UK Government

RAF063/2223: Social Housing Decarbonisation Fund (SHDF) Wave 1

Impact evaluation report – technical annex

Department for Energy Security and Net Zero (2026)

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Contents

1. Evaluation overview

1.1 Introduction

This is the technical annex for the Wave 1 impact evaluation report (the second of two externally commissioned Wave 1 evaluation reports). The impact evaluation aimed to respond to the following five research questions:

- RQ5. To what extent, and how, has Wave 1 delivered benefits for social housing tenants, including delivering warm, energy-efficient homes, improved tenant health and wellbeing outcomes, and reduced risk of fuel poverty?
- RQ6. To what extent, and how, has Wave 1 improved social housing landlords' capacity and capability to decarbonise their housing stock?
- RQ7. How effectively has Wave 1 delivered intended environmental and cost benefits, specifically energy, carbon and bill savings?
- RQ8. To what extent and how did Wave 1 deliver retrofit installations which were high quality and represent good value for money for DESNZ?
- RQ9. To what extent and how has Wave 1 contributed towards intended wider impacts, including supporting the green economy and supply chain for retrofitting social housing?

1.2 Methodological approach

The Wave 1 impact evaluation takes a mixed methods approach, drawing on surveys and interviews with stakeholders and beneficiaries, secondary data, and synthesising findings against impact evaluation questions.

In an initial scoping phase, the evaluation team first developed a Theory of Change (ToC) (detailed in section 3 of this annex). The evaluation used Contribution Analysis (CA) to assess the contribution that Wave 1 has made to the impacts identified in the ToC. This involved developing hypothesised 'contribution claims' about what effect Wave 1 might have had on intended impacts. The full detail of the Contribution Analysis is provided in section 2 of this annex.

As part of the evaluation scoping, the evaluation team engaged an expert panel to provide scrutiny and quality assure the approach.

The following data sources were drawn upon extensively to address the impact evaluation questions:

- Resident surveys, interviews and focus groups. The impact evaluation was primarily informed by the post-installation survey and focus groups, whereas the process evaluation was primarily informed by the during-installation survey and interviews as well as limited interviews with non-participating residents.
- Interviews with supply chain representatives.

- Interviews and focus groups with Social Housing Landlords (SHLs).
- Interviews and focus groups with staff representing DESNZ senior management and the Integrated Delivery Team (IDT) team, the Delivery Partner (DP) and the Technical Assistance Facility (TAF).
- Secondary data, including application and scheme monitoring data.

These are discussed in more detail in other sections of this Technical Annex. The evaluation also incorporated case studies to explore projects and themes of particular interest. More details on these are provided in the next section.

1.3 Case study approach

Overview

Case studies have formed a central part of the Wave 1 evaluation. Their purpose is to provide an in-depth examination of key projects and themes. Six project-based case studies and three thematic case studies were developed for the Wave 1 evaluation. Case studies were also used for sampling SHLs, residents and supply chain stakeholders for interviews and focus groups, as described separately in other sections of this Technical Annex.

Selection of case studies

Six Wave 1 projects were selected to be case studies for the process evaluation:

1. Durham County Council
2. Coventry City Council
3. London Borough of Waltham Forest
4. Norwich City Council
5. Crawley Borough Council
6. Liverpool City Region Combined Authority

The process for selecting case studies began by creating a shortlist of projects meeting a number of priority areas for developing further understanding. These priority areas included projects which: experienced a large change in the number of properties being treated; had particularly high or low costs per property or per measure; were making good progress with delivery; had faced particular challenges during delivery; or were using innovative approaches in their delivery. These shortlisted projects were then checked in line with other criteria to ensure there was good representation of a range of project characteristics.[1] The final selection of case study projects was agreed with DESNZ.

