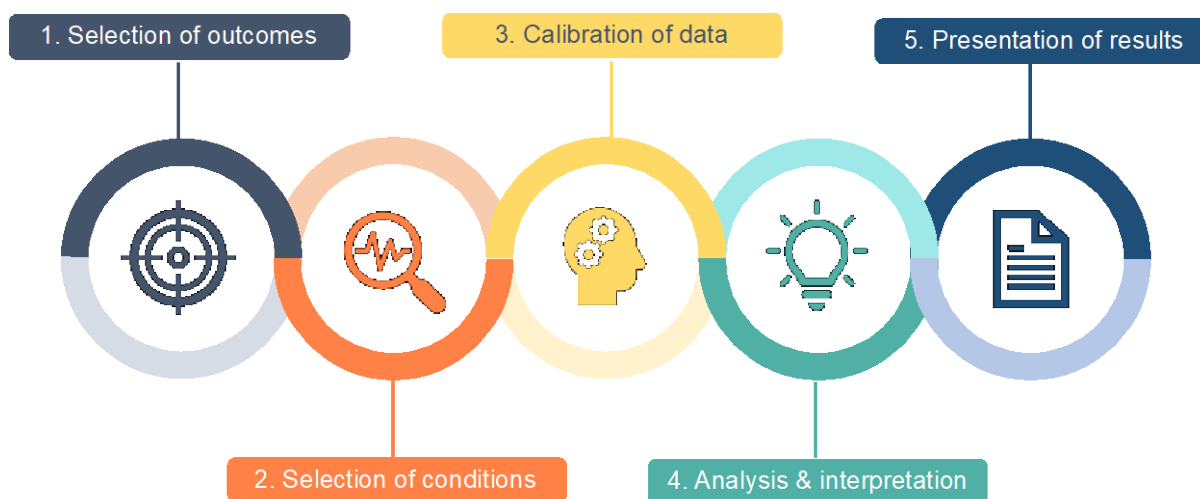
Step 1. Selection of outcomes

Initially, QCA was a central element of the overall approach to outcome evaluation; and as such, it was originally planned to conduct a separate QCA for each of the outcomes set out in the programme ToCs (Figures A1 and A2). However, due to various practical constraints, specifically data availability and resource intensity of the method, and the complexity of using

QCA for certain outcomes (see Table A33 for further information), it was decided to limit the use of QCA to only the two outcomes that we felt would benefit the most from this approach and where it was feasible to apply QCA. The final list of outcomes was selected through an interactive and iterative process involving discussions with DESNZ around the feasibility of applying QCA (e.g. proportion of costs saved was removed from the list due to lack of data to measure cost savings) and objectivity of the measure (e.g. resident satisfaction and project success would have required subjective assessments).

Figure A4: Narrowing the focus of the QCA on two outcomes of interest

LONG LIST

1. Rate of completion of retrofits
2. Unit cost of retrofit
3. Proportion of costs saved
4. Value for money rating
5. Energy performance improvement
6. Tenant satisfaction
7. Fidelity to bid
8. Project success

SHORT LIST

1. Timeliness
2. Scale (number of retrofits completed)
3. Cost-efficiency
4. Cost-reduction
5. Tenant satisfaction

FINAL LIST

1. Achievement of planned scale
2. Little or no deviation from initial unit cost estimates

Table A33: Rationale for discarding certain outcomes from the QCA

Rate of completion of retrofits	Several variants of the indicator were considered e.g.:
	Number of properties retrofitted: this measure was discarded as it was considered to be a shallow measure of success.
	Number of retrofits divided by number of months of delivery – this measure was discarded because timeliness of retrofits whilst desirable, is not an outcome in itself.
	This indicator was subsequently revised to number of properties retrofitted relative to original plans (achievement of planned). The rationale for this indicator is provided after this table.
Unit cost of retrofit/cost-efficiency	Instead of comparing unit costs of retrofits delivered by projects (which depend on factors such as depth of retrofit, accessibility of properties, archetypes etc.), it was decided that it would be more insightful to

	analyse any deviation between planned and actual unit costs achieved by projects.
Proportion of costs saved	Explored in-depth as part of cost reduction analysis (Chapter 8 of the main report) and hence, excluded from QCA.
Value for money rating	This indicator was discarded to avoid multiple indicators on cost efficiency and based on a consideration of data and effort involved in conducting VfM assessment at project level.
Energy performance improvement	Explored in-depth as part of building performance assessment (Chapter 5 of the main report) and hence, excluded from QCA.
Resident satisfaction	An assessment/ rating of resident satisfaction by project would have been highly subjective. Moreover, resident satisfaction was removed from the QCA as it was being explored under resident outcomes (Chapter 6 of the main report).
Fidelity to bid (matching original cope to final achievement)	Although interesting, an assessment against this indicator would have required calculating an overall rating of projects based on assessment three dimensions: timeliness, scale and specification/depth of retrofitting.
Project success (qualitative perceptions of success)	This indicator was discarded as it was regarded as being too subjective and lacking empiricism.

The two outcomes of interest that were eventually selected, correspond to the main objectives of the SHDF(D) and WHR programmes:

Demonstrating how innovation and scale drive down the cost of retrofit. Projects were required to include an appropriate number of properties in their bids to deliver and demonstrate the required economies of scale. As such, whether a project achieved scale (measured in terms of the number of retrofits completed relative to original plans) is regarded as one of the measures of project success.

Achieving cost reduction in retrofitting of buildings through innovation and economies of scale. In reality, projects could not achieve the planned cost reductions (which were envisaged in their initial proposals) due to significant cost escalation (resulting from general inflation as well as supply chain disruptions and capacity constraints); nonetheless, some projects were successful in managing and controlling the costs of retrofits. As such, it is of interest to systematically explore the conditions under which projects achieved their initial unit cost estimates.

The table below sets out how the two outcomes of interest were defined, measured and assessed.

Table A34: Definition and measurement of successful outcomes

Outcome	Outcome 1: achievement of planned scale	Outcome 2: little or no deviation from initial unit cost estimates
Definition	The number of properties retrofitted by a project as compared to original plans	Unit cost of retrofit as compared to original plans Unit cost = all costs and all financial inputs (including matched funding) divided by number of retrofits completed
Data sources	Original plans as per project applications Actual number of properties retrofitted based on SHDFD(D) management information from June 2023 and validated in June 2023 for WHR	Original plans as per project applications Actuals as per data provided by DESNZ, final reports, grant assurance letters (where available)
Calibration rules and rubrics	0 = the number of properties retrofitted by the project was significantly lower than originally planned i.e. 50% or lower as compared to the original bid 0.33 = the project was completed at a reduced scale (51%-90%) 0.67 = the project was completed at a slightly reduced scale (91%-99%) 1 = the project was completed at scale (100%)	0 = cost per retrofit was higher than initially anticipated 1 = there was little (up to +5%) or no deviation from initial unit cost estimates

Step 2: Selection of conditions and calibration rules

The next step was to identify and define the conditions which could lead to the two outcomes of interest. A major practical challenge in the application of QCA methodology is to choose from many possible causal conditions. While from a theoretical point of view, it might be tempting to include a large number of conditions; in practice, the number of conditions should

be parsimonious to avoid the problem of limited diversity.[48] When there is not enough empirical evidence to test certain theoretical expectations, then the algorithm may produce false-positive findings, leading to unreliable results. As a rule of thumb, there should be 5-8 conditions for sample sizes smaller than 100.[49]

Initial selection of conditions was based on theory and empirical knowledge. Based on a literature review, the findings from the process evaluation and empirical case knowledge (derived from in-depth portfolio analysis and desk research), conditions were identified that might have influenced: (a) the scale of retrofit achieved and (b) cost efficiency (assessed as little or no deviation from original unit cost estimates). These were discussed with DESNZ. It was initially planned that the preliminary long-list of conditions would be further sharpened and refined on the basis of interviews with project teams and a validation workshop with DESNZ.

For each condition, calibration rules and rubrics were developed. The coding of the presence/absence of a condition needs to be carried out with an explicit rationale, in order to ensure consistency across all cases. The conditions may be coded in either of the following ways:

- Crisp sets (csQCA) where for each case, the presence or absence of a condition is recorded using nominal data i.e. a 1 or 0.

- Fuzzy sets (fsQCA), where a condition may be partly present or partly absent, represented by a value of 0.67 or 0.33 for example. In fuzzy sets, values are calibrated (either continuously or with cut offs) between two extremes representing fully present (1) or fully absent (0).

- A combination of crisp and fuzzy sets.

Very early on in the analysis, it became clear to us that project outcomes can be achieved to a greater or lesser extent, and that project conditions can be present to a greater or lesser degree. We therefore tried to avoid a binary approach to assessment of outcomes and conditions; instead we applied a fuzzy set QCA (fsQCA) to allow us to capture the qualitative differences in the outcomes and conditions of SHDF(D) and WHR projects. For each condition, we developed clear scoring criteria (rubrics) as well as qualitative or numerical descriptors for each score.

---

[48] In QCA, a researcher assesses all possible combinations or configurations of conditions. If the number of conditions included in the analysis equals "k", then the number of logically possible configurations of conditions that could explain some or all of the outcomes equals "2^k". As a result, the number of theoretically possible configurations of conditions can easily surpass the number of empirical cases in the analysis. Having too many conditions will likely mean that no cases fall into a particular configuration, and that configuration cannot be assessed by empirical examples. When one or more configurations are not represented by the cases, this is known as limited diversity.

[49] According to Kane et al (2014), for a case study design with a small (e.g. 10–15) or intermediate (e.g. 16–100) number of cases, one should aim for fewer than five conditions. Marx (2010) and Thygeson, Peikes, and Zutshi (2013) recommend for csQCA a ratio greater than 3 cases to 1 condition for an analysis with 3 or 4 conditions; and 4 cases to 1 condition for an analysis with 5 or 6 conditions; and an analysis that includes 50 cases should have no more than 7 conditions. Marx and Duşa (2011) recommend having at least eighteen to twenty cases for five conditions and Mello (2021) advises a ratio of at least five cases per condition in a research design.

The initial set of conditions was further refined through several iterations. We drew upon multiple sources of information (project data, documents, and interviews) to assess each of the initial conditions across all cases. Through this process, we iteratively gathered more detailed information on the conditions affecting (a) retrofit scale, and (b) project costs / cost per property. As a result, some conditions were no longer seen as relevant or useful, or consistent data on them across all cases were not available. These conditions were removed from the QCA – see Table A31. On the other hand, new conditions emerged as relevant and these were added to the analysis. This process also led us to refine the calibration rules and scores for some conditions. Most notably, outcome 2 conditions were converted into a crisp set due to lack of sufficiently granular information required for a fuzzy set analysis. The evaluation team discussed each of the conditions identified and to streamline these further to reduce them to the most important ones. This process was then reiterated to further reduce the number of conditions – see Table A35.

Table A35: Rationale for discarding or refining certain conditions from the QCA

Accessibility of site	This condition was initially added as the process evaluation found site accessibility to have an effect on deliverability of the Cornwall and Argyll and Bute projects, but on further review of project documentation and interview transcripts, accessibility did not emerge as an issue affecting delivery.
Continuity of project delivery team (staff turnover during delivery)	This condition was refined to include cases where whole consortium partners changed and to refer to the severity of the change, as judged based on project reporting and feedback in interviews.
Effective engagement and communication with residents	This was removed as a condition, as there was no clear evidence from the project reporting and interview data to support a hypothesis that poor engagement was causally linked to reduced scale of retrofit or cost effectiveness. Residents did not dropout or refuse to participate solely because of engagement approaches, and resident engagement was not flagged as a driver of high costs / significant unexpected costs. Moreover, we felt that an assessment.
Timeliness in obtaining planning permission	Removed as a condition as further review of documentation and of the project team interview data did not flag this as a factor affecting project scale or costs.
Project complexity (in terms of the number and type of measures involved)	Removed, as it was difficult to make a consistent and fair judgement of project complexity given the diversity of the funded projects.
Engagement in and application of lessons learned within the project	Removed, as all projects arguably applied lessons and judgement of varying scale of applying such lessons is overly-subjective.

Project complexity (in terms of the number and type of measures involved)	Removed, as it was difficult to make a consistent and fair judgement of project complexity given the diversity of the funded projects.
Whole building approach (e.g. whereby projects scheduled the construction works so that equipment such as scaffolding could be utilised in a single go to reduce costs)	Removed as this did not come across as a factor affecting scale or costs in subsequent documentation review and stakeholder interviews.
Brick slip (used, alternative used, not used/not needed)	Initially added on assumption that the use of brick slips increased project costs and where alternatives were used, this might have supported cost reduction. However, this condition was subsumed under "cost control and management" (condition 2.2) in order to reduce the number of conditions for outcome 2.
External Wall Insulation (EWI)	Initially added an assumption that EWI might constrain cost efficiency because it is generally more expensive that other measures, but now removed as a condition as all projects included EWI as a measure and given the changes to measurement of cost efficiency (comparison between planned and actual cost per retrofit).
Delays in procurement	Removed as a condition as this issue was covered by conditions 1.1 and 1.4 (see Table A36 on final list of conditions for outcome 1).
Issues of coordination with utility companies on overhead cables	Initially added as a condition as this was flagged in the process evaluation as contributing to cost escalation and project delays in the case of two projects, but removed here in order to streamline the number of conditions and because it was highly specific to two cases.
Innovation by design (Outcome 2) – the extent to which innovations envisaged in project design (to achieve cost reductions) were implemented	Removed due to insufficient objective evidence.
Solutions innovation (Outcome 2) - whether a project implemented innovative solutions to deal with unanticipated problems/ challenges	Removed due to insufficient objective evidence.

Table A36: Final list of conditions for outcome 1

Condition	Description	Calibration rules and rubrics	Set type	Data sources
1.1	No disruption from staff or contractor turnover (disruption)	0 = Staff or contractor turnover was disruptive to project delivery 1 = Staff or contractor turnover was not disruptive to project delivery	Crisp set 0 1	Project change requests Ricardo summary of interim reports Interviews Final reports
1.2	Cost management (unit costs)	0 = cost per retrofit significantly higher than initially anticipated (more than 50% higher) 0.33 = much higher (10 to 50% higher) 0.67= higher (5 to 10% higher) 1 = marginal or no change (up to 5% higher)	Fuzzy set 0 0.33 0.67 1	Project change requests Ricardo summary of interim reports Interviews Final reports
1.3	Limited number of sites per project (sites)	Number of sites per project at baseline, where a site = different town / city / region of the country or a location of the same town / city which does not allow for use of resources (equipment / materials / labour) to be easily shared. 0 = 5+ 0.33 = 3-5 0.67 = 2-3 1 = one site	Fuzzy set 0 0.33 0.67 1	Project proposals

Condition	Description	Calibration rules and rubrics	Set type	Data sources
1.4	Existing relationships with contractors and suppliers = about level of pre-existing trust in and confidence in quality of work + speed of access to supply chain (relationships)	0 = the project lead did not have existing relationships with contractors and suppliers and/or had to undertake new competitive process 1 = the project lead had existing relationships, framework contracts or supply arrangements (e.g. call-off contract and/or long-term, ongoing contract for works / internal staff)	Crisp set 0 1	Project proposals Interviews Final reports

Table A37: Final list of conditions for outcome 2

Condition	Description	Calibration rules and rubrics	Set type	Data sources
2.1	Procurement approach (procurement)	0 = non-fixed prices and/or no advance purchases 1 = fixed price - direct award (design-and-build) and/or advance purchases	Crisp set 0 1	Project proposals Interviews
2.2	Cost control and management (costcontrol)	0 = project did not implement any measures/ solutions to deal with cost escalation 1 = project implemented measures/ solutions to deal with cost escalation	Crisp set 0 1	Interviews Ricardo summary of interim reports DESNZ compilations of lessons learned Ipsos process evaluation Final reports
2.3	Piloting (piloting)	0 = no pilot phase 1 = project ran initial pilot phase before full scale roll-out	Crisp set 0 1	Project proposals Interviews Interim reports Final report
2.4	Low or no unanticipated remedial works (remedial)	0 = project experienced unanticipated or unbudgeted remedial or enabling works 1= project experienced no unanticipated or budgeted (within contingency pot) remedial or enabling works	Crisp set 0 1	Interviews Interim reports Final reports

Step 3: Calibration of outcomes and conditions

Data were collected to assess and score each condition across all cases. An important step in every QCA application is to transform the raw input data (often a combination of qualitative and quantitative data) to data that can be processed with QCA tools; this process is known as 'data calibration'. In practical terms, this means that for each case (i.e. project), its outcomes and conditions are assessed and assigned scores using pre-defined rubrics or scoring criteria (Tables A35 and A36). This results in a data matrix. The data matrices for outcomes 1 and 2 are presented below.

Table A38: Data matrix for outcome 1

	Outcome 1	Conditions			
Project	Scale	Disruption	Unit Costs	Sites	Relations hips
Stratford-on-Avon	1	1	1	0	0
Cornwall	0,33	0	0	1	1
Argyll & Bute	1	1	1	0	0
Wychavon	0,33	1	0,33	0	0
Stroud	0,67	1	0,67	0,33	0
Nottingham City	0,33	0	0,33	1	0
Aberdeen	0	1	0	0,33	0
Nottinghamshire	1	1	1	0,67	1
Clackmannanshire	1	1	1	1	1
Fenland	0,33	1	0,33	0,67	1
Northampton	1	0	1	1	1
Manchester City	0,33	1	0	1	0
LBBD	0	1	0	0	0
Leeds City	1	1	1	1	1
WHR-Sutton	0	0	0	0,67	1
WHR-Nottingham	1	1	1	0	0

Table A39: Data matrix for outcome 2

	Outcome 2	Conditions			
	Unit cost	Procurement	Cost control	Piloting	Remedial
Stratford-on-Avon	1	1	1	1	0
Cornwall	0	0	1	1	0
Argyll & Bute	1	1	0	0	1
Wychavon	0	1	1	1	0
Stroud	0	1	1	0	0
Aberdeen	0	0	1	0	0
Nottinghamshire	1	0	1	0	1
Clackmannanshire	1	1	0	1	1
Fenland	0	0	1	1	0
Northampton	1	0	1	0	1
Manchester City	0	0	1	1	0
LBBD	0	0	0	1	0
Leeds City	1	1	1	1	0
Nottingham City	0	0	1	1	0

Note: WHR projects were not included in outcome 2 due to lack of data on all conditions.

Step 4: analysis and interpretation

A specialised software - fs/QCA - was used to identify the conditions or combinations of conditions that lead to successful outcomes. The results of the analysis are presented in section 1.3. Prior to discussing the results, however, it is useful to discuss some limitations and challenges associated with this method.

Box 1. Limitations and challenges of applying QCA

QCA cannot cope with missing data; therefore, all factors or conditions must be scored. As noted previously, some conditions had to be discarded due to lack of data. Moreover, due to missing data, WHR projects were excluded from the analysis of outcome 2. This reduces the empirical evidence base for the analysis and therefore risks introducing a degree of bias in the results.

The number of conditions that can be effectively employed in a QCA is limited. As discussed above, with every condition added, the number of truth table[50] rows grows exponentially, resulting in problems related to a high number of logical remainders and limited empirical diversity. This limitation confines the number of relevant conditions that can be tested in any given analysis.

Given the iterative nature of the process and requirement for case familiarity, the application of this method is highly resource intensive. The time and budget planned for QCA were disproportionate to the resource required, limiting the scope of iterations that could be undertaken.

Data on final realised project costs or match funding /additional funding secured by projects were not available at the time of the analysis. These data are provided in final reporting documentation, which is issued only after project completion and hence, were not available in time (for most projects) for QCA. Total project costs have been calculated by summing up DESNZ grant with match funding figures. The match funding figures are calculated based on grant intensity[51] stipulated in the grant funding agreements and DESNZ grant amounts claimed. It is possible that projects supplemented match funding (with own funds or with additional funding from other sources) as they have had to respond to increased project costs. The documents of three projects suggest that this might have been the case (Stratford-on-Avon, Cornwall, Leeds City). Actual project costs are important for establishing the average unit cost of retrofit per project. In the absence of this data, we have used the best available information to conduct the analysis.

Strictly speaking, QCA does not prove causality or reveal explanatory power. Instead, it unravels associations between conditions and outcomes, thereby providing support for the existence of causal relationships. It is up to the researcher to decide (based on

---

[50] A truth table shows all logically possible configurations of a given set of conditions. A truth table has 2 raised to the power of k rows, with k being the number of causal conditions

[51] Amount of grant as a percentage of total project costs

theoretical and empirical knowledge) whether to interpret identified patterns as causal relationships.

A5.4 QCA results and interpretation

This section describes the results separately for each outcome of interest. In order to understand the results, it is first useful to have a brief discussion on parameters of fit. The QCA analysis generates different parameters of fit which help evaluating the analyses of necessity and sufficiency. These are as follows:

- **Consistency**: When used to test for the presence of a necessity relationship, consistency reports the degree to which cases exhibiting the outcome also exhibit the proposed necessary condition. A score of 1.0 indicates that the necessary condition is present whenever the outcome is present. When used to test for sufficiency, a score of 1.0 indicates that whenever the sufficient condition is present, the outcome is present. Scores less than 1.0 indicate imperfect relationships. For necessary conditions, consistency is typically set very high, at 0.90; whereas for sufficient conditions, lower consistency values (e.g. 0.75 for crisp sets and 0.80 for fuzzy sets) are relatively common.[52]

- **Coverage** provides a measure of empirical importance. It shows the percentage of the outcome that is covered by a solution; in other words how much of the outcome is "explained" by a particular condition or combination of conditions. Coverage values should usually be 0.60 or higher. Importantly, however, the thresholds for what is deemed 'good' can vary with the research design and aim of the research (Schneider, and Wagemann 2010).

Outcome 1: achievement of scale

Following established QCA practice, the data was first analysed for necessary conditions. The table below presents the results for the analysis of necessary conditions for outcome 1: achievement of scale using the fsQCA calibrated data (which is the data matrix for outcome 1 presented in Table A38).

Using a consistency threshold of 0.90 and a coverage threshold of 0.60, cost management emerges as a necessary condition for achieving scale. This means that projects which achieved planned scale, were those that were able to control and manage their costs to ensure that there was little or no deviation from initial unit cost estimates. A comparison of this with information presented in Table A37 validates this result. Only six projects achieved their planned scale (Orbit Housing Incremental Whole House Retrofit Programme, Warmer Homes Argyll & Bute, Nottinghamshire Net Zero Carbon Housing Demonstrator, Alva Community Regeneration through Decarbonisation, Northampton Whole House Retrofit and Leeds Whole House Retrofit). These were also the only projects that managed to meet their initial until cost

---

[52] See for example, Schneider and Wagemann, 2012; Mattke et al., 2020; Maier et al., 2020

estimates (+/- 5%). In some respects this is an obvious finding when considering that projects had fixed budgets and hence, the number of properties retrofitted was smaller than initial plans in case of projects which could keep a lid on their initial unit cost estimates.

Table A40: Results of the analysis of necessary conditions, outcome 1: achievement of scale (fsQCA)

Condition	Consistency	Coverage
No disruption from staff or contractor turnover (disruption)	0.800481	0.605455
Cost management (unit costs)	0.920673	0.958698
Limited number of sites per project (sites)	0.639423	0.569593
Existing relationships with contractors and suppliers (relationships)	0.560096	0.665714

Next, we carried out an analysis of sufficiency. To do so, the calibrated data was incorporated into a truth table. The truth table lists all possible configurations of the conditions[53] and shows how the empirical case observations or projects are distributed among the different configurations. Thus, with the four conditions here, the number of logically possible configurations is 16. Out of 16 logically possible configurations, eight were empirically observed. The truth table was minimised using a frequency threshold of 1 and consistency threshold of 0.80 (see Table A46).

---

[53] The truth table is a data matrix with 2k rows that represent all possible configurations of conditions that are logically possible

Table A41: Customised truth table for outcome 1

Disruption	Unit Costs	Sites	Relationsh ips	Number	Scale	Raw consist.	PRI consist.	SYM consist
1	1	0	0	3	1	1	1	1
1	1	1	1	3	1	1	1	1
0	1	1	1	1	1	1	1	1
1	0	1	1	1	0	0.492537	0	0
1	0	1	0	1	0	0.39759	0	0
1	0	0	0	3	0	0.247191	0	0
0	0	1	0	2	0	0.246269	0	0
0	0	1	1	2	0	0.197605	0	0

Note: only shows configurations that meet the following frequency and consistency norms: Row consistency = 0.8 and Frequency threshold = 1

Cost management (unit cost) emerges as the most important condition as it is present in all combinations of the solution. This is understandable as it is a necessary condition. It also emerges as a sufficient condition when counterfactuals are taken into account (parsimonious solution). No combination of conditions were found to be sufficient. Again, this reflects the point made earlier that in a context of fixed budgets, costs become the most decisive factor for achieving scale.

Box 2: Overview of solutions

The **standard analysis** produces three types of logically reduced configurations of conditions that are sufficient for the outcome under scrutiny: a complex solution, an intermediate solution, and a parsimonious solution.

The **complex solution** is exclusively based on the empirical information at hand. It only works with empirical rows that are associated with a positive outcome, above the specified consistency and frequency thresholds (i.e. the customised truth table). It does not make assumptions about the empty rows in the truth table (logical remainders) and side steps the counterfactual reasoning.

The **parsimonious solutio**n (that is, the simplest solution) on the other hand, takes into account all truth table rows with logical remainders. When generating the parsimonious solution, the software uses the logical remainder rows in whatever way it can to achieve the fewest terms (i.e. conditions and operators) in the solution. Those logical remainders that are used are called "simplifying" assumptions because using a row without any cases requires an assumption about whether hypothetical cases that would belong to the row would have membership in the outcome set. If assuming membership in the outcome set produces a simpler solution, then the software will make that assumption. Alternatively, if assuming non-membership in the outcome set yields a simpler solution, then the software will make that assumption. Thus, parsimony drives the assumptions made during minimisation to generate the most parsimonious solution. A weakness of the parsimonious solution is that it does not consider the plausibility of the simplifying assumptions that were used to derive it. This means that the parsimonious solution may rest on unrealistic assumptions about hypothetical data. Hence, the parsimonious solution should always be scrutinised for its simplifying assumptions, which means examining the logical remainder rows that were included in its calculation.

The intermediate solution includes logical remainders, but only those deemed sensible. To do so, the software takes directional expectations into account. The minimisation proceeds by including only those logical remainder rows that result in a simpler solution and are consistent with directional expectations. Thus, the intermediate solution prioritises consistency with directional expectations over parsimony to arrive at a simpler solution.

Source: Kahwati, L.C. and Kane, H.L., 2018. Qualitative comparative analysis in mixed methods research and evaluation (Vol. 6). Sage Publications.

Outcome 2: Little or no deviation from unit costs estimates

The analysis did not reveal any necessary condition(s) for achievement of initial unit cost estimates. The analysis of necessary conditions does not indicate that any of the four conditions is necessary for the achievement of outcome. In other words, none of the conditions causes the outcome by itself.

Table A42: Results of the analysis of necessary conditions, outcome 1: achievement of scale (csQCA)

Condition	Consistency	Coverage
Approach to procurement (procurement)	0.666667	0.666667
Cost control and management (costcontrol)	0.666667	0.363636
Running a pilot phase (piloting)	0.500000	0.333333
Low or no unanticipated remedial works (remedial)	0.666667	1.000000

From the analysis, "low or no unanticipated remedial or enabling works" emerges as a sufficient condition for projects to meet their initial unit cost estimates. In other words, the outcome (little or no deviation from initial unit cost estimates) occurs whenever the respective condition (low or no remedial or enabling works) is present. Although this is the parsimonious solution, it corresponds to the empirical case data at hand (see Table A37: data matrix for outcome 2).

One can see from the data that all four projects which had little or no unanticipated/ unbudgeted remedial or enabling works (Argyll & Bute, Nottinghamshire, Clackmannanshire, and Northampton) managed to achieve their unit cost estimates. However, the outcome can also occur in absence of the sufficient condition; this happened in the cases of Stratford-upon-Avon and Leeds City. Nonetheless, the results should be treated with caution. Our theoretical and empirical case knowledge suggests that in reality, multiple conditions likely interacted in their contribution towards the outcome. Data permitting, a more granular analysis using fuzzy sets, would perhaps have revealed such combinations of conditions.

In summary, based on available empirical data, low or no unanticipated remedial or enabling works emerges as a sufficient condition for SHDF(D) projects to have achieved their initial unit cost estimates. However, the outcome could also have resulted from other conditions such as the effectiveness of measures undertaken to control and management costs, or a project's approach to procurement or their decision to undertake a pilot. It is also conceivable that a combination of these factors contributed to successful project outcome. This was however, not possible to determine due to lack of granularity of underlying data. Moreover, ideally, it would have been helpful to have been able to assess the effectiveness of measures taken by projects

to control and manage costs (such reducing scope or number of measures installed, replacing material with cheaper alternatives etc.). However, available data did not permit this. One can only glean the number and types of cost control measures undertaken, but it was not possible to determine the effectiveness of these measures in reducing costs.

However, the analysis undertaken for outcome 2 has still facilitated a deep analysis of project delivery, cost challenges, and cost enablers, which has fed into the overarching analysis of cost reduction in Chapter 8 of the main report.

Table A43: Customised truth table for outcome 2

Procurement	Cost Control	Piloting	remedial	Number	Unit Cost	Raw consist.	PRI consist.	SYM consist
0	1	0	1	2	1	1	1	1
1	0	0	1	1	1	1	1	1
1	0	1	1	1	1	1	1	1
1	1	1	0	3	0	0.666667	0.666667	0.666667
0	1	1	0	4	0	0	0	0
0	1	0	0	1	0	0	0	0
1	1	0	0	1	0	0	0	0
0	0	1	0	1	0	0	0	0

Logical remainders = 8

A5.5 Methodological lessons and reflections

Although the findings and results of the analysis have been limited, the application of QCA in the context of this evaluation proved to be useful in building detailed knowledge of how projects differed and the potential linkages and correlations between different project experiences and outcomes (which have supported cost reduction and value for money analysis) and generating methodological insights and learnings. These are summarised as follows:

- **QCA depends on the quality, depth, and consistency of underlying evidence.** There is need for complete and consistent data across projects. For example, in this case the analysis was constrained by lack of consistent information across sites on the extent to which costs of remedial and enabling works were unanticipated, effectiveness of cost control measures undertaken etc.

- **The selection of conditions and indicators has a strong impact on the research results**, and therefore must be based on careful consideration and strong arguments. It can be practically challenging to respect the principle of parsimony in selection of conditions given the diversity of projects and the complexity of context, and where there are many external factors.

- **The scoring of factors or preconditions can require considerable judgment and subject matter expertise**, making it subjective if it is not calibrated for consistency through clear application of criteria across case studies. It is hence, important to factor in a process of joint scoring and validation together with DESNZ policy teams.

- **The need to allow sufficient time and resources for iterative process**, QA process (particularly validation of reliability and consistency of scoring) and gap-filling data collection exercises.

Annex 6: Economic evaluation

This Annex sets out in detail the methodology used for assessing the value for money of the SHDF(D) and WHR programmes. Value for Money (VfM) is a balanced judgement about finding the best way to use public resources to deliver policy objectives (HM Treasury, 2022).[54] This economic evaluation has taken a '4E's framework'[55] in order to:

- Provide an in-depth analysis of the costs of the programme, projects and installations and weigh these against the evaluated outcomes; and

- Generate lessons from findings, as they emerge, to inform DESNZ, local authorities and housing associations, whole house retrofit providers and other key stakeholders as to the different values of approaches taken and to support the design of future programmes and projects.

This methodology is explained in detail below.

A6.1 Introduction

A description of the programmes is provided in Chapter 4 of the main report, with the outputs and outcomes they expect to achieve set out in the Theories of Change (as included in section A1.2.2 of this Technical Annex). An economic evaluation of the programmes needed to primarily focus on those outcomes which can be assessed and the context for findings (to ensure lessons from the delivery of the projects can be taken from the economic evaluation). The outputs and outcomes of the WHR and SHDF(D) programmes were set out in the business cases.

Table A44. Anticipated outputs and outcomes of WHR and SHDF(D) as measured in this VfM

Outputs	Outcomes
Development of new delivery models	An increase in supply chain capacity through and capability: Jobs supported by the programme Supply chain confidence Increase in supply chain skills
Innovations tested	Residents understanding of how to use retrofit technology
Delivery of 2,033 properties retrofitted	Residents level of satisfaction with the retrofit

---

[54] [The Green Book: Central Government Guidance on Appraisal and Evaluation](#). HM Treasury, 2022.
[55] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/49551/DFID-approach-value-money.pdf

Outputs	Outcomes
1,277 properties converted to EPC C rating (SHDF(D) only)	Improved energy performance of the retrofitted property, which would lead to: Reduced energy costs to residents Carbon savings Improved property aesthetics A reduction in damp, mould and draughts, leading to health and wellbeing benefits.
Training completed by workers in the sector	Learnings generated for Government and local authorities

The evaluation team considered different approaches and a synthesis approach was identified as the most feasible to provide evidence to underpin the economic evaluation.

This approach included utilising qualitative information and quantitative data collected and analysed in other strands of the evaluation about the outputs and outcomes the programme has achieved and how the projects have contributed towards these outcomes being achieved. This approach was guided by the 4E's framework,[56] focusing on the economy, efficiency, effectiveness and equity of the programme.

The evaluation team explored whether a Cost Benefit Analysis (CBA) – an approach where monetary values are calculated for the impacts, and the value of the impacts is compared to expenditure - or a Cost Effectiveness Analysis (CEA) – where costs per outcome achieved are assessed - were feasible for the economic evaluation, but these were deemed to be infeasible due to challenges such as:

- An inability to quantify the additional long-term impacts of the intervention that would be included in a HM Treasury Green Book[57] compliant CBA (such as the economic impact, CO2 emissions and changes in wellbeing), meaning the outcome evaluation design implemented did not provide quantifiable estimates (see outcome evaluation section).

- Many long-term impacts, as those specified above, are not observable within the evaluation timeframe. Therefore, a full assessment of the outcomes of the programmes could not be fully valued.

- An inability to disentangle outcomes, the programme and project expenditure (programme inputs) required to achieve different outcomes meant not all outputs or outcomes could be attributed a unit cost. This would mean a CEA on its own would provide insufficient findings for the evaluation.

---

[56] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/49551/DFID-approach-value-money.pdf

[57] The Green Book: Central Government Guidance on Appraisal and Evaluation. HM Treasury, 2022.

- There was no counterfactual approach used for the evaluation, as justified in section A1.7 on overarching methodological strengths and limitations of the evaluation.

The evaluation team explored the feasibility of undertaking a scenario based economic evaluation (modelling the potential benefits of the programmes under different contexts and assumptions, including multiple outcomes), but this approach was not followed as it would not provide a robust assessment of the economic value of the programmes. Similarly, a partial CBA, focussing on a limited number of outcomes or a single outcome was explored. However, the lack of robust findings of the additional outcomes the programmes have achieved would potentially overstate the value of the outcomes achieved – and omitting other outcomes from the analysis would not present a clear finding of the value of the programmes. Undertaking this approach could potentially detract from the other findings around the outcomes achieved by the programmes.

It was therefore agreed to focus on a qualitative assessment of value for money, containing elements of quantitative costs analysis, as outlined in further detail below.

A6.2 Methodology

The evaluation team undertook a qualitative value for money assessment. As mentioned above, other approaches were considered. The evidence for this assessment came from the other strands of the process and outcome evaluation, alongside collection and analysis of project data, secondary data and thematic analysis of qualitative interviews.

The qualitative value for money exercise was grounded in the '4E' approach. This is summarised in the figure below. However, as mentioned above, it was not possible to provide metrics for the costs per different outcomes achieved due to data and evaluability challenges, therefore the assessment took a more qualitative approach than some VfM assessments using this framework.