[1] Case studies were selected to ensure spread across the following project characteristics: regions; consortia projects and those led by individual LAs; types of properties retrofitted; properties with mixed tenure; clean heat installations; properties with an EPC rating below D; different installation stakeholder configurations; projects that received SHDF(D) and/or other government retrofit funding (e.g. from Sustainable Warmth, LAD schemes).

For the three thematic case studies, Technopolis suggested some initial ideas for themes to explore which would bring additional value rather than duplicating core analysis already being undertaken for the process, impact or economic evaluations. DESNZ then agreed the final three themes to be covered, listed below:

- Implementing PAS 2035.
- Installing measures in hard-to-treat properties.
- Retrofit activity of SHLs not participating in Wave 1.

Case study reporting

Case studies were written up as concise, self-contained reports published separately alongside the Wave 1 Process Evaluation report[2], except the case study on "Retrofit activity of SHLs not participating in Wave 1" which was published alongside the Wave 1 Impact Report. Case studies draw upon a wide variety of data sources including primary data from surveys and interviews with SHLs, residents and supply chain stakeholders, and analysis of secondary scheme monitoring data. Availability of data sources varied across case studies, as detailed in each case study report.

[2] DESNZ (2024) 'Social Housing Decarbonisation Fund Wave 1 Evaluation'

2. Contribution Analysis

The evaluation used Contribution Analysis (CA) to assess the contribution that Wave 1 has made to the impacts identified in the ToC. This involved developing hypothesised 'contribution claims' about the effect of Wave 1 on intended impacts. These were formulated using the structure that: X intervention leads to Y scheme impact because of Z underlying scheme mechanism.

CA recognises that interventions exist within an external context which affects their contribution to impacts. External factors may contribute to, or even limit, the intervention's impact. As such, 'alternative explanations' were also formulated alongside the contribution claims. The developed contribution claims and alternative explanations are all set out within the relevant sections of the ToC presented in Section 3 of this Technical Annex.

The evidence expected to be gathered if a contribution claim or alternative explanation held true was identified during the scoping phase of the evaluation. This evidence was then gathered through both primary data collection and secondary data analysis. The evidence found was then mapped back against the contribution claims and alternative explanations. This is also set out within the relevant sections of the ToC presented in Section 3 of this Technical Annex.

During analysis and ahead of the impact evaluation phase, we also considered if any other evidence, not foreseen during the scoping phase of the evaluation, had emerged which needed to be added to the framework.

The strength of the evidence against each contribution claim and alternative explanation was assessed using a specific framework developed by Delahais and Toulemonde (2017).[3] This framework uses four criteria to assess the strength of evidence as set out below. These criteria were considered in terms of how they could be applied to the specific context of this evaluation and the nature of the evidence that was expected to be available:

1. **Authoritative:** indicates a piece of evidence which has already passed a thorough test under the responsibility of credible authorities (e.g., peer reviewed papers) in so far as the point at issue is not in dispute among differing authorities. For this evaluation, we considered official statistics to be authoritative sources. Additional project self-reported monitoring data was not counted as authoritative as it was subject to inconsistencies in reporting which were not quality assured to the same level.

2. **Triangulation:** sources are considered to be independent from one another in so far as they stem from stakeholders having different vested interests. Pieces of evidence originating from such sources are mutually reinforcing as far as they converge. This could include data of different types, such as interview statements that were in line with findings from analysis of secondary data.

[3] Thomas Delahais & Jacques Toulemonde (2017) 'Making rigorous causal claims in a real-life context: Has research contributed to sustainable forest management?', Evaluation, Volume 23, Issue 4, pages 370-388

3. **Consistent chronology:** this is never a sufficient argument for confirming a contribution claim but it may be used for refuting an assumed contribution. For example, if some suppliers of energy efficiency measures had started retrofit works on a specific housing stock before the start of Wave 1, then this would suggest that Wave 1 did not lead to the retrofit of that housing stock.