Figure A5: NAO 4'E's framework
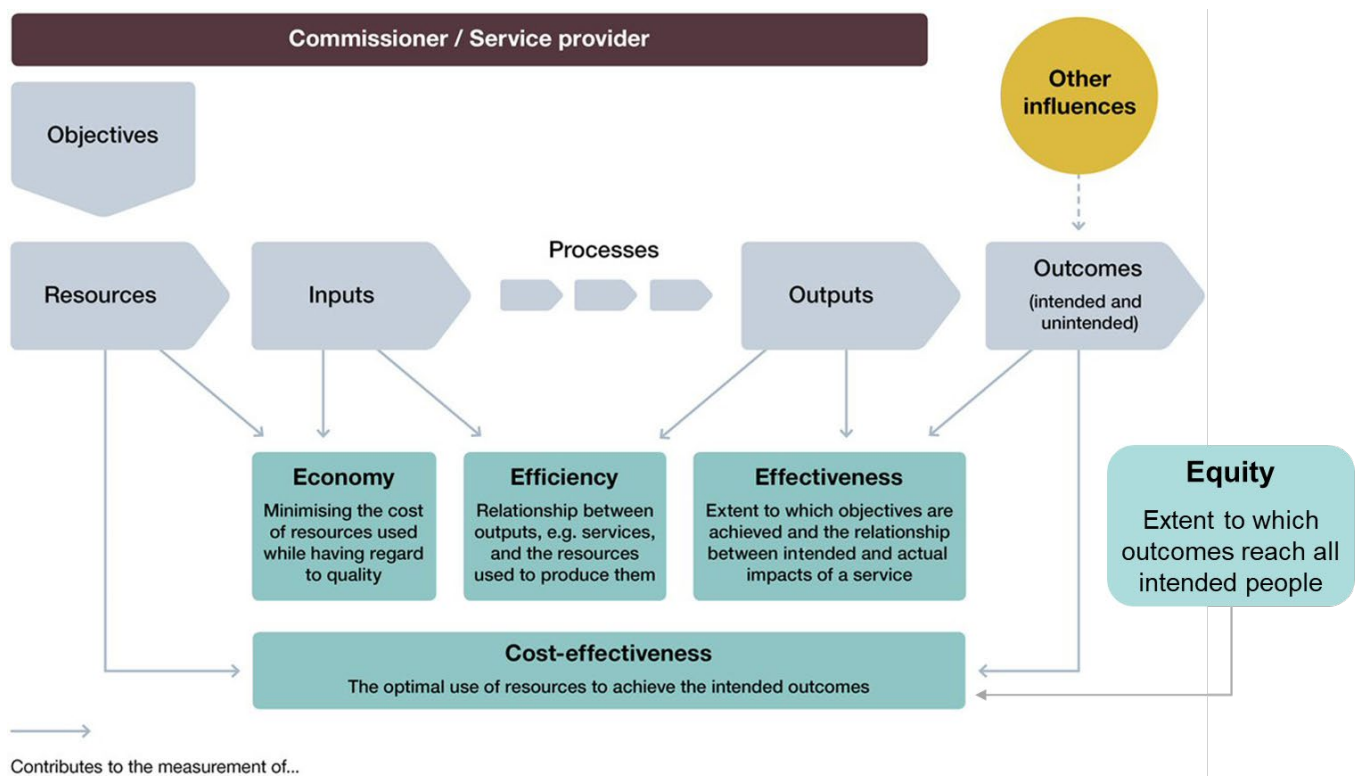
A6.2.1 Adaptation of NAO 3'E's diagram[58]

A series of economic evaluation questions were developed under each of the 'E's. These were designed to align with the programmes ToCs from a cost and equity perspective. These were used to inform the data collection and analysis conducted for the VfM assessment. The table below highlights the key evaluation questions and where the information was collected from. The approach taken to answering these questions is described in more detail below.

---

[58] NAO 3'E's approach available at: https://www.nao.org.uk/successful-commissioning/general-principles/value-for-money/assessing-value-for-money/

Table A45: Key Value for Money evaluation questions

Evaluation question	Data sources and analytical workstreams
Economy	
What was the cost for the activities delivered and how did these compare to expectations?	Project management information (invoicing, monthly/quarterly/final reporting)
How have projects minimised the costs / reducing cost escalations for each activity?	Cost reduction analysis (see Annex 4) Interviews with project leads and wider delivery teams Project management information (monthly/quarterly/final reporting) Secondary data sources (benchmarking)
Efficiency	
What were the costs to achieve outputs, how do these compare to expectations and do these offer value for money?	Project management information (invoicing, monthly/quarterly reporting) Cost reduction analysis (see Annex 4) Contribution Analysis (CA), Qualitative Comparative Analysis (QCA)
What factors contributed to the differences in expected cost per retrofit activity/home upgraded?	Cost reduction analysis (see Annex 4) Interviews with project leads and wider delivery teams
Effectiveness (relates to all outcome evaluation questions, and outcomes in Table A23)	
What outcomes have been achieved by the programme and how does this compare to expected outcomes in the business case?	Outcome evaluation (Contribution Analysis (CA), Qualitative Comparative Analysis (QCA)), management information Interviews with project leads and wider stakeholders Existing literature (to model some impacts)
What factors contributed to the outcomes achieved?	Outcome evaluation (CA, QCA), Project management information Interviews with project leads and wider stakeholders
How reasonable are the costs required to achieve the outcomes?	Outcome evaluation (CA, QCA)

Evaluation question	Data sources and analytical workstreams
	Interviews with project leads and wider stakeholders
	Resident survey and qualitative interviews
Equity	
Were the programmes / projects designed and delivered in economically disadvantaged areas?	Project management information (location of intervention)
	Secondary data sources (e.g. IMD, Levelling Up priority areas)
	Process evaluation findings
Were the projects delivered to individuals in need of public intervention?	Project management information (location of intervention)
	Resident survey (status of residents)
	Resident qualitative research (situation of residents prior to intervention)
	Census data (local profile of population)
	Secondary data sources (e.g. IMD, Levelling Up priority areas, housing statistics)
Did the processes used by local authorities promote an equitable distribution of funds?	Process evaluation findings
	Interviews with project leads and wider stakeholders

A6.2.2 The economy of the projects

This explores whether the activities have been delivered at the lowest possible cost. The economic evaluation drew on the following work strands and data sources:

- the cost reduction analysis (detailed below and in Annex 4),

- a review of programme management information (programme expenditure), and

- findings from the qualitative interviews, exploring the processes and mechanisms put in place at a programme and project level.

The cost reduction analysis which is relevant to the economic evaluation explored:

- The total number of activities planned to be undertaken within the project budget at baseline and the number of activities actually delivered.

- The number of each type of activity planned to be undertaken and actually delivered.

- The level of expenditure required to deliver these activities.

This approach was used as there was no consistent reporting by projects of the actual costs achieved to deliver individual retrofit activities. As most projects (15 out of the 16 projects) have not reported how much it cost to deliver individual measures, it was not possible to explore the actual cost for each retrofit activity undertaken and to compare these to industry standards, to explore whether certain activities had been delivered in an economical manner whereas others had not. Therefore, the economic evaluation examining the cost of delivery and the measures delivered included an analysis of the qualitative data, to understand how and why projects achieved the costs per retrofit activities.

A6.2.3 The efficiency of the projects / programme

The efficiency section of the VfM analysis explored the relationship between the costs and outputs achieved.

The efficiency research drew on findings from:

- The cost reduction analysis (Annex 4).

- Analysis of project management information (analysis of project costs, the outputs achieved by each project and the reporting of any challenges and/or accelerators projects encountered in achieving outputs),

- The QCA (based upon analysis of total committed expenditure (grant + match funding) divided by the committed number of properties (not the actual delivered)) (Annex 5)

- The process evaluation,[59] and

- Qualitative interviews with the project delivery teams (Annex 1).

The first part of the efficiency analysis explored the technical efficiency of the projects – namely, did the projects achieve the number of outputs expected or targeted at the outset, were they achieved within the required timescales and whether procurement arrangements supported competition. If the projects did not, then the reasons for this were explored through analysis of the qualitative data sources listed above. This analysis was supported by an analysis of the qualitative data and an assessment of the other outputs the programme had achieved (for example training courses completed and innovative approaches used) – although it was not possible to quantify these outputs.

The second part of the efficiency analysis explored evidence of synergies, flexible processes or other factors which supported more efficient achievement of outcomes as the projects progressed. The evidence for this came from a thematic analysis of stakeholder interviews, although there was limited evidence available to inform an assessment of these factors.

---

[59] Joint Process Evaluation Report - Whole House Retrofit (WHR) and Social Housing Decarbonisation Fund Demonstrator (SHDF(D)), BEIS/DESNZ Research Paper Series Number 2023/008.

A6.2.4 The effectiveness of the projects / programme

The effectiveness section of the VfM evaluation explored how effective the programme had been in achieving outcomes, and the strength of evidence that the outcomes achieved were cost effective. The effectiveness analysis has been undertaken at a programme, rather than project level, as it has not been possible to disaggregate the outcomes achieved by projects. The effectiveness research largely drew on findings from:

- The market outcomes analysis (Annex 3).

- The QCA analysis (Annex 5).

- The resident survey (Annex 1).

- The energy and thermal analysis (Annex 1).

- Analysis of project management information (Annex 1) and

- Analysis of the qualitative research (Annex 2)

The outcomes that the effectiveness analysis focussed on were set out in Table A50, which links back to the programme level ToC. The findings from the other strands of research demonstrated the outcomes achieved by the programmes and how far these aligned with the initial expectations of the programmes.

The approach to the effectiveness analysis has been:

- Identify the outcomes achieved by the programmes from the workstrands mentioned above, and how far the outcomes can be attributed to the programme.

- Utilise the evidence to assess whether the outcomes achieved meet the initial objectives as set out in the business cases or in the Theory of Change (see Annex 1).

- The strength of the evidence that the outcomes had been realised were also included in effectiveness assessment – noting where evidence for an outcome is weak.

- Assess the timeliness of outcomes achieved – for some outcomes (such as supply chain capacity and skills) could still be achieved in the future, and the evaluation may have taken place too early to fully capture these outcomes.

- Comparing the weighted analysis of the outcomes achieved to the costs required to deliver the outcomes to inform an assessment of cost effectiveness.

There were significant data availability and evaluation challenges which shaped the design of this approach, the most important of which was an inability to disentangle the inputs required to achieve different outcomes, and a lack of quantitative information on the additional outcomes that the programmes have achieved. This meant that the assessment of effectiveness was largely a qualitative assessment.

Limitations to the VfM approach generally are discussed in section A6.3. The evaluation also aimed to compare the cost effectiveness of the programmes against other comparable interventions – however, given the more qualitative nature of the VfM approach described

above, this has proved challenging and benchmarks have not been discovered. However, it was anticipated that given the pilot nature of the programmes that there would be limited comparable programmes in any case.

Table A46: Outcomes and impacts of the programme and use in economic evaluation

Measurable outcomes	Data sources used	Workstream informing economic evaluation	Barriers and potential use
Resident outcomes (Relates to outcome evaluation questions R1, R2 and R3)			
Residents' satisfaction with retrofit	Information on the levels of satisfaction with the retrofit is being collected in the resident survey and resident interviews workstream.	The resident survey and resident interviews analysis provided indicative information about the level of satisfaction with the retrofit activities. However, this data only covers those surveyed, and is not representative of the wider population of programme beneficiaries.	The resident survey had a low base (n=256, although only 151 responded to questions around satisfaction due to the questions only being asked to those where retrofit activity had been completed) and was not statistically representative of the target population. The low base also meant that data could not be disaggregated by project. Some of the outcome data collected in the survey relates to outcomes that may be realised over the longer term, and due to the timing of the evaluation the survey may not adequately captured the full outcomes of the programmes. Finally, the survey did not collect baseline measures, therefore changes in outcome metrics cannot be observed.\n\nThese factors should be considered when interpreting the findings from the survey.

Measurable outcomes	Data sources used	Workstream informing economic evaluation	Barriers and potential use
Residents' understanding of how to use retrofit	Information on the levels of understanding of the retrofit is being collected in the resident survey and resident interviews / mobile diary (AppLife) workstream.	The resident survey and resident interviews analysis provided indicative evidence of the level of understanding of how to use the retrofit. However, this data only covers those surveyed, and is not representative of the wider population of programme beneficiaries.	The resident survey had a low base (n=256 although only 151 responded to questions around satisfaction due to the questions only being asked to those where retrofit activity had been completed) and was not statistically representative of the target population. The low base also meant that data could not be disaggregated by project. Some of the outcome data collected in the survey relates to outcomes that may be realised over the longer term, and due to the timing of the evaluation the survey may not adequately captured the full outcomes of the programmes. Finally, the survey did not collect baseline measures, therefore changes in outcome metrics cannot be observed. These factors should be considered when interpreting the findings from the survey.
Energy bills reduction	Energy bill information is not collected by the projects. The resident survey did provide some evidence of changes in bill payments; however, the effect of the	The resident survey analysis provided indicative information of bill savings, although there were challenges in interpreting this	The evaluation was not able to collect robust primary data on the number of households that have experienced an

Measurable outcomes	Data sources used	Workstream informing economic evaluation	Barriers and potential use
	programmes is difficult to disentangle from other factors contributing to changes in energy bills. Modelling analysis undertaken as part of the thermal analysis workstream used project data on the types of retrofits delivered and the energy rating of retrofitted properties, alongside evidence from the literature to estimate a bill saving as a result of the retrofits.	data (there are multiple factors other than the retrofits influencing changes in energy bills). However, this data only covers those surveyed, and is not representative of the wider population of programme beneficiaries. The information on EPC ratings was analysed as part of the thermal analysis, and the findings from this have fed into the economic evaluation.	energy bill reduction or the scale of bill savings. The resident survey had a low base (n=256) and was not statistically representative of the target population. The low base also meant that data could not be disaggregated by project. Some of the outcome data collected in the survey relates to outcomes that may be realised over the longer term, and due to the timing of the evaluation the survey may not adequately captured the full outcomes of the programmes. Finally, the survey did not collect baseline measures, therefore changes in outcome metrics cannot be observed. Additionally, the findings from the survey cannot be used to infer actual values of bill savings, as there are multiple factors and self-reporting and perception biases which could influence the change in bill payments in the same timeframe, so changes cannot be fully attributed to the programmes.

Measurable outcomes	Data sources used	Workstream informing economic evaluation	Barriers and potential use
			These factors should be considered when interpreting the findings from the survey. It was possible to estimate bill savings using a modelling approach using the number of properties upgraded to a higher EPC rating (gross outcome achieved), and the value of these savings. This analysis was undertaken as part of the analysis of building performance (energy and thermal outcomes) (see Annex 2 and Chapter 5 of the main report).
Improving building aesthetics	Information reported by the projects (pre and post retrofit property condition assessments) provides data on building condition, which can be used as a proxy measure for building aesthetics. In addition, the workstreams with residents investigate their views on aesthetics of the retrofit.	The building performance (energy and thermal outcomes) analysis provided evidence of the extent to which the projects have supported improving building aesthetics, as will the resident survey and resident interviews – this analysis fed into the economic evaluation.	The data sources provide gross measures of buildings improved and perceptions of improvements from residents. However, the data source only covers 833 of the 1,352 properties retrofitted, so there is a significant proportion of properties with no information about this outcome (38% with missing data). The resident survey had a low base (n=256) and was not statistically representative of the target population.

Measurable outcomes	Data sources used	Workstream informing economic evaluation	Barriers and potential use
			The low base also meant that data could not be disaggregated by project. Some of the outcome data collected in the survey relates to outcomes that may be realised over the longer term, and due to the timing of the evaluation the survey may not adequately captured the full outcomes of the programmes. Finally, the survey did not collect baseline measures, therefore changes in outcome metrics cannot be observed. These factors should be considered when interpreting the findings from the survey.
Reductions in mould, damp, draughts	Information on instances of mould, damp and draughts was collected in the resident survey and resident interviews workstreams. Further information was reported in the project reports.	The resident survey analysis and management information provided estimates of the number of households with reductions in mould, damp and draughts. However, this data only covers those surveyed, and is not representative of the wider population of programme beneficiaries.	The resident survey had a low base (n=256) and was not statistically representative of the target population. The low base also meant that data could not be disaggregated by project. Some of the outcome data collected in the survey relates to outcomes that may be realised over the longer term, and due to the timing of the evaluation the survey may not adequately captured the full outcomes of the programmes. Finally,

Measurable outcomes	Data sources used	Workstream informing economic evaluation	Barriers and potential use
			the survey did not collect baseline measures, therefore changes in outcome metrics cannot be observed. These factors should be considered when interpreting the findings from the survey.
Quality of life / wellbeing / health status	There was no data source which could be used to assess the change in quality of life or wellbeing of residents as quality of Life (health status) and wellbeing information was not collected by the projects. The ONS provide data sources which collect this data (such as the Annual Population Survey and Understanding Society), but these data sources provide average values for a local area, not information for individual residents that have benefitted from the projects. There was a question in the resident survey asking whether it's had a positive impact on physical and mental health, which was used in the economic evaluation.	The resident survey and interview analysis provided estimates of the number of households with a positive impact on physical and mental health. However, this data only covers those surveyed, and is not representative of the wider population of programme beneficiaries.	It was not possible to assess this additional impact of the projects quantitatively as part of the evaluation. There was no baseline measure of quality of life or wellbeing. The resident survey asked questions around mental health, but without baseline measures it was not possible to know how much the indicator had changed by. Therefore it was infeasible to robustly assess the quantitative impact the programme has had on this impact and monetise this. However, the findings from the resident survey can be used to provide an indication of the outcomes achieved. The resident survey had a low base (n=256) and was not statistically

Measurable outcomes	Data sources used	Workstream informing economic evaluation	Barriers and potential use
			representative of the target population. The low base also meant that data could not be disaggregated by project. Some of the outcome data collected in the survey relates to outcomes that may be realised over the longer term, and due to the timing of the evaluation the survey may not adequately captured the full outcomes of the programmes. Finally, the survey did not collect baseline measures, therefore changes in outcome metrics cannot be observed. These factors should be considered when interpreting the findings from the survey.
Performance outcomes (Relates to outcome evaluation question P1)			
Reduction in carbon emissions	The projects collected some information relevant to this outcome, such as energy demand, and use of renewable energy systems. However, they did not collect data carbon usage by the properties upgraded. There were no secondary data sources which collect data on carbon emissions by property, which	The thermal analysis workstream provided evidence of the likely changes in carbon emissions, and this was used in the economic evaluation.	The thermal analysis provided gross measures of changes in carbon emissions. These were modelled estimates of changes in carbon emissions, rather than observed changes. This did not estimate the additional effect the projects have had.

Measurable outcomes	Data sources used	Workstream informing economic evaluation	Barriers and potential use
	could be used to robustly measure the impact on carbon emissions.		
Supply chain outcomes (Relates to outcome evaluation questions M1, M2 and M3)			
Jobs supported	Project reports provided details on the number of jobs supported by the project, however, there were inconsistencies in the jobs included in these figures between projects, therefore an alternative approach (using a ratio of funding to jobs supported) was proposed. The qualitative interviews with project teams provided a third data source to be used to assess the jobs supported by the projects.	The market analysis workstream (utilising CA) provided evidence of the extent to which the projects have supported jobs – utilising the reported job numbers and qualitative findings - this analysis fed into the economic evaluation, and provided evidence of the extent to which the programme contributed towards this.	The data sources provided gross measures of jobs supported and the value of these jobs, but not the additional impact of the programmes – therefore the market analysis workstream findings were used.
Reducing unemployment and increases in GVA as a result of jobs supported	The increase in jobs could contribute to a reduction in unemployment – however, the projects did not collect data which could be used to estimate the impact of the programme on local unemployment. DWP produce estimates of benefit claimants, and the ONS (through the Annual Population Survey or Business Structure Database) estimate local employment. Local output estimates are	N/A	Employment / benefits claimants / GVA / wages estimates from the ONS and DWP were not able to detect the impact of the programme on the local economy, as the projects were not expected to have a sufficiently large enough impact to move average local indicators. Therefore it was assessed as infeasible to assess this impact as part of the economic evaluation.

Measurable outcomes	Data sources used	Workstream informing economic evaluation	Barriers and potential use
	also produced by the ONS, and the Annual Survey of Hours and Earnings collects data on wages, all of which could support an assessment of changes in output as a result of reduced unemployment.		
Supply chain confidence	Information on suppliers' confidence in securing future work and the reputation of their organisations) was not collected by projects. There are no secondary data sources which could be used to quantify these impacts. However, qualitative evidence which is being collected from project leads and the supply chain.	The market analysis workstream (utilising CA) provided evidence of the extent to which the projects have contributed towards supply chain confidence.	The information collected allowed the evaluation team to assess the effect the programmes have had on supply chain confidence qualitatively and include in the VfM assessment.
Supply chain skills and capacity	Information on the skills within the supply chain was only available from the qualitative interviews undertaken with project teams, and this has been used to inform the assessment of this outcome.	The market analysis workstream provided evidence of the extent to which the projects have supported skills and capacity in the supply chain – this analysis fed into the economic evaluation.	The information collected allowed the evaluation team to assess the effect the programmes have had on supply chain confidence qualitatively and include in the VfM assessment
Cost reductions	The projects provided details of their cost reduction strategies, with some projects providing estimates of how	Cost reduction analysis (see below)	There were no barriers to using this outcome in the economic evaluation, and the cost reduction analysis. However,

Measurable outcomes	Data sources used	Workstream informing economic evaluation	Barriers and potential use
	much the cost reduction strategies should save. Secondary data sources (e.g. project management information) also provided reasonable estimates of the costs associated with specific activities; however most projects did not provide evidence on the actual spend per activity.		there were limitations to this analysis (see Annex 4).
Learning outcomes (Relates to outcome evaluation questions L2, L3 and L4)			
Learning outcomes	The projects provided information on key learnings in their project reporting, and the qualitative interviews also captured information about lessons learned.	The market analysis, QCA and analysis of qualitative interviews provided evidence of the lessons learned at a programme level and the types of lessons that have been learned.	Although it was not possible to robustly estimate the precise number of lessons learned, the impact analysis from the market analysis and QCA provided an indication of the lessons learned and the contribution the programme has made to achieving these lessons.

A6.2.5 The equity of the programmes

The equity section of the VfM research explored how programme delivery reached programme beneficiaries, and those that could potentially face barriers in accessing the benefits of the programmes. The equity analysis largely used evidence from:

- The process evaluation

- Analysis of programme and project level management information

- Analysis of secondary data sources (such as the levelling up index, Index of Multiple Deprivation and the Census) and

- The qualitative research.

The evaluation explored the following types of equity:

Economic equity: This analysis aimed to explore whether the residents receiving the support were less well-off households and in less well-off regions. The analysis at a headline level looked at quantitative indicators (such as average IMD score and Levelling Up Fund index). It should be noted that targeting specific areas was not included as part of the programme business case. The analysis involved:

- Identifying the geographic areas (local authority, Lower Super Output Area, Middle Layer Super Output areas) in which the projects had operated. This was taken from project management information.[60]

- Comparing the economic indicators of the areas the projects operated in with national averages, to inform an assessment of the equity of expenditure.

Equity in processes: This analysis aimed to explore whether the processes used to deliver the projects supported an equitable access to outcomes. The analysis used findings from the process evaluation and qualitative information form the delivery team interviews. However, there was limited information available in these data sources and robust conclusions could not be formed.

Resident equity: The aim of this analysis was to explore if the areas the projects delivered in had disproportionate numbers of residents with specific protected characteristics (based on the structure of the local population). The programmes did not collect information on the characteristics of the residents receiving retrofit activity – therefore the evaluation team accessed and analysed data from the English Census, English Household Survey and Scottish Household survey, alongside findings from the resident survey. As described in the economic equity bullets above, the analysis involved:

---

[60] The areas that the projects were delivered in were identified by taking the postcodes of the properties delivered to and matching these to Lower Super Output Areas (so each Lower Super Output Area had at least one project property within its boundary)

- Identifying the geographic areas (local authority, Lower Super Output Area, Middle Layer Super Output areas) in which the projects had operated. This was taken from project management information.[61]

- Comparing the population characteristics of the areas the projects operated in with national averages, to inform an assessment of the equity of access to outcomes.

From this analysis, it was possible to infer whether individuals with protected characteristics faced particular barriers in accessing the benefits of the programmes. The evaluation team explored the following characteristics:

- Age

- Ethnicity.

A6.3 Methodological limitations

The approach described above was selected as the most appropriate for the economic evaluation on the basis of the data available and the evaluation aims. However, some key limitations should be noted:

- A lack of robust quantifiable information on the additional long-term impacts expected to drive economic returns. The reasons for this are:

  o Employment and productivity: The lack of a counterfactual case means that the outcome evaluation did not provide a quantified estimate of the additional jobs the projects supported locally. Although the number of jobs supported by projects could have been monetised using a GVA per job metric, this would not have represented the additional impact of the programme at a local level (and would not have taken into account any displacement within the economy at a national level). The method was therefore assessed to be unreliable and a risk of providing misleading conclusions about the value of the programmes.

  o Social and resident outcomes such as wellbeing: It was not possible to identify individuals benefitting from the programmes in secondary data sets (such as the Annual Population Survey or Understanding Society) which measure wellbeing. Further, although the resident survey collected information about wellbeing, it did not collect this information pre- and post-installation, to explore changes in wellbeing following the intervention, meaning results are subject to recall bias. It also only surveyed residents directly affected by the programmes (in receipt of installations) so could not provide counterfactual evidence. It has therefore not been possible to form conclusions about the additional impact the programmes have had on social outcomes.

---

[61] The areas that the projects were delivered in were identified by taking the postcodes of the properties delivered to and matching these to Lower Super Output Areas (so each Lower Super Output Area had at least one project property within its boundary)

- o Environmental outcomes: It was challenging to measure the impact of the programmes on carbon emissions due to the timeframe of the evaluation (conducted alongside and shortly after project delivery), with changes to carbon emissions expected to be observed over five to ten years post project completion, as households become used to the new environment. The thermal analysis strand of the evaluation utilised a modelled approach to provide an indicator of the likely environmental effects of the programme, and these have been used in the economic evaluation. However, these are estimates, and without empirical evidence should be treated with caution.

- Lack of a counterfactual case: As described in section A1.7 of this Technical Annex, the evaluation did not utilise a counterfactual case, meaning the additional outcomes the programmes have achieved have not been quantitatively measured. This limitation informed the design of the economic evaluation and the VfM approach used.

- Inability to disentangle outcomes: Many of the outcomes of the programmes were linked together and were challenging to disentangle from one another (for example the resident and performance outcomes are all linked by having a more energy efficient property). Further, it was not possible to apportion input costs at either a project or programme-level, to the different outcomes of interest, on the basis of available programme data. This meant that the evaluation was only able to provide estimates of the cost per retrofit completed, and no other output or outcomes achieved could be assessed by producing metrics of costs per outcome achieved.

- Limited direct comparability with other programmes: the limitations mentioned above and the qualitative nature of the approach taken meant that there was no opportunity to compare the findings of this economic evaluation to other comparable programmes – however it should also be noted that there were limited comparable programmes which the findings could have been compared to in any case.

- Data availability: Some data which would have been useful to support the economic evaluation was not available. For example, most projects had not reported a cost per activity (for example the cost per cavity wall insulation installed). Therefore, the analysis was often undertaken at a property rather than activity level. The data limitations for each data source are presented in Table A23.

- Timing of the evaluation: The time period over which some of the outcomes were expected to be observable (for example the economic, wellbeing and environmental outcomes mentioned above) did not fall within the evaluation timeframes. Therefore, a full assessment of the outcomes of the programmes could not be achieved, and the value of those outcomes achieved after the evaluation was completed could not be valued.

- Analysis undertaken at both project and programme level: The economic evaluation had to undertake some analysis at a project level (incorporating only project costs) and some at programme level, on the basis of available data. Where analysis has been conducted at a programme level, the whole programme costs have been used.

Annex 7: Quantitative data collection tools

This Annex outlines the data collection tools used in for the quantitative research, distributed to households that were part of the WHR or SHDF(D) programmes.

A7.1 Warm-up letter

Residents initially received a 'warm-up' letter inviting them to participate in our research, and outlining the purpose of the research as well as how their data would be used.

Figure A6: warm-up letter

Dear Resident,

Tell us about your experience of energy-efficiency works in your area.

Ipsos is looking to collect feedback from social housing residents about some energy-efficiency works in your area. Ipsos UK is an independent research company. In partnership with the Energy Saving Trust, they have been commissioned by the Department for Business, Energy, and Industrial Strategy (BEIS) to assess the pilot programme funding the works to your property, known as the Social Housing Decarbonisation Fund Demonstrator.

Ipsos is contacting you as you live in a property selected for energy-efficiency works under this pilot programme. We will invite you to take part in a survey in early 2023 to find out about your experience of the programme.

What the research will involve

Taking part in the research is voluntary. Taking part will involve completing a survey which will be posted to your address. You can complete the survey either on paper or online via a link provided. The survey will take around 10 minutes and can be completed at a time convenient for you.

The survey will ask you about your experience of having the building works in your home. The questions will cover your views about the works and any measures installed, and if they have made a difference to your home.

If you decide to take part, you will receive a £10 voucher once the research is completed. All the information you share will be treated as strictly confidential and used for research purposes only.

If you would like to stop receiving Ipsos research communications for this project, or have questions about taking part, please contact Ipsos at beisresidentsurvey@ipsos.com or call

> FREEPHONE 0800 5422161, quoting your unique 8 character reference at the top of this letter.

A7.2 Cover letter

A cover letter was delivered to households, comprising of information on how to complete the resident survey, and confirming that individuals will receive a financial incentive for their time.

Figure A7: cover letter

Dear Resident,

Tell us about your experience of energy-efficiency works in your area.

Ipsos is looking to collect feedback from social housing residents about some energy-efficiency works in your area. Ipsos UK is an independent research company. In partnership with the Energy Saving Trust, they have been commissioned by the Department for Energy Security & Net Zero (formally the Department for Business, Energy, and Industrial Strategy) to assess the pilot programme funding the works to your property.

Ipsos is contacting you as you live in a property selected for energy-efficiency works under this programme. We are inviting you to complete a survey to find out how the programme involved or affected you. It covers experiences leading up to and during the building works, and the impacts of any works delivered in your daily life. The survey should take approximately 10 minutes to complete.

As a thank you for taking part Ipsos will send you a £10 voucher.

How do I take part? Participation in this survey is voluntary. If you wish to take part, please complete EITHER the online survey OR the postal survey. Please do not complete both.

Complete online

Visit https://ipsos.uk/beisresidentsurvey, or scan the QR code at the top of this letter

Enter your access code: <XXX>

Complete the survey

OR complete on paper

Complete the enclosed questionnaire

Return using the freepost envelope provided. No stamp is required

Please complete / return the survey by June 2023.

What if I need help? If you have any questions, need help to complete the survey, or if you would like to stop receiving Ipsos research communications for this project, please call FREEPHONE 0800 5422161 or email beisresidentsurvey@ipsos.com, quoting your 8-character reference at the top of this letter. You can also confirm this is a legitimate survey by contacting your landlord at [INSERT CONTACT].

By completing and returning your questionnaire booklet or online survey you give consent for your data to be processed in line with Ipsos's privacy policy. To see a copy of this privacy policy, please visit https://www.ipsos.com/en-uk/privacy-data-protection. All the information you share will be treated as strictly confidential and used for research purposes only.

A7.3 Resident Survey

The resident survey comprised of 37 questions:

Questions about the property you currently live in

The first set of questions is to find out a bit more about your home and what it was like to live there before the energy-efficiency works took place.

Q   Were you living in the property before the work started?

PLEASE TICK ONE BOX ONLY

☐ Yes   ☐ No

IF YOU HAVE ANSWERED "NO" TO Q1, THANK YOU BUT WE ARE LOOKING FOR FEEDBACK FROM THOSE WHO WERE LIVING IN THE PROPERTY BEFORE THE WORK STARTED.

YOU DO NOT NEED TO COMPLETE THE REST OF THIS SURVEY OR POST IT BACK.

Q   Which of the following best describes the type of property you live in?

PLEASE TICK ONE BOX ONLY

☐ Ground-floor flat / apartment   ☐ Mid-floor flat / apartment   ☐ Top-floor flat / apartment

☐ Detached house   ☐ Semi-detached house   ☐ Mid-terraced house

☐ End-terraced house   ☐ Bungalow   ☐ Other (please specify)

Q How many people are there in your household altogether, including any children and yourself? PLEASE TICK ONE BOX ONLY

☐ 1 (Just me)   ☐ 2   ☐ 3

☐ 4   ☐ 5 or more

Q Approximately when was the property built?

PLEASE TICK ONE BOX ONLY

☐ Before 1919   ☐ 1919 - 1930   ☐ 1931 - 1944

☐ 1945 - 1964   ☐ 1965 - 1980   ☐ 1981 - 1990

☐ 1991 - 1995   ☐ 1996 - 2001   ☐ After 2001

☐ Don't know

The energy saving installation (including reasons for applying)

Q Thinking about an average week during last winter (without lockdown restrictions), on how many weekdays (Monday to Friday) was someone at home during the day (9am-5pm)?

PLEASE INPUT A NUMBER BETWEEN 0-5

☐   ☐ Don't know

Q Before the energy-efficiency work, which of these was the main way you heated your home?

PLEASE TICK ALL BOXES THAT APPLY

☐ Central heating – mains gas   ☐ Central heating – other (e.g. oil or liquid petroleum gas)

☐ Electric radiators or storage heaters   ☐ Open fire or wood burning stove

☐ Don't know   ☐ Something else (please specify in the box provided)

[ ]

Q Before the energy-efficiency work, which of these other type(s) of heater did you use in your home?

PLEASE TICK ALL BOXES THAT APPLY

☐ Gas fire (mains gas)   ☐ Gas fire (bottled gas)

☐ Electric plug-in room heaters (including fan/radiant heaters)   ☐ Other electric heaters (including towel rails or ...)

☐ Open fire burning coal/wood/smokeless fuel   ☐ Enclosed fire or stove burning coal/wood/smokeless fuel

☐ Aga or Rayburn stove (any fuel)   ☐ Something else (please specify in the box provided)

☐ None of these – GO TO Q9

[ ]

Q Thinking about these other types of heaters, overall, do you use them more or less often since the energy-efficiency work was completed?

PLEASE TICK ONE BOX ONLY

☐ More often ☐ Less often ☐ About the same

☐ Don't know ☐ Not applicable – the work has not been completed

---

Q Before the energy-efficiency work began, during the winter, was the property…

PLEASE TICK ONE BOX ONLY

☐ Much colder than you would have liked ☐ A bit colder than you would have liked ☐ About right

☐ A bit warmer than you would have liked ☐ A lot warmer than you would have liked ☐ Both too warm and too cold

☐ Don't know

Q Before the energy-efficiency work began, during the summer, was the property…

PLEASE TICK ONE BOX ONLY

☐ Much colder than you would have liked ☐ A bit colder than you would have liked ☐ About right

☐ A bit warmer than you would have liked ☐ A lot warmer than you would have liked ☐ Both too warm and too cold

☐ Don't know

Q Before the energy-efficiency work began, overall, how satisfied, or dissatisfied were you with the condition of your home?

PLEASE TICK ONE BOX ONLY

Very satisfied	Fairly satisfied	Neither satisfied nor dissatisfied	Fairly dissatisfied	Very dissatisfied	Don't know
☐	☐	☐	☐	☐	☐

Q Before you had the energy-efficiency work, did you have any of these problems with your home? PLEASE TICK ALL BOXES THAT APPLY

☐ Difficulty heating my home to a comfortable temperature even with the heating on

☐ Condensation/steamed up windows

☐ It was too expensive to heat my home to a comfortable temperature

☐ Draughts

☐ Damp walls, floors, foundations etc

☐ Don't know

☐ Rot in windows frames or floors

☐ None of these

☐ Mould/mildew

☐ Something else (please specify in the box provided)

Q Which of the following energy-efficiency measures have been / are being installed on your home?

PLEASE TICK ALL BOXES THAT APPLY

☐ Wall insulation   ☐ Loft or roof insulation   ☐ Floor insulation

☐ New windows or doors   ☐ Draught proofing   ☐ Don't know

☐ New heating system   ☐ Powered ventilation   ☐ Other (please specify)

Q Has the work on your property been completed?

PLEASE TICK ONE BOX ONLY

☐ Yes – GO TO Q15   ☐ No – GO TO Q16   ☐ Don't know – GO TO Q16

Q How long ago was the work completed?
PLEASE TICK ONE BOX ONLY

☐ Within the last 2 weeks   ☐ Within the last month   ☐ Within the last 3 months

☐ 3 months ago, or longer   ☐ Don't know

Q What were your reasons for having the energy-efficiency work?

PLEASE TICK ALL BOXES THAT APPLY

☐ To save money on energy bills

☐ To make my home warmer or more comfortable

☐ To bring my home up to modern standards

☐ The boiler/heating was broken or nearing the end of its life

☐ To increase my home's value

☐ To reduce energy use for environmental reasons

☐ I was doing other work to my home

☐ The measures were offered for free/at a reduced price

☐ I was offered insulation to get new heating

☐ I had no choice – landlord/building owner said that the work had to be done

☐ Another reason (please specify)

☐ Don't know

The energy saving installation

We'd now like to understand the how you found the experience of the installation process. If the work on the property has not yet been completed, please answer the questions based on your experiences to date.