4. **Signature:** this occurs when X (the intervention) causes Y and leaves a trace/signature that points unequivocally back to X. This is similar in nature to the concept of a "Smoking Gun" test in Process Tracing. This was sought within interviews or focus groups where respondents were asked to describe clear, illustrative examples of the change that the scheme had made in their practice or processes. For example, where a landlord who interacted with SHRA described how they used a particular tenant liaison strategy recommended by SHRA (the 'trace/signature' of SHRA contribution) to secure tenant consent.

Each of the pieces of evidence collected was categorised as either authoritative, triangulated (in combination with other pieces of evidence), chronological and/or signature. A framework (shown in Table 1) was then used to consider the strength of different pieces of evidence that related to one contribution claim or alternative explanation. This enabled us to make a judgement about the overall strength of evidence in support of each claim.

Table 1: Criteria for assessing the strength of multiple pieces of evidence relating to one contribution claim/alternative explanation

Overall strength of evidence category	Criteria
Strong evidence in support of contribution claim	Criteria met IF: A) Consistent Chronology tests passed. AND: B) Based on Authoritative source PLUS Triangulated evidence. OR: C) Based on Signature PLUS Triangulated evidence.
Moderate evidence in support	Criteria met IF: A) Consistent Chronology tests passed. AND: B) Authoritative source evidence, OR: C) Signature evidence. However, some inconsistency in findings. Some sources point towards different conclusions - evidence does not Triangulate across all sources.
Limited or weak evidence in support	Criteria met IF: A) Consistent Chronology tests passed. AND: B) Evidence from Signature sources is mixed - for example, findings from interviews show some stakeholders' views support claim, but not others. C) Evidence not based on Authoritative source.
No evidence in support	Criteria met IF: A) Consistent chronology tests fail. AND/OR: B) No evidence in support of contribution claim across other sources.

Once we reached overall conclusions for each contribution claim and related alternative explanations, we then used the following criteria to assess the overall contribution of Wave 1 and the extent to which this was sufficient and/or necessary. In summary, a 'sufficient' condition is a causal factor with enough explanatory power to cause the outcome on its own. A 'necessary' condition is one that must be present for the outcome to occur, but may be part of a wider causal package of influencing factors that work in combination to produce an outcome.

- Level 1 – strong evidence in support of contribution claim, but limited or no evidence in support of alternative explanations. Conclude that the intervention caused the results and was 'sufficient'.
- Levels 2 or 3 – Strong/moderate evidence in support of both contribution claim and alternative explanations. Conclude that both the programme levers and external factors worked in combination to cause results. If evidence in support suggests the programme was a 'necessary' factor, this equates to level 2. If not necessary, but supplementary, this equates to level 3.
- Level 4 – Strong evidence in support of alternative explanations, but limited or no evidence in support of contribution claim. Conclude that outcome would have happened anyway and intervention did not cause the results.

3. Theory of Change

The Theory of Change (ToC) was originally developed in early 2023 as part of the scoping stage for the evaluations of Wave 1 and Wave 2.1. This version was reviewed and updated in June 2024 in light of the findings from the Wave 1 process evaluation. It has now been reviewed and updated again in light of the findings from the Wave 1 impact evaluation.

The ToC describes the aims of Wave 1 and the processes by which the inputs and activities are expected to lead to outputs, outcomes, and benefits. Developing a ToC is a key first step of any evaluation, as it sets out an agreed understanding of what outcomes are expected and necessary to assess success of the scheme in question. The ToC was used to develop evaluation questions and a methodological approach for the evaluation, incorporating both primary and secondary data.

The overarching ToC, and the different causal pathways captured within, are presented in detail in sections 3.1 to 3.6 below.

3.1 SHDF Wave 1 rationale and objectives

The UK has legislated to reduce greenhouse gas emissions to net zero by 2050. The UK has some of the oldest, and least energy efficient, homes in Europe. To reach net zero, it is necessary to almost entirely decarbonise homes. The 2019 Conservative manifesto included a £3.8 billion