Q Thinking about the installation process, to what extent were you satisfied or dissatisfied with the following? PLEASE TICK ONE BOX ONLY FOR EACH ROW

		Very satisfied	Fairly satisfied	Neither satisfied nor dis-satisfied	Fairly dis-satisfied	Very dis-satisfied	Don't know	Not applic-able
a)	Communication from the local authority / your landlord	☐	☐	☐	☐	☐	☐	☐
b)	Communication from installers	☐	☐	☐	☐	☐	☐	☐
c)	Noise levels	☐	☐	☐	☐	☐	☐	☐
d)	Numbers of visits / inspections	☐	☐	☐	☐	☐	☐	☐
e)	Cleanliness	☐	☐	☐	☐	☐	☐	☐
f)	General disruption to you / the household	☐	☐	☐	☐	☐	☐	☐
g)	How long you had to wait for the installation to be scheduled	☐	☐	☐	☐	☐	☐	☐
h)	General disruption to your wider area	☐	☐	☐	☐	☐	☐	☐
i)	Information provided to you at the end of works	☐	☐	☐	☐	☐	☐	☐

Q Thinking about the time it took to complete the energy-efficiency work, how did this compare with your expectations?

PLEASE TICK ONE BOX ONLY

☐ It took longer than expected   ☐ It took less time to install than expected   ☐ It took the amount of time I expected

☐ I had no expectation   ☐ The work has not been completed

Q Taking all your experiences into account, overall, how satisfied, or dissatisfied are you with the installation process?
PLEASE TICK ONE BOX ONLY

Very satisfied	Fairly satisfied	Neither satisfied nor dissatisfied	Fairly dissatisfied	Very dissatisfied	Don't know	Not appli-cable
☐	☐	☐	☐	☐	☐	☐

Result of having the measures installed

These next questions relate to the impact, if any, the work has had on your property and those who live there. If the work has not yet been completed on the property you may leave these questions blank, unless you feel you are able to answer some or all.

Q Thinking about the energy-efficiency work that has been installed in your property, to what extent were you satisfied or dissatisfied with the following now it has been completed? PLEASE TICK ONE BOX ONLY FOR EACH ROW

		Very satisfied	Fairly satisfied	Neither satisfied nor dis-satisfied	Fairly dis-satisfied	Very dis-satisfied	Don't know	Not appli-cable
a)	Ability to heat the property to a comfortable temperature	☐	☐	☐	☐	☐	☐	☐
b)	The quality of the installation	☐	☐	☐	☐	☐	☐	☐
c)	How your home looks	☐	☐	☐	☐	☐	☐	☐
d)	The quality of the air inside your home	☐	☐	☐	☐	☐	☐	☐

Q Have you seen any changes to your household energy bills since the work has been completed? PLEASE TICK ONE BOX ONLY

☐ Yes, they are cheaper – GO TO Q23

☐ Yes, they are more expensive – GO TO Q22

☐ No – GO TO Q23

☐ Don't know – GO TO Q23

☐ Not applicable – work has not been completed – GO TO Q23

Q You mentioned that your bills are more expensive since the work has been completed. Given that the national cost of energy has risen sharply over the last few months, do you feel that the work has prevented your bills from rising even further, or not? PLEASE TICK ONE BOX ONLY

Yes – prevented a much bigger rise	Yes – prevented a slightly bigger rise	No – would be the same	No – bills are higher because of work	Don't know
☐	☐	☐	☐	☐

Q

To what extent do you agree or disagree with the following statements in relation to the energy-efficiency work that has been installed in your property?

PLEASE TICK ONE BOX ONLY FOR EACH ROW

		Strongly agree	Tend to agree	Neither agree nor disagree	Tend to disagree	Strongly disagree	Don't know	Not applicable
a)	It has had a positive impact on my physical health	☐	☐	☐	☐	☐	☐	☐
b)	It has had a positive impact on my mental health	☐	☐	☐	☐	☐	☐	☐
c)	My property is more comfortable to live in	☐	☐	☐	☐	☐	☐	☐
d)	My home is a nicer place to live	☐	☐	☐	☐	☐	☐	☐
e)	I am confident using the things that have been installed in my home	☐	☐	☐	☐	☐	☐	☐
f)	My home has fewer issues like damp, mould and condensation	☐	☐	☐	☐	☐	☐	☐
g)	It is now easier to save energy in my home	☐	☐	☐	☐	☐	☐	☐

Q

Considering all the aspects above, overall, how satisfied or dissatisfied are you with the impact the energy-efficiency work has had on your property? PLEASE TICK ONE BOX ONLY

Very satisfied	Fairly satisfied	Neither satisfied nor dissatisfied	Fairly dissatisfied	Very dissatisfied	Don't know	Not applicable
☐	☐	☐	☐	☐	☐	☐

Q And, overall, how satisfied or dissatisfied are you with the impact the energy-efficiency work has had on those living in the property?

PLEASE TICK ONE BOX ONLY

Very satisfied	Fairly satisfied	Neither satisfied nor dissatisfied	Fairly dissatisfied	Very dissatisfied	Don't know	Not applicable
☐	☐	☐	☐	☐	☐	☐

Q As a result of having energy-efficiency work, would you say you are more or less likely to consider other energy saving installations in the future? PLEASE TICK ONE BOX ONLY

Very likely	Quite likely	Neither likely nor unlikely	Quite unlikely	Very unlikely	Don't know	Not applicable
☐	☐	☐	☐	☐	☐	☐

Some questions about your household

To ensure that we are meeting the needs of all residents, it is important that we ask you a few questions about yourself. These questions are voluntary; however as with all the questions in this survey your answers will be completely confidential.

Q Which of the following best describes the gender of each person in your household? Please include yourself and any children
PLEASE TICK ONE ANSWER PER PERSON

	Person 1 (me)	Person 2	Person 3	Person 4	Person 5	Person 6	Person 7	Person 8	Person 9	Person 10
Male	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Female	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other (please specify below)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q And how old is each person in your household? Please include yourself and any children. PLEASE TICK ONE ANSWER PER PERSON

	Person 1 (me)	Person 2	Person 3	Person 4	Person 5	Person 6	Person 7	Person 8	Person 9	Person 10
Under 6	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6 - 13	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
14 - 17	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
18 - 64	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
65+	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q Does anyone in your household have any long-standing illness, disability or infirmity that limits their normal day to day activities?

PLEASE TICK ONE BOX ONLY

☐ Yes –
GO TO Q30

☐ No –
GO TO Q31

☐ Prefer not to say –
GO TO Q31

Q To what extent does this long-standing illness, disability or infirmity limit the day-to-day activities of this person? Normal day to day activities include everyday things like eating, washing, walking and going shopping.

PLEASE TICK ONE BOX ONLY

☐ It limits their activities all of the time

☐ It limits their activities some of the time

Q What is your ethnic group?

PLEASE TICK ONE BOX ONLY

☐ English/Welsh/Scottish/Northern Irish/British

☐ Any other White background

☐ Indian

☐ Pakistani

☐ Bangladeshi

☐ Chinese

☐ Any other Asian background

☐ Black African

☐ Black Caribbean

☐ Any other Black background

☐ Arab

☐ Any other single ethnic group

☐ Mixed / Multiple ethnic groups

☐ Prefer not to say

Q Which of these options best describes the working status of the chief income earner in your household?

The Chief Income Earner is the person in your household with the largest income, whether from employment, pensions, state benefits, investments or any other source.

If two or more people in the household have the same income, please answer about the person who is the oldest.

If the Chief Income Earner is TEMPORARILY off work for some reason, please answer about their working status before they were temporarily off work.

PLEASE TICK ONE BOX ONLY

☐ Full-time paid work (30+ hours per   ☐ In full-time higher education

☐ Part-time paid work (8 – 29 hours per   ☐ Unemployed (seeking work)
week)

☐ Part-time paid work (Under 8 hours   ☐ Not in paid employment (not
per week)   seeking work)

☐ Retired   ☐ Don't know

☐ Still at school

Q Is anyone in your household, including yourself, currently receiving any of these benefits?
PLEASE TICK ALL BOXES THAT APPLY

☐ Income support	☐ Carer's Allowance
☐ Income-Based Jobseeker's Allowance (JSA)	☐ Severe Disablement Allowance
☐ Income-Based Employment and Support	☐ Industrial Injuries Disablement Benefits
☐ Universal credit	☐ Contribution-Based Jobseeker's Allowance (JSA)
☐ Pension Guarantee Credit (excluding Pension Savings Credit)	☐ Contribution-Based Employment and Support
☐ Child Tax Credit	☐ Housing Benefit
☐ Working Tax Credit	☐ Other state benefits
☐ Disability Living Allowance	☐ None of these
☐ Personal Independence Payment (PIP)	☐ Don't know
☐ Attendance Allowance	☐ Prefer not to answer

Final questions

Q Ipsos may conduct further research on this topic in the future. Would you be happy for someone from Ipsos to re-contact you and invite you to participate in this research in the next 12 months? PLEASE TICK ONE BOX ONLY

☐ Yes
☐ No

Q   The Department for Business, Energy and Industrial Strategy (BEIS) may conduct further research on this topic in the future. Would you be happy for someone from BEIS to re-contact you and invite you to participate in this research in the next 12 months?
PLEASE TICK ONE BOX ONLY

       ☐   Yes
       ☐   No

Q   As a follow up to this survey Ipsos will be conducting further research with residents to understand more about their experiences over the next couple of months. This could involve taking part in a one-to-one discussion with a researcher or keeping an online diary for a short period of time. Those who take part in these activities would receive a financial gift to thank them for their time.

    Please note that not everyone who say yes will be contacted to take part.

Would you be happy for Ipsos to contact you to invite you to take part in further research?

   PLEASE TICK ONE BOX ONLY

       ☐   Yes
       ☐   No

Q We would like your permission to link the information you provided in this survey with other datasets held by the Government to enrich the research findings to help us understand people's experiences of using and paying for energy. These records include but are not limited to: Department for Business, Energy and Industrial Strategy (BEIS), Department for Work and Pensions (DWP), Department of Health and Social Care (DHSC). You can change or withdraw your permissions at any time by contacting the evaluation team at beisresidentsurvey@ipsos.com or call FREEPHONE 0800 5422161, quoting your unique 8-character reference at the top of the enclosed letter. If you withdraw your permission, data that has already been linked will be retained but no future linking will take place.

Do you give permission for the information you have provided in this survey to be linked to your home address and be passed to the Department for Business, Energy and Industrial Strategy, so your records can be identified and linked to your survey responses? PLEASE TICK ONE BOX ONLY

☐ Yes

☐ No

Annex 8: Qualitative data collection tools

This Annex outlines the data collection tools used in for the qualitative research, distributed to households that were part of the WHR or SHDF(D) programmes.

Prior to qualitative evaluation activities taking place, Ipsos created a number of recruitment materials. Where needed, different materials were created for the resident qualitative interviews, and mobile diary (AppLife) ethnography. More information on how these were developed can be found in Annex 1.

A8.1 Reassurance Letters

Ipsos

Department for
Business, Energy
& Industrial Strategy

ADDRESS
ADDRESS
ADDRESS
ADDRESS

[DATE]

Dear [TENANT NAME],

Ipsos UK is looking to speak to social housing tenants about the energy-efficiency works recently completed in your area. Ipsos UK is an independent research company. They have been commissioned by the Department for Business, Energy and Industrial Strategy (BEIS) to assess the pilot scheme funding the works to your property, known as the Social Housing Decarbonisation Fund Demonstrator.

Ipsos UK is contacting you as you live in a property selected for energy-efficiency works under this pilot scheme. BEIS has securely shared your contact details with Ipsos UK as you agreed to be contacted about taking part in research. We are now inviting you to take part in a research interview about your experience.

Taking part in this research is voluntary. Those who are eligible to take part will receive a £50 either as a direct payment or a voucher once the interview is complete.

Please note: you may have received a letter from us in December that notified you about an upcoming survey about the energy-efficiency work in your home. This research interview is separate to the survey.

What a research interview involves

Taking part involves a one-to-one interview with an Ipsos UK researcher over the telephone or video call. The interview would last no more than 60 minutes and would be conducted at a time convenient for you. During the call a researcher would ask you about your experience of having the building works in your home. The interview would cover your views on the different measures installed and how, if at all, they have made a difference to your home.

Taking part in the research is voluntary and you can change your mind at any time. All the information you share will be treated as strictly confidential and used for research purposes only.

What will happen next?

Ipsos UK will be in touch to invite you to take part in this research. If you have any questions about taking part, please contact [RECRUITER NAME] either by telephone [TELEPHONE] or by email, at [EMAIL].

If you would like to verify the authenticity of this research, please contact [NAME, TITLE, COMPANY] either via telephone [TELEPHONE] or via email at [EMAIL].

Yours Sincerely,

[NAME]

[NAME] | [POSITION] | Ipsos | [EMAIL]

RELEVANT COUNCIL/ PROJECT LOGO

Department for
Energy Security
& Net Zero

ADDRESS
ADDRESS
ADDRESS
ADDRESS

[DATE]

Dear [TENANT NAME],

Ipsos UK is looking to speak to social housing tenants about the energy-efficiency works recently completed in your area. Ipsos UK is an independent research company. They have been commissioned by the Department for Energy Security and Net Zero (formerly known as the Department for Business, Energy and Industrial Strategy (BEIS)) to assess the pilot scheme funding the works to your property, known as the Social Housing Decarbonisation Fund Demonstrator or Whole House Retrofit schemes.

Ipsos UK is contacting you as you live in a property selected for energy-efficiency works under these schemes. DESNZ has securely shared your contact details with Ipsos UK, as you agreed to be contacted about taking part in research. We are now inviting you to take part in a video diary to tell us about your experience.

Taking part in this research is voluntary. Those who are eligible to take part will receive a £125 either as a direct payment or a voucher once the research is complete. Please note: you may have received a letter from us recently which notified you about an upcoming survey about the work in your home. This research is separate to the survey.

What the research involves
The video diary research will take place over two weeks during March 2023. The research involves downloading an app to your smart phone or tablet, then completing four ten-minute tasks using video and/ or photos each week for two weeks. The tasks would focus on the measures you have had installed in your home and any difference they have made for you and your home.

Both before and after taking part the video diary you will have a telephone call lasting 20-30 minutes with an Ipsos UK researcher scheduled at times convenient for you. During the initial call, the researcher would ask about the measures you have had installed and introduce you to the video diary app. The follow-up call will ask you to reflect on taking part.

Taking part in the research is voluntary and you can change your mind at any time. All the information you share will be used for research purposes only.

What will happen next?
Ipsos UK will be in touch to invite you to take part in this research. If you have any questions about taking part, please contact **Rebecca Paton** either by telephone (07831702513) or by email, at rebecca.paton@ipsos.com. If you would like to verify the authenticity of this research, please contact [NAME, JOB TITLE], either via telephone [TELEPHONE NUMBER] or via email, at [EMAIL].

Yours Sincerely,

Polly Hollings
Polly Hollings | Research Director | Ipsos | polly.hollings@ipsos.com

A8.2 Privacy Notices

All about our research and what taking part would involve

We invite you to take part in this research because we understand that you have recently had energy-related works to your home organised by your landlord. This may have involved building surveys, home visits, and installing insulation, new windows, boilers or solar panels.

Who are we?
Ipsos UK is an independent research company commissioned by the UK Government Department for Business, Energy and Industrial Strategy (BEIS) to assess the grants which funded these works. This scheme is known as the Social Housing Decarbonisation Fund Demonstrator. You can find out more about this scheme here.

Ipsos is one of the largest research companies in the UK. We conduct social research on behalf of the government, charities, the voluntary sector and commercial organisations. Ipsos is bound by the rules of the Market Research Society Code of Conduct, which is the governing body for market research organisations.

Why are we doing this research?
We want to speak to you to find out about your experience of the renovation works. We would like to understand your views on the different measures installed and how, if at all, they have made a difference to your home. The research will help the Government understand how to support energy efficiency installation schemes in the future.

Why have we contacted you?
We are contacting you because you live in a property that has had energy efficient measures installed by your landlord as part of the programme. BEIS has securely shared your details with Ipsos as you agreed to be contacted about taking part in research. We are now inviting you to take part in a research interview about your experience.

Do I have to take part?
No, participation is voluntary. Even if you agree to take part now you can change your mind at any time, and you do not have to give a reason. You can also choose to not answer individual questions during the interview.

What will taking part involve?
If you agree to take part, we will arrange a **telephone or online video interview** at a convenient time for you. A researcher from Ipsos will call you and the interview will last **up to 60 minutes**. The interview will be a one-to-one discussion between you and the Ipsos researcher and will focus on your experience of having energy measures installed in your home.

As a thank you for taking part you will receive £50 once the interview is complete. This will be paid to you via BACS transfer or as a Love2Shop voucher.

Ipsos and BEIS may wish to carry out further research on this topic over the next few months. There would be an additional payment for taking part in this further research. We can provide further information and will ask for your consent to re-contact you during the interview.

20-076732-01 Participant Information Sheet: Project leads

Will you record what I say?

It is up to you. We would like to audio record the interview if you are happy for us to. This is so we don't forget what you said when writing the report a few months later.

Audio recordings will only be used for research purposes and will be stored securely and deleted 12 months after the completion of the research project in August 2023.

Is this research confidential?

Yes, the information you give Ipsos will be treated as strictly confidential. Ipsos adhere to the Market Research Society Code of Conduct and UK GDPR. We treat all personal information as confidential and keep it secure. The information you provide during your interview will be used for the purpose of report writing only. No-one other than the research team and selected parties, such as transcribers, will have access to your data. Your name and details will not be passed on to anyone without your permission.

What will happen to the information I provide?

The information you provide during the interview will be stored securely and used for the purpose of report writing only. Three months after the research is completed your contact details and any personal information will be deleted.

Your responses including your experiences of the building works will be used to inform our findings. While we will not name you in our reporting, because we are only speaking to a small number of people from your local area, there is a chance your comments could be identifiable to someone familiar with the project. We will deal with this sensitively in any report writing to minimise the risk of you being identified.

When we write our findings, we might use quotes. We will ask for your consent to use quotes from your interview in our reporting. We will say that the quotes come from someone whose property has been renovated by your landlord but will not use your real name, for example we might include a quote and say something like 'this quote comes from someone in [location], aged 60 who had a heat pump installed.'

Ipsos may share a transcript of the interview with the BEIS project team for quality assurance purposes. Transcripts are a word-for-word written copy of the interview made from the audio recording. Any details that could identify you or people in your household such as names or your address will be removed before it is shared with BEIS. Transcripts will be stored securely, with access only given to BEIS analysts working on this project. Ipsos and selected parties will handle data in accordance with data protection legislation.

You have a right to change your mind if you no longer wish to take part. If you decide that you do not want us to use what you have shared, please contact us at mia.fennimoreholdsworth@ipsos.com within the two weeks following your interview with the Ipsos researcher.

Where can I get more information?

You can find more information about the personal data we will collect, how we will use it, who we share it with and what your legal rights are in the privacy notice for the project. If you would like to speak to someone about taking part in the research, please contact **Rebecca Paton** either by telephone (07831702513) or by email rebecca.paton@ipsos.com.

Privacy Policy

This Privacy Policy explains who we are, the personal data we collect, how we use it, who we share it with, and what your legal rights are.

About Ipsos and the Project Team

- Ipsos (Market Research) Limited is a specialist research agency, commonly known as "Ipsos UK". Ipsos UK is part of the Ipsos worldwide group of companies, and a member of the Market Research Society. As such we abide by the Market Research Society Code of Conduct and associated regulations and guidelines.
- Ipsos, in partnership with Energy Saving Trust (EST) and Technopolis, has been commissioned by the UK Government Department for Energy Security and Net Zero (DESNZ), formerly known as the Department for Business, Energy and Industrial Strategy (BEIS), to conduct a joint evaluation of its Whole House Retrofit (WHR) and Social Housing Decarbonisation Fund Demonstrator (SHDF(D)) programmes, pilot schemes for funding social housing energy efficiency renovations.

What is this research about?

- The aim of the evaluation is to provide in-depth analysis of the social housing renovations supported by WHR/ SHDF(D). The findings will be used by DESNZ to support the design and implementation of the programmes in the future.
- As part of the evaluation, we are carrying out an AppLife video diary task with tenants who have had energy efficiency measures installed in their home as part of the SHDF(D) or WHR schemes.

What personal data has Ipsos received for this study?

- Ipsos has your personal data because we have been asked by DESNZ to carry out a research study on their behalf. DESNZ has shared this with us under an agreement (called a 'memorandum of understanding') and a data sharing agreement signed by your local authority to support evaluation activities.
- DESNZ has shared a limited amount of your personal data so that we can invite you to take part in this research study. The personal data that DESNZ has shared with Ipsos for this study is your name, email and/or phone number.

What is Ipsos' legal basis for processing your personal data?

- Ipsos requires a legal basis to process your personal data. Ipsos' legal basis for processing is your **consent** to take part in this research study.
- If you wish to withdraw your consent at any time, please contact us at the below Ipsos address at the end of this document. Further information on your rights can be found in the section below covering 'Your Rights'.
- If you wish to stop receiving communications about this research, please contact **Mia Fennimore Holdsworth at mia.fennimoreholdsworth@ipsos.com**.

How will Ipsos use any personal data including your research responses?

- Responding to this study is entirely voluntary and any answers are given with your consent.
- Ipsos UK will keep your personal data in strict confidence in accordance with this privacy notice.
- Ipsos will use your personal data and responses solely for research purposes.
- We will share your responses including any photos or videos you share with the Department for Energy and Net Zero, and within the Research Team. The Research Team is comprised of researchers from Ipsos, Energy Saving Trust (EST) and Technopolis.
- Videos and photos you share during the diary will be shared in confidence within their organisations and with social housing stakeholders that DESNZ has a close-working relationship with.

196

Privacy Policy

- We will remove personally identifiable information (excluding your voice and face) when reporting our findings and sharing any photos and videos. However, you may still be identifiable to someone familiar with the project. This is because we are only speaking to a small number of people as part of this study. We will deal with this sensitively in any editing to minimise the risk of you being identified.
- Please note the only time we would disclose any information that identifies you would be if you were to share something that suggests you or someone else is at risk of serious harm. In this case, we may need to tell someone but would discuss with you first.
- If you give us your consent, we will share your recorded material(s) publicly, including video footage or photos that include your voice and face. For example, we may use screenshots or pictures of you within our published research report or pass on recorded materials for government information and marketing purposes. In this case, your name, address, and any other personally identifiable information (excluding your voice and face) will not be shared.
- If you give us your permission, we will link the answers you have given in the interview to other data collected as part of the project about your home, including physical details about your property (property type, age of property, floor area), the works carried out and any changes to your home's energy performance. This will help us to understand the full picture of the works and we will ask for your consent to do this.

How will Ipsos ensure my personal information is secure?

- Ipsos takes its information security responsibilities seriously and applies various precautions to ensure your information is protected from loss, theft, or misuse. Security precautions include appropriate physical security of offices and controlled and limited access to computer systems.
- Ipsos has regular internal and external audits of its information security controls and working practices and is accredited to the International Standard for Information Security, ISO 27001.

How long will Ipsos retain my personal data and identifiable responses?

- Ipsos will only retain audio recordings of telephone interviews and your personal data including email address and telephone number for up to 3 months after the research project ends. The research project is due to end in August 2023.
- We share your personal details with our third-party recruiter Paton Williamson Consultancy to invite you to take part in this evaluation research. Ipsos and Paton Williamson Consultancy will securely delete your personal details from our systems once the study and any quality control checks are complete. This is usually carried out within three months of research project close.
- Videos and photos will be retained by Ipsos and the Department for Energy Security and Net Zero indefinitely.
- If you consent to video footage or photos of you being shared publicly, we will not be able to retrieve this data once published.
- Your phone number and email address will be collected for the purpose of inviting you to take part in an interview via telephone or Microsoft Teams. Your email address will be stored on Microsoft Outlook by the researcher who will interview you and then it will be deleted within 14 days of taking part in the interview. After deletion your email address will be permanently removed from Office 365 servers within 31 days (please note this is separate to any personal data that might be collected within the interview itself – see 'where will my personal data be held and processed' section below).
- for this study will be stored by Ipsos in data centres and servers within the United Kingdom.

Your rights

- You have the right to access your personal data within the limited period that Ipsos holds it.
- If you want to contact DESNZ or Ipsos about the data they hold about you, please see their contact details below.

2

A8.3 Information sheets

All about our research and what taking part would involve

We invite you to take part in this research because we understand that you have recently had energy-related works to your home organised by your landlord. This may have involved building surveys, home visits, and installing insulation, new windows, boilers or solar panels.

Who are we?
Ipsos UK is an independent research company commissioned by the UK Government Department for Business, Energy and Industrial Strategy (BEIS) to assess the grants which funded these works. This scheme is known as the Social Housing Decarbonisation Fund Demonstrator. You can find out more about this scheme here.

Ipsos is one of the largest research companies in the UK. We conduct social research on behalf of the government, charities, the voluntary sector and commercial organisations. Ipsos is bound by the rules of the Market Research Society Code of Conduct, which is the governing body for market research organisations.

Why are we doing this research?
We want to speak to you to find out about your experience of the renovation works. We would like to understand your views on the different measures installed and how, if at all, they have made a difference to your home. The research will help the Government understand how to support energy efficiency installation schemes in the future.

Why have we contacted you?
We are contacting you because you live in a property that has had energy efficient measures installed by your landlord as part of the programme. BEIS has securely shared your details with Ipsos as you agreed to be contacted about taking part in research. We are now inviting you to take part in a research interview about your experience.

Do I have to take part?
No, participation is voluntary. Even if you agree to take part now you can change your mind at any time, and you do not have to give a reason. You can also choose to not answer individual questions during the interview.

What will taking part involve?
If you agree to take part, we will arrange a **telephone or online video interview** at a convenient time for you. A researcher from Ipsos will call you and the interview will last **up to 60 minutes**. The interview will be a one-to-one discussion between you and the Ipsos researcher and will focus on your experience of having energy measures installed in your home.

As a thank you for taking part you will receive £50 once the interview is complete. This will be paid to you via BACS transfer or as a Love2Shop voucher.

Ipsos and BEIS may wish to carry out further research on this topic over the next few months. There would be an additional payment for taking part in this further research. We can provide further information and will ask for your consent to re-contact you during the interview.

20-076732-01 Participant Information Sheet: Project leads

Department for
Business, Energy
& Industrial Strategy

Will you record what I say?

It is up to you. We would like to audio record the interview if you are happy for us to. This is so we don't forget what you said when writing the report a few months later.

Audio recordings will only be used for research purposes and will be stored securely and deleted 12 months after the completion of the research project in August 2023.

Is this research confidential?

Yes, the information you give Ipsos will be treated as strictly confidential. Ipsos adhere to the Market Research Society Code of Conduct and UK GDPR. We treat all personal information as confidential and keep it secure. The information you provide during your interview will be used for the purpose of report writing only. No-one other than the research team and selected parties, such as transcribers, will have access to your data. Your name and details will not be passed on to anyone without your permission.

What will happen to the information I provide?

The information you provide during the interview will be stored securely and used for the purpose of report writing only. Three months after the research is completed your contact details and any personal information will be deleted.

Your responses including your experiences of the building works will be used to inform our findings. While we will not name you in our reporting, because we are only speaking to a small number of people from your local area, there is a chance your comments could be identifiable to someone familiar with the project. We will deal with this sensitively in any report writing to minimise the risk of you being identified.

When we write our findings, we might use quotes. We will ask for your consent to use quotes from your interview in our reporting. We will say that the quotes come from someone whose property has been renovated by your landlord but will not use your real name, for example we might include a quote and say something like 'this quote comes from someone in [location], aged 60 who had a heat pump installed.'

Ipsos may share a transcript of the interview with the BEIS project team for quality assurance purposes. Transcripts are a word-for-word written copy of the interview made from the audio recording. Any details that could identify you or people in your household such as names or your address will be removed before it is shared with BEIS. Transcripts will be stored securely, with access only given to BEIS analysts working on this project. Ipsos and selected parties will handle data in accordance with data protection legislation.

You have a right to change your mind if you no longer wish to take part. If you decide that you do not want us to use what you have shared, please contact us at mia.fennimoreholdsworth@ipsos.com within the two weeks following your interview with the Ipsos researcher.

Where can I get more information?

You can find more information about the personal data we will collect, how we will use it, who we share it with and what your legal rights are in the privacy notice for the project. If you would like to speak to someone about taking part in the research, please contact **Rebecca Paton** either by telephone (07831702513) or by email rebecca.paton@ipsos.com.

20-076732-01 Participant Information Sheet: Project leads

AppLife Video Diary Information Leaflet

We invite you to take part in this research because we understand that you have recently had energy-related works to your home organised by your landlord. This may have involved building surveys, installing insulation, new windows, boilers, or solar panels.

Who are we?

Ipsos UK is an independent research company commissioned by the UK Government Department for Energy Security and Net Zero (DESNZ), formerly known as the Department for Business, Energy and Industrial Strategy (BEIS), to assess the grants which funded these works. This scheme is known as the Social Housing Decarbonisation Fund Demonstrator or Whole House Retrofit scheme.

Ipsos is one of the largest research companies in the UK. We conduct social research on behalf of the government, charities, the voluntary sector, and commercial organisations. Ipsos is bound by the rules of the Market Research Society Code of Conduct, which is the governing body for market research organisations.

Why are we doing this research?

We want to find out about your experience of the renovation works. We would like to understand your views on the different measures installed and how, if at all, they have made a difference to your home. The research will help the Government understand how to support energy efficiency installation schemes in the future.

Why have we contacted you?

We are contacting you because you live in a property that has had energy efficient measures installed by your landlord as part of the programme. DESNZ has securely shared your details with Ipsos as you agreed to be contacted about taking part in research. We are now inviting you to take part in a research AppLife video diary about your experience.

Do I have to take part?

No, participation is voluntary. Even if you agree to take part now you can change your mind at any time, and you do not have to give a reason. You can also choose to not answer individual questions during the AppLife video diary, however not answering two or more questions could impact your entitlement to the incentive.

What will taking part involve?

Prior to taking part the research, you will have **an initial telephone call** with an Ipsos UK researcher (via telephone or Teams). The telephone call would last between 20-30 minutes and would be conducted at a time convenient for you. During the initial call, the researcher would ask about the measures you have had installed and introduce you to the video diary app.

The **online diary research will be run for two weeks during March 2023**. The research involves downloading an app to your smart phone or tablet, then completing **three to four short ten-minute tasks per week**. The tasks would ask about the measures you have had installed in your home and if they have made a difference to you and your home. You will be asked to provide feedback as photos or videos.

21-004694-01: Tenant Qual – AppLife Information Sheet

After taking part in the online diary research, you would have **a follow-up telephone call** with an Ipsos UK researcher (via telephone or Teams). The telephone call would last between 20-30 minutes and would be conducted at a time convenient for you. During the call a researcher would ask you to reflect on your experience of taking part in the video diary and may ask some follow-up questions about the tasks you completed.

As a thank you for taking part you will receive £125 once the video diary and final interview are complete. This will be paid to you via BACS transfer or as a Love2Shop voucher, and we will get your details for this in the final call. We would like you to complete all the tasks but missing two or more of the tasks could impact your entitlement to the incentive.

Is this research confidential?

Ipsos adhere to the Market Research Society Code of Conduct and UK GDPR. We treat all personal information as confidential and keep it secure. Ipsos will use the recorded materials (videos and photos) you share in our evaluation reports for the Social Housing Decarbonisation Fund Demonstrator and Whole House Retrofit schemes. The Department for Energy Security and Net Zero (DESNZ) will use materials internally and share in confidence with social housing stakeholders it has a close working relationship with. We will remove personally identifiable information (excluding your voice and face) when reporting our findings and sharing any photos and videos. However, you may still be identifiable to someone familiar with the project, because we are only speaking to a small number of people as part of this study.

If you consent for us to do so, we would also like to share your recorded materials publicly, including video footage or photos that include your voice and face. This is your choice and you do not have to agree to this to take part in the research. If you do agree, your name, address, and any other personally identifiable information (excluding your face and voice) will be removed/changed before they are published. We will ask for your permission to do this at the beginning of the research and will confirm this with you again at the end of the video diary. Examples of how DESNZ might use your recorded materials include being published on government websites to inform people about experiences of taking part in the Social Housing Decarbonisation Fund Demonstrator scheme and living with and using energy efficiency installations.

If you give us your permission, we will link the answers you have given in the AppLife video diary to other data collected as part of the project about your home, including physical details about your property (property type, age of property, floor area), the works carried out and any changes to your home's energy performance. This will help us to understand the full picture of the works and we will ask for your consent to do this during the AppLife video diary.

You also have a right to change your mind if you no longer wish to take part. If you decide that you do not want us to use what you have shared, please contact Mia Fennimore Holdsworth at **mia.fennimoreholdsworth@ipsos.com** within the two weeks following your AppLife video diary with the Ipsos researcher.

What happens next?

Your feedback will be used in two ways. It will form part of written reports for DESNZ. We may also use your recorded materials in a video, either as video clips, or as edited videos, which DESNZ will use internally and share with social housing stakeholders.

21-004694-01: Tenant Qual – AppLife Information Sheet

Where can I get more information?

You can find more information about the personal data we will collect, how we will use it, who we share it with and what your legal rights are in the **privacy notice** for the project.

If you have any queries about the research or difficulties with the app, please contact **Mia Fennimore Holdsworth** at mia.fennimoreholdsworth@ipsos.com.

How do I get started with the video diary?

To download **the app** from your smartphone search for **"Ipsos AppLife"** in the search function in the App Store (iPhone) or Play Store (Android) and download directly from there. The app is free to download. It will ask for your username and password to login. **You will be sent your login details via email.**
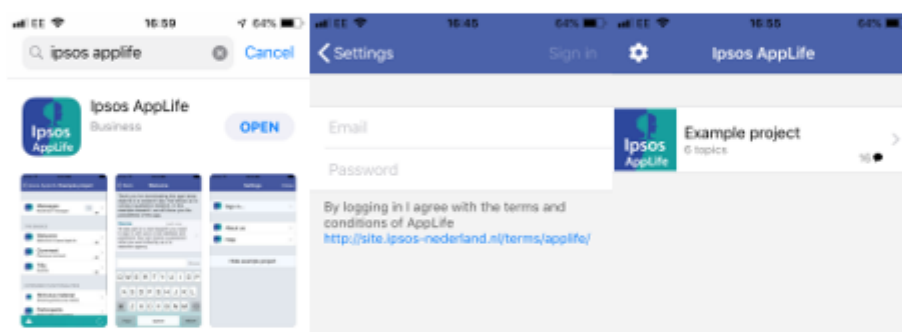
1. Search for "Ipsos AppLife" in the search function in the App Store (iPhone) or Play Store (Android) to download the app

2. Login using the details emailed to you

3. Click on a question to respond

Using the app to answer questions is simple and easy. The app will send you **regular reminders asking you to complete the task,** so please make sure that you have your notifications on. The tasks will be shown on the homepage. **Simply tap on a topic to share your experiences** and upload a video/image. You will need to be connected to the internet to upload your videos/images.

Different tasks will be uploaded every few days over the two-week period. You will be able to add your response to the tasks at any time, but we would be grateful if you could complete them as quickly as possible. Completing the tasks will **take no longer than 10 minutes per task**.

When recording videos, please make sure that you are **recording yourself speaking to the camera and/or showing us around your home.** The best way to do this will be in a **quiet place with no background noise,** and where you are **not directly in front of a light**

21-004694-01: Tenant Quali – Service Information Sheet

source, so that we can see you! Please remember that these videos will be shared with DESNZ so keep this audience in mind when deciding what to share.

Please remember not to take any pictures or videos of other people such as friends, family, children, or anyone other than you, as we do not have their consent to take part.

If you have any queries about the research or difficulties with the app, please contact **Mia Fennimore Holdsworth** at mia.fennimoreholdsworth@ipsos.com.

Where can I get advice and support?

We understand that the research might make you think about things in a new way, and you might want to talk to someone about it afterwards or look for further information. We have provided some links below from a range of different organisations that could be useful.

Support around rising energy bills:
Household Support Fund
If you are struggling to pay for essentials such energy, you can apply for support to cover these costs with this fund. Call your local council or go on their website for details. Find your local council information here: https://www.gov.uk/find-local-council

British Gas Energy Trust - www.britishgas.co.uk/energy/british-gas-energy-trust.html
British Gas Energy Trust are an independent charitable trust set up to support families and individuals facing financial hardship and fuel poverty.

National Energy Action - https://www.nea.org.uk/get-help/wash-advice/wash-referral/
A national fuel poverty and energy efficiency charity that offers a free support service known as WASH (Warm and Safe Homes).
Phone: 0800 304 7159

Financial advice:
The Money Advice Service - www.moneyadviceservice.org.uk/en/corporate/contact-us
Free & impartial money advice (on all aspects, not just debt, including mortgages, pensions, insurance, general budgeting), including online tools & calculators.
Freephone: 0800 138 777
Typetalk: text 18001 then 0800 915 4622

Turn2us - www.turn2us.org.uk
A national charity that helps people in financial hardship to gain access to welfare benefits, charitable grants and support services.
Freephone: 0808 802 200

Mental Health and Wellbeing:
Samaritans - www.samaritans.org
A charity that provides emotional support for anyone who is struggling or in distress.
Freephone: 116 123
Email: jo@samaritans.org (response time 24 hours)

Mind - www.mind.org.uk
A mental health charity offering information and advice to people with mental health problems.
Phone: 020 8519 2122

21-004694-01: Tenant Quall – Apply Information Sheet

A8.4 Screeners

Screener

Hello my name is [RECRUITER NAME],

Can I check that I'm speaking with [NAME] at [ADDRESS]?

Ipsos is carrying out research to understand social housing tenants' experiences of energy-related works funded by government. You should have received a letter telling you about this.

We are inviting you to take part in this research as we understand that you have had building work in our home organised by your landlord, funded by a pilot government scheme. This is known as the Social Housing Decarbonisation Fund Demonstrator. It may have included building surveys, and installing heat-saving measures, like insulation, windows, heat pumps or solar panels.

By taking part in the research, your answers will help the Government understand how the programme has worked and help to inform future energy efficiency schemes, as well as hear your opinion on the works that have taken place in your home.

The research itself will involve a one-to-one interview (either via Microsoft Teams or over the telephone) and will last up to 1 hour at a time convenient for you. You will receive £50 for your time once the interview is completed.

First, we would like to check you are eligible to take part. This will take less than 5 minutes. The answers that you give today will be kept securely by Ipsos UK. anything you say during the research exercise itself or during this interview will remain confidential.

During this call I will need to ask specific questions about you. We use this to ensure that we understand the different circumstances of people we include in the research. This information will only be collected with your consent.

You have the right to withdraw your consent or object to our processing of your information at any time. The research activity and this interview will be conducted in accordance with the Market Research Society Code of Conduct, and the information you provide will be treated in accordance with data protection law.

Q1.	Are you happy to continue on this basis? SINGLE CODE ONLY			
	Yes	1		CONTINUE
	No	2		THANK AND CLOSE

Screening questions

Q2a.	Can I confirm you were offered energy-related installations in your home by your landlord? These might have included insulation, windows, heat pumps or solar panels. RECRUITER NOTE: We are looking to speak to people who were offered measures for their home, but did not have them installed, in January/February 2023. SINGLE CODE ONLY		
	Yes	1	CONTINUE TO Q2C
	No	2	CONTINUE TO Q2B

Q2b.	Ipsos may be speaking to people who live in areas where works were carried out but who were not offered these, next year. Would you be happy for Ipsos to contact you again by email or telephone to invite you to take part in a research interview next year on this topic? This would be in January or February. You do not need to say now whether you would take part in this, just whether you would be happy for Ipsos to contact you about it. Are you happy to agree to be re-contacted by Ipsos on this basis? SINGLE CODE ONLY		
	Yes	1	THANK AND CLOSE
	No	2	THANK AND CLOSE

Q2c.	Did you agree to have works installed in your home? SINGLE CODE ONLY		
	Yes	1	CONTINUE TO Q2C
	No	2	CONTINUE TO Q3

Q2d.	Have these works been completed? SINGLE CODE ONLY		
	Yes	1	CONTINUE TO Q4
	No	2	CONTINUE TO Q4

Q3.	Ipsos would like to speak to people were offered works but did not have them installed next year. Would you be happy for Ipsos to contact you again by email or telephone to invite you to take part in a research interview next year? This would be in January or February. The interview would ask for your views on the energy measures and any reasons why you did not have them installed. You do not need to say now whether you would take part in this, just whether you would be happy for Ipsos to contact you about it. Are you happy to agree to be re-contacted by Ipsos on this basis? SINGLE CODE ONLY		
	Yes	1	THANK AND CONFIRM PERMISSION TO RECONTACT AND CLOSE
	No	2	RECORD FOR INFORMATION AND CLOSE

Q4.	Were you involved in conversations with the local council to organise the installation of the energy efficiency measures in your home? SINGLE CODE ONLY		
	Yes	1	CONTINUE
	No, this was someone else	2	ASK FOR A REFERRAL TO PERSON WHO DID

Q5.	How old were you on your last birthday? SINGLE CODE ONLY		
	Under 18	1	THANK AND CLOSE
	18-24	2	RECORD FOR INFORMATION
	25-34	3	
	35-44	4	
	45-54	5	
	55-65	6	
	Over 65	7	

Q6.	Which of the following describes how you think of yourself? SINGLE CODE		
	Male	1	RECORD FOR INFORMATION
	Female	2	
	In another way	3	
	Prefer not to say	4	

Q7.	Which of the following devices do you currently own and would be able to use for the interview? MULTI CODE		
	Laptop	1	CONTINUE
	Desktop PC	2	
	Telephone	3	
	Tablet	4	RECORD FOR INFORMATION
	Smartphone	5	
	None of the above	6	THANK AND CLOSE

Q8.	Ipsos may contact you again by email or telephone after the research interview has taken place to invite you to take part in follow-up research on this topic. You do not need to say now whether you would take part in this, just whether you would be happy for Ipsos to contact you about it. Are you happy to agree to be re-contacted by Ipsos on this basis? SINGLE CODE ONLY		
	Yes	1	CONTINUE
	No	2	RECORD FOR INFORMATION

Q9.	CHECK ACCESSIBILITY REQUIREMENTS: We would like to make sure that your participation is as comfortable as possible. Please can I check, do you have any accessibility requirements for example, would you like the information in large print on any written communication?
	WRITE IN:

Q10.	As thank you for taking part we will arrange for £50.00 to be sent to you via bank transfer after your telephone interview is complete. This can be provided via BACs transfer or Love2Shop voucher. Which would you prefer? If BACs transfer could I please record your sort code and account number for this purpose?
	SORT CODE: ACCOUNT NO.:

Interview booking form

Date of recruitment:

Time of recruitment:

	Please record the following:	
	Name	
	Email address for interview	
	Phone number	
Additional notes		

A8.5 Topic guides

SHDF(D) / WHR: Discussion Guide for participating social housing tenants

Draft– Tranche 1 qualitative interviews

Instructions for interviewers

Set up: Recruitment will be carried out based on sample supplied by BEIS. Please ensure the availability you provide to carry out interviews is up to date.

Preparation: Please ensure you are fully prepared for the interview by reading:

- The executive summary of the process evaluation report.

- The interim report provided by the relevant project prioritising the tenant related sections.

- Check landlord in portfolio analysis

- The 'mini plan' for the qualitative work with tenants

- (If a case study location) the relevant case study.

Focus of the interview: The aim of these interviews is to understand and explore the tenant experience of whole house retrofits funded by two BEIS pilot schemes: the Social Housing Decarbonisation Fund Demonstrator (SHDF(D)) and Whole House Retrofit Competition (WHR). One discussion guide has been designed for social housing tenants participating in projects funded by either SHDF(D) or WHR.

Project terminology: please note that many tenants may not identify or be aware of the SHDF(D) and WHR funding the projects, or behind their experiences of retrofit activities. Please use project specific names (as detailed in the process evaluation report) where possible and also reflect participant language. For example, they may refer to the project name, they may refer to 'the works at [address/ estate/ neighbourhood] or they may refer to the organisation with which they have had contact: in some instance this may be the local authority, in others it may be a contractor or a private registered provider (i.e., housing association landlord). This is referred to as [PROJECT REFERENCE] throughout the guide.

Whole house retrofit activities terminology: participants may describe the works/ whole house retrofit activities completed on their property in different ways. Whilst this is referred to as 'works/installation' throughout the discussion guide, please reflect the language that participants use.

Project stages: there are several stages of the retrofitting works/installations, for example pre-installation surveying, remedial works before the installation could begin, the installation itself, and any follow-up/post-installation works. Please note the experiences of each stage mentioned by participants.

Sensitive or emotive subjects: tenant experiences are likely to be wide-ranging. While you should aim to cover as many relevant parts of the discussion guide as possible, be prepared to allow time to accommodate any emotive topics that may come up, for instance:

   a. Mental and physical health problems or loneliness exacerbated by living in a cold home
   b. Frustration/guilt about not being able to afford to heat their home
   c. Disruptive/upsetting experiences with tradesmen coming into the home
   d. Periods of not feeling safe in the home, due to scaffolding/other works creating security issues
   e. Persistent issues with the property after works are finished.

A leaflet which signposts participants to support resources will be shared following the interview.

Length of the interview: the interview will last up to 1 hour.

Recording of interviews: All interviews are to be recorded (using OBS software) where consent has been agreed. Ensure that you ask for consent and get agreement on the recording (see below).

Recontact: We would like to get back in touch with participants to invite them to take part in a AppLife diary task in a few months, and to invite them to take part in a survey. Please ensure you ask about this and gather a 'yes' or 'no' to recontact at the end of the discussion.

Evaluation questions explored

Interviews amongst participating social housing tenants will explore the following evaluation questions:

1. Evaluate tenants' experiences of the retrofitting process.
   a. Here we will specifically explore tenant experiences of how local authorities have delivered the projects.

2. Report the tenants' perspective on project outcomes, regarding comfort, bills, wellbeing, aesthetics, install quality, and overall environment post-retrofit.
   a. Here we will specifically explore tenant satisfaction with the retrofits (individual and environmental).

3. Understand their energy behaviours pre- and post-retrofit, in particular those that undermine or validate energy or bill savings modelled in SAP.
   a. Here we will specifically explore tenant behaviour and how, if at all, this has changed post-retrofit.
   b. Support theory-based cost-effectiveness analysis and comparative analysis of outcomes under different projects. Here we will specifically explore whether tenants have seen any change in their energy bills since the retrofit.

Discussion guide

Section 1: Introduction and consents   (5 mins)

The aim of this section is to introduce the interview to participants and gather consents.

- Introduce self and Ipsos.

- Explain purpose of interview: Ipsos are carrying out a study to assess government-funded energy-related renovations in social housing. We would like to understand your experience of the works in your home and how, if at all, the installs have made a difference in your day-to-day life. This research will shape how the government can support people taking part in similar programmes in the future.

- This research is separate to any other research activities (e.g., interviews or questionnaires) that you may have been asked to complete on behalf of your landlord.

- Thank you for agreeing to take part in this interview. This interview should last up to one hour and you will receive £50 to thank you for taking part. This will be paid via BACS bank transfer or as a Love2Shop voucher.

It is essential that the interviewer asks for consent to record the interview and covers the bullets below.

- *Interviewer: explain that in line with data protection we'd like to record their consent to take part in the interview and to confirm that they have received the project materials. Please record consent. If participant does not consent for the interview to be audio recorded please turn off audio recorder once consent is captured.*

- You understand that Ipsos' legal basis for processing your data is your consent to take part in this research. Your participation in this interview is voluntary and you can change your mind at any time and do not have to provide a reason for doing so.

- Your feedback will only be used for evaluation purposes.

- All our research adheres to the Market Research Society Code of Conduct and the UK General Data Protection Regulation/Data Protection Act. Ipsos will store your personal data securely and any personal information will be securely deleted 12 months after the completion of the evaluation. There is more information about how we use your data in our privacy policy which will have been sent to you along with your invitation. Please let us know if you need another copy.

- Your feedback, including your experiences of the building works, will be used to inform our findings which we will write up in a report. This report will be made public and published on gov.uk. While we will not name you in our reporting, because we are only speaking to a small number of people from your local area, there is a chance your comments could be identifiable to someone familiar with the project. We will deal with this sensitively in any report writing to minimise the risk of you being identified.

- When we write our findings, we might use quotes. We will ask for your consent to use quotes from your interview in our reporting. We will say that the quotes come from someone whose property has been renovated by your landlord but will not use your real name, for example we might include a quote and say something like 'this quote comes from someone in [location], aged 60 who had a heat pump installed.' We will ask if you're happy for us to use quotes from this interview again at the end.

- We would like to record the discussion for analysis purposes and to help us accurately collect findings for the research. The recordings will not be shared outside of the Ipsos, Energy Saving Trust and Technopolis Evaluation Team, will be securely stored and retained by us and destroyed after the completion of the evaluation.

- **Are you happy to proceed with the interview?**

Section 2: Participant introduction   (5 mins)

The aim of this section is to warm the participant up to the interview format and start to build rapport. This section provides opportunity to learn more about the participants' housing situation and will provide useful contextual information about participants which may support analysis e.g., installation experiences for those living alone vs. families.

Interviewer: the questions in this section are mainly descriptive, but only have a short time allocated to them so they should be covered quickly with the participant.

It would be great to start by getting to know about you and your home a little more…

1. To start us off could you please introduce yourself and, if you're happy to tell me, would you mind telling me how old you are?

2. What type of property do you live in? Probe on:
   a. Flat, house, detached, semi, terraced etc.
   b. Number of bedrooms
   c. Rented from Council/Housing Association

3. And how long have you lived in this home?

4. And who, if anyone, do you live with; what are their ages?

5. What kind of heating and hot water system does your home have? *Prompt if needed*:
   a. Gas or oil central heating
   b. Electric storage heating
   c. Heat pump
   d. Solar thermal
   e. Heat network or communal heating (*If needed – this is usually where there is one large boiler that heats all the homes in a block)*
   f. Other (e.g., portable heaters, solid fuel, etc.)

6. How do you pay for the energy you use in your home (electricity, hot water and heating)? *Prompt on:*
   a. Direct debit
   b. Pre-payment meter
   c. It's included in your overall rent

7. And thinking back to before you had the measures installed, how energy efficient would you say your home was then? Why?
   Interviewer - if participant queries definition of 'energy efficient' say 'how easy it was to keep your home warm in winter'.

8. And please can you think back to before you had the measures installed. Were there any specific issues around heating or the temperature of the property? *Prompt*:
   a. Damp
   b. Mould or mildew

   c. Draughts or cold spots
   d. Rot in windows, frames or floors
   e. Condensation/ steamed up windows
   f. Problems heating the property to a comfortable temperature (too hot or cold)
   g. Too expensive to heat to a comfortable temperature.

Interviewer: please make note of these to explore later when discussing benefits of the works (where we can see if the participant feels that these have been resolved).

Section 3: Installation experience and satisfaction   (10 mins)

This section will explore the following evaluation questions: how do local authorities engage tenants; how do local authorities deliver the projects; and are occupants satisfied with the retrofits.

I'd like to start by thinking about when you first heard about the [PROJECT REFERENCE]

  9. How did you first become aware of the [PROJECT REFERENCE] and having energy efficient measures installed in your home?
    a. What did you think about the [PROJECT REFERENCE] when you first heard about it?
    b. What information did you receive/ who did you speak to about it?

  10. How did you reach your decision to go ahead and get the measures installed? What was your decision-making process?

  11. Why did you decide to have the measures installed?
    a. What sounded appealing? What did you think the benefits would be for you and your home?
    b. What concerns did you have? How did you overcome these? Was anything done to address any concerns you had?
    How did you feel about it being a whole house approach?
    IF NEEDED: A whole house approach looks at all the different ways that a house works, including heating, insulation and ventilation, and how these factors affect each other. This approach aims to achieve better results in terms of energy savings, comfort and quality than treating each factor separately.

  12. And please can you tell me a little about what measures you had installed?
    a. Were there any remedial works required (works that needed to be done to the property before the installations could begin)? E.g. de-infestation.
    b. Were there any follow-up works required? E.g. repainting.
    c. *Interviewer: please make note of the measures installed and refer to these throughout the discussion when talking about 'measures'.*

  13. What were your experiences during the works/ installation?
    Interviewer please note: participants may mention different stages of the works: surveying, installation process, follow-up/post-installation
    a. What worked well?
    b. What could have been improved?

14. And how was the communication you had with the Local Authority throughout your involvement with the [PROJECT REFERENCE]?
    a. Who did you typically speak to?
    b. What worked well/ less well?
    c. How satisfied were you with the communication you had with them? *PROBE ON: frequency and quality of communication*

15. And overall, how satisfied are you with the works? Why?
    a. What are your views on the works now that they are complete/ near complete?
    b. Are there any specific measures that you are particularly satisfied with?
    c. To what extent are the measures working as you expected?
    d. Did you experience any problems or issues with any of the measures? If yes: what? How was this resolved?
    e. What have been your thoughts on the installations taking a whole house approach? How satisfied have you been with this?

16. And overall, how did you feel about the level of involvement you had in the works being carried out? *PROBE ON EXPERIENCES OF:*
    a. Government official visits *Interviewer: Please emphasise these are not the same as home visits that were part of the installation/ WHR process.*
    b. Building surveys
    c. Sensors in homes

Section 4: Perceived impacts   (20 mins)

This section aims to explore: are occupants satisfied with the retrofits; how has tenant behaviour changed post-retrofit; are tenants paying less on their energy bills post-retrofit.

I'd like to think now about what the benefits or drawbacks of the works have been for you...

17. What do you think the **benefits** of the works have been?
    a. For you/ your family
    b. For your home
    c. For the local area
    d. For the environment and climate
    e. *Prompts: feelings of pride, being able to host people in comfort, feeling less isolated, finding it easier to sleep.*

18. And what do you think the **drawbacks** of the works have been?
    a. For you/ your family
    b. For your home
    c. For the local area
    d. For the environment and climate

Interviewer: please allow participant to spontaneously raise benefits and drawbacks. If not already discussed, please then prompt on the following areas:

19. Thinking back to the issues you mentioned earlier, [*Interviewer: refer to responses to question 7*] have these been resolved?

20. Have you seen any changes to your bills based on the works in your home?
    a. What changes? *Interviewer: if possible please ask participant to describe any change e.g. how much, if at all, their bills has changed or in what way it compares to bills prior to the installation.*
    b. Are these what you expected?
    c. Why do you think these have changed? Probe: energy costs, less need to use energy, using energy differently.

21. Have you seen any differences in how you use energy in your home since the energy efficiency measures were installed? IF YES: how? *Prompt and probe for reasons for energy change:*
    a. Heating/ lights/ appliances
    b. Using energy differently in particular rooms in your home.
    c. Using energy differently when it is particularly hot or particularly cold.
    d. Using energy differently at particular times of the day/ times of the year
    e. Due to changes in energy costs/ the current cost of living
    f. How do you feel about the energy efficiency of your home now compared to before the works were carried out?

22. Have you seen any differences in how you use your home since the works were completed? For example, do you use rooms differently?
    a. IF YES: How?

23. What impact, if any, has the installation had on how comfortable you feel in your home? Why?
    b. How does the temperature of your home feel compared to before you had the works carried out?
    c. We know that some people wear extra clothing during the colder months. Is this something you previously did in your home? And is this something you are doing since the works have been carried out?

24. What impact, if any, has the installation had on your health or the health of people in your household? This could include physical or mental health.

25. And what impact has the installation had on the look of your home?
    a. Likes and dislikes?
    b. Internally and externally?

26. What impact have the installations carried out locally, including in your home, had on the look of your local area? What have neighbours said about it? Overall, how do you think the installations in your local area have affected your community?

27. What impact, if any, has there been on the relationship you have with your landlord/ Housing Association/ Local Council?

Section 5: Knowledge/ understanding and behaviour change   (15 mins)

This section will explore: how has tenant behaviour changed post-retrofit. To support exploration of behaviour change, we have considered the COM-B framework[1] and included prompts around the following factors (each play a role in supporting behaviour):

Capability: whether people have the knowledge and skills to carry out the desired behaviour.

Opportunity: how environmental and social factors influence the desired behaviour.

Motivation: where there are reflective and automatic processes that influence decision making and behaviour.

Interviewer: please note that participants may have had passive measures installed e.g., insulation that do not require operation therefore please adapt below questions to the participant situation.

Capability:

28. What information did you receive about the measures being installed in your home, both before and after the works were carried out?
    a. Did the guidance/information provided help you to understand how to use the measures installed in your home? Was it clear?

29. How, if at all, did you learn how to use the measures? Were you given information or guidance about what to do/ what not to do when using them?

30. How do you feel about using/ operating the new measures installed in your home?
    a. How clear are you on how to use the measures? What, if anything, are you unclear about?
    b. Do you feel confident using the new measures? Why/ why not?
    c. Where would you go if you had any questions about using the new measures?

Opportunity:

31. How easy or difficult is it to use the new measures? Why?

32. Is how you use them different to how you used the measures you had in your home previously? Or do you use them in the same way?

33. What about other people in the house? How do they find using the measures?
    a. Do you agree on how to best use the measures? *Prompt: the temperature to set the thermostat at, whether to use the measures to save energy, or to enjoy a warmer home.*

34. Are there particular times or situations when it is easier to use the measures?

---

[1] Michie et al https://social-change.co.uk/files/02.09.19_COM-B_and_changing_behaviour_.pdf

35. Are there particular times or situations when it is difficult to use the measures?

36. We know that people use and manage heating in their homes differently. I'd like to ask if you did any of the following before or since the works in your home. For each of the below:
    - Did you do this before the works were carried out on your home? Why/ why not?
    - Have you done this since the works have been carried out? Why/ why not?

    a. Dry clothes on radiators.
    b. Keep doors and windows closed during winter when the heating is on.
    c. Use radiator valves, thermostats or smart controls to customise your heating (e.g. by turning heating low or off in different rooms).
    d. [IF HAVE HAD A HEAT PUMP INSTALLED] And thinking about the heat pump installed in your home, do you currently run this uninterrupted at a low temperature? Why/ why not?
    e. [IF HAVE HAD MECHANICAL VENTILATION INSTALLED] And do you use the mechanical ventilation installed? Do you use this instead of opening windows? Why/ why not?

Motivation:

37. What do you think are the benefits, if any, of following guidance/information on how to use the measures?
    a. Are you clear on why it is beneficial to follow the guidance/information on how to use the measures?

38. Are there instances when you might decide not to follow the guidance/information or be unable to follow the guidance/information for any reason?

39. And thinking back to before you were involved in the [PROJECT REFERENCE], has your view on energy use in your home changed at all?
    a. IF YES: how has it changed? Why do you think this is?
    b. Overall, what do you think the benefits are for reducing energy use in your home?

Section 6: Overall/ shared experiences and wrap up   (5 mins)

This section will ask about the SHDF(D) programme as a whole and will ask questions about the potential appetite for future whole house retrofitting activities. This section will also wrap up the discussion and check for permission to re-contact.

We are now coming to the end of our discussion, and I'd like to ask some final questions about your experience of [PROJECT REFERENCE].

40. Have you spoken about your experience of the SHDF(D) programme with anyone e.g., neighbours, family, friends, others?
    a. IF YES: Who? What have you spoken about?
    b. What would you say to someone who was considering being part of a similar project in the future?

41. Would you consider getting more energy efficiency measures installed in your home in the future?

   a. Why/why not?
   b. Would you consider taking part in another programme like this? Why/why not?

42. Is there anything you would like to add about your experience that we have not discussed?

43. As I mentioned earlier, we will write a report at the end of the research which might use quotes. We will say that the quotes come from someone whose property has been renovated by your landlord but will not name anyone or say who has said what. However, there is a chance that someone familiar with the project and renovations might be able to identify you because of things that you tell us about yourself and your experience of the building works and because we are only speaking to a small number of people who have had renovations in your local area. We will deal with this sensitively in any report writing to minimise the risk of you being identified. Would you be happy for us to use your quotes in our reporting?
   a. *Interviewer: please capture a yes or no response.*

44. In the next few months, Ipsos will be carrying out further research on this topic on behalf of BEIS. This research will involve asking people to take part in a diary task over 2 weeks. This will involve taking part in a further short interview and downloading an app to your smart phone or tablet and completing 3 or 4 short 10-minute tasks a week to tell us more about the measures installed in your home. Those who take part would receive £125 as a financial thank you for their time. Would you be happy for Ipsos to recontact you to invite you to take part in this diary? You do not need to say now whether you would take part, just whether you are happy for us to get in touch to invite you.
   a. *Interviewer: please capture a yes or no response.*

45. If possible, we would like to be able to link the answers you have given in this interview to other data collected as part of the project about your home, including physical details about your property (property type, age of property, floor area), the works carried out and any changes to your home's energy performance. This will help us to understand the full picture of the works. Would you be happy for us to do this?
   a. *Interviewer: please capture a yes or no response.*

46. Finally, Ipsos will also be carrying out a survey about peoples' experiences of having measures installed in their home. This will be an online survey and you will receive an invitation to take part in the post. It would be really helpful if you could complete the survey as it will help BEIS understand peoples' experiences of having measures installed. Would you be happy to receive an invitation?
   a. *Interviewer: please capture a yes or no response.*

Check incentive arrangements, thank and close

SHDF(D) / WHR: AppLife topic guide for participating social housing tenants

AppLife topic guide/task list

Instructions

Recruitment: Recruitment for the AppLife diary task will firstly be based on consent collected during the interviews conducted with participating social housing tenants in Tranche 1 and 2 of this research. Prior to taking part in the AppLife diary, one of the research team will give each participant an introductory call. This call will be up to 20 minutes long and will provide some more details on the activities, provide the privacy policy and information sheet as well as explain the consent process.

Purpose: The purpose of the AppLife video diary task will be to check participants' understanding of their new systems, including what they have had installed and how the measures work, as well as testing their response to stimuli to understand their behaviours.

Overview: The AppLife diary will consist of three to four tasks per week, over the course of two weeks (6-8 tasks in total) conducted by 10-15 participants. Each task will take the participant up to 10 minutes to complete and could include responses in video format, as photos or text responses.
Whilst we will ask participants to take videos of themselves, we won't exclude people from taking part who feel uncomfortable with this and in these instances, we will ask them to video their surroundings or similar instead.

Evaluation questions explored

Interviews amongst participating social housing tenants will explore the following evaluation questions:

1. Report the tenants' perspective on project outcomes, regarding comfort, bills, wellbeing, aesthetics, install quality, and overall environment post-retrofit.
   a. Here we will specifically explore tenant satisfaction with the retrofits (individual and environmental).
2. Understand their energy behaviours pre- and post-retrofit, in particular those that undermine or validate energy or bill savings modelled in SAP.
   a. Here we will specifically explore tenant behaviour and how, if at all, this has changed post-retrofit.
   b. Support theory-based cost-effectiveness analysis and comparative analysis of outcomes under different projects. Here we will specifically explore whether tenants have seen any change in their energy bills since the retrofit.

				Key aims
Welcome message	*Welcome and hello!* Thank you for taking part in the AppLife diary. Over the next 2 weeks, you will be asked to complete 3-4 short tasks per week. To complete the diaries please • Make sure your notifications turned on so you receive reminders • Do not include other people who have not agreed to take part • Ensure you take your videos in an area which is well-lit and without any background noise If you have any questions, please contact the support team via the App (from the home screen, click messages), or contacting Mia Fennimore Holdsworth at mia.fennimoreholdsworth@ipsos.com. If you have any further questions about the research, please refer to the Information Sheet provided to you by email. As a thank you for taking part you will receive £125 - this will be paid to you after you complete the follow-up call. Finally, to remind you, you have agreed that the videos and pictures will be seen by researchers at Ipsos UK, the Department for Energy Security and Net Zero, and their stakeholders. **Please refer to the Privacy Policy for more information.** We look forward to hearing all about your views and experiences, and we hope you enjoy taking part!			*The aim of this section is to introduce participants to the research, remind them what they will need to do for the diary, and repeat key details from the privacy policy about how their data will be shared.*

TASKS				
Task no.	Topic	Question header	Follow up prompts/ description	Key aims
1	Introductions	Introduce yourself and your home! *Share your video response here!*	We'd love to get to know you and your home a bit better. Please give us a video tour of your home to tell us… - …a bit about yourself and your household. *Note: please don't show other household members in your video* - …how long have you lived here - …what works have taken place - …what you like and don't like about your home	*The aim of this activity is to have members introduce themselves and get them used to sharing information via the app, as well as for us to see their homes*
2	Living with the energy efficiency measures	Recent changes to your home *Share your video response here!*	Please take a video telling us what it is like living with your new measures. Answer the following questions: - What do you think about the changes to your home? - What was your home like before? - How have the works made a difference to you? - Are there any measures that you're particularly satisfied with? Please show us. - Have you faced any issues with the changes? Please tell us about what these are, and where possible, show us on video. These could include:	*The aim of this activity is to have participants demonstrate the works that were done in their home, what they like about them and whether they have any problems.*

			o Damp, draughts, rot, or anything like this o Problems with using the measures o Problems heating the property to a comfortable temperature (too hot or cold) *Just a reminder that your response will be shared with DESNZ and trusted social housing stakeholders they have a close working relationship with. We will check whether you are happy for your responses to be shared publicly at the end of the diary.*	
3	Scenario 1: Radiators	Imagine your heating isn't working like usual! What would you do? *Share your video response here!*	Imagine that you've woken up on a cold day and found your heating hasn't come on. You have reported this to your landlord, but the engineer can't come out until tomorrow morning. Please take a video telling us what you would do in this situation over the next 24 hours. - Talk us through the steps you would take to stay warm, taking a video of what you would do, or talking us through the steps you would take. - **You don't need to make these changes in real life – just talk us through what you would do and tell us why you would do this.** *Just a reminder that your response will be shared with DESNZ and trusted social housing stakeholders they have a close working relationship with. We will check whether you are happy for your responses to be shared publicly at the end of the diary.*	*The aim of this activity is for us to understand participants' responses to stimuli in the context of their homes and their heating systems*
4	Your heating settings	Tell us about your heating settings *Share your picture/video response here!*	We'd like to know what heating settings and heating schedule you have set up. If you're able to, please show us (with video or images of your settings) 1) what temperature is your thermostat set to and 2) what times your heating is set to come on. - How is your heating set and why? - Is this a comfortable temperature on this setting? - How confident are you changing the settings? - How different is this to how you managed your heat before the works were carried out? *Just a reminder that your response will be shared with DESNZ and trusted social housing stakeholders they have a close working relationship with. We will check whether you are happy for your responses to be shared publicly at the end of the diary.*	*The aim of this activity is for us to check participant's understanding of their heating system, and to see how they have their heating system set up*

| 5 | Scenario 2: Bills | What steps would you take to reduce the cost of energy in your home?

Share your video response here! | We are all aware that the cost of energy has increased dramatically in recent months. *Please note: there is information support and resources relating to the cost-of-living crisis and rising bills available as a permanent post on the app.*

Have you taken any steps to bring the cost of your heating down?
- If so, please talk us through the steps you have taken, what impact these steps have had on your comfort or your bills.
- If not, please first tell us why you haven't taken any steps and then what steps you would take to bring the cost down, including what you would do and the steps you would take.
    o *Please note: you don't need to make these changes in real life – just talk us through what you would do and tell us why you would do this.*
- Are these the same steps you would have taken before the works were completed in your home? Please explain what actions are the same/different?

Just a reminder that your response will be shared with DESNZ and trusted social housing stakeholders. We will check whether you are happy for your responses to be shared publicly at the end of the diary. | *The aim of this activity is for us to understand participants' knowledge of their heating systems* |
| 6 | Final reflection exercise | Final thoughts

Share your video response here! | We've now come to the last task as part of your video diary, thank you so much for taking part! We hope you have enjoyed the past two weeks.

For your final task, please record a video of you telling us about your experience with the SHDF(D) or WHR programme and video diary task.
- Would you consider getting more energy efficiency measures installed in your home in the future? If so, which measures?
- Would you consider taking part in another scheme like this in the future?
- How has your experience been with the video diary app? Do you have any suggestions for how we could improve it in the future?
- Has taking part in this video diary made you think any more about energy efficiency and the environment? | *The aim of this activity is to have participants reflect on their video dairy, and energy efficiency more broadly* |

			Just a reminder that your response will be shared with DESNZ and trusted social housing stakeholders. We will check whether you are happy for your responses to be shared publicly at the end of the diary.	
7	Consent 1	Data sharing	We've come to the end. Congratulations! As we mentioned at the start, we'd like to share extracts from this research publicly, in research outputs and DESNZ communications about social housing decarbonisation projects. **Can DESNZ publish extracts from your uploads in research and communications about the works?** This does not affect your entitlement to receiving your incentive for taking part. If you'd like to review your uploads you can do so by clicking on the tasks. - Yes, I'm happy for DESNZ to share extracts from my uploads publicly - No, I'm not happy for DESNZ to share extracts from my uploads publicly	*To gather informed consent from participants on what we do with their videos and images*
8	Consent 2	Data linking	We would like to understand the full picture of your home in context. You can find out more about this in our Privacy Policy. **Can we link your uploads to other data collected as part of the project about property, such as its age, any works carried out?** This does not affect your entitlement to receiving your incentive for taking part. - Yes, I'm happy for my data to be linked to other data collected as part of the project - No, I'm not happy for my data to be linked to other data collected as part of the project	*To gather informed consent from participants so that we can link this data to other data we have on them and their property*

Thank you	*Thank you and goodbye.*	*The aim of this section is to thank members for taking part in the diary, repeat key details from the privacy policy about how their data will be shared, and remind them of the next step in the study (the online workshop).*
	Thank you very much for your contributions to this diary! We hope you enjoyed the experience. More information on how your findings will be taken forward is available in the Privacy Policy. If you have any questions about this, or anything else to do with the research, please contact **Mia Fennimore Holdsworth** at mia.fennimoreholdsworth@ipsos.com.	
Permanent post	Thank you for taking part in the video diary. We understand that talking about certain things can raise concerns or questions. Below we've provided a list of organisations that may be able to help if you have any questions or would like to talk to someone. These will remain available to you throughout the entirety of the video diary, and you can refer to them at any time.	*The aim of this is to provide participants with access to energy advice and information should they need it at any stage during the diary.*
	If you have any questions or issues with the building works carried out in your home, please contact either your landlord or your Local Authority.	
	Support around rising energy bills:	
	Household Support Fund	
	If you are struggling to pay for essentials such energy, you can apply for support to cover these costs with this fund. Call your local council or go on their website for details.	
	Find your local council information here: https://www.gov.uk/find-local-council	
	British Gas Energy Trust	
	British Gas Energy Trust are an independent charitable trust set up to support families and individuals facing financial hardship and fuel poverty.	
	www.britishgas.co.uk/energy/british-gas-energy-trust.html	
	National Energy Action - https://www.nea.org.uk/get-help/wash-advice/wash-referral/	
	A national fuel poverty and energy efficiency charity that offers a free support service known as WASH (Warm and Safe Homes).	
	Phone: 0800 304 7159	
	Financial advice:	
	The Money Advice Service - www.moneyadviceservice.org.uk/en/corporate/contact-us	
	Free & impartial money advice (on all aspects, not just debt, including mortgages, pensions, insurance, general budgeting), including online tools & calculators.	
	Freephone: 0800 138 777	

	Typetalk: text 18001 then 0800 915 4622	
	Turn2us - www.turn2us.org.uk	
	A national charity that helps people in financial hardship to gain access to welfare benefits, charitable grants and support services.	
	Freephone: 0808 802 200	
	Mental Health and Wellbeing:	
	Samaritans - www.samaritans.org	
	A charity that provides emotional support for anyone who is struggling or in distress.	
	Freephone: 116 123	
	Email: jo@samaritans.org (response time 24 hours)	
	Mind - www.mind.org.uk	
	A mental health charity offering information and advice to people with mental health problems.	
	Phone: 020 8519 2122	
	Marmalade Trust - https://www.marmaladetrust.org/	
	Supporting people experiencing loneliness to make new friendships and connections.	
	Phone: 07566 244788	
	The Silver Line Helpline	
	A free, confidential telephone service just for older people. They provide friendship, conversation and support 24 hours a day, 7 days a week across the UK.	
	Phone: 0800 4 70 80 90	

A8.6 Signposting leaflet

[PROJECT name]
Share your views

Ipsos UK are looking to speak to social housing tenants who have had energy-related works recently installed in their homes.

WHO ARE WE?

Ipsos UK are a research company. We are commissioned to assess a pilot scheme funding energy efficiency improvements in social housing, known as the Social Housing Decarbonisation Fund Demonstrator.

WHY ARE WE DOING THIS RESEARCH?

We want to speak to you to find out about your experience of the works delivered in your home. We would like to understand your views on the different measures installed and how, if at all, they have made a difference to your day-to-day life.

WHAT WILL TAKING PART INVOLVE?

If you agree to take part, we will arrange a telephone or online video interview at a convenient time for you. A researcher from Ipsos will call you and the interview will last up to 60 minutes.

We are looking to speak to people between [DATES].

Those who take part will receive £50 once the interview is complete, with opportunities for further bonuses for follow-on participation.

WHAT TO DO NEXT?

If you are interested in taking part, please contact [CONTACT DETAILS] who will be able to provide more information. If you are concerned about the authenticity of this research, please contact [HOUSING PROVIDER CONTACT]

[CONTACT] will ask you some questions to check your eligibility to take part. Not everyone who responds to this leaflet may be selected to take part.

Ipsos | Department for Business, Energy & Industrial Strategy

This publication is available from: www.gov.uk/government/publications/whole-house-retrofit-and-social-housing-decarbonisation-fund-demonstrator-joint-process-evaluation

If you need a version of this document in a more accessible format, please email alt.formats@energysecurity.gov.uk. Please tell us what format you need. It will help us if you say what assistive technology you use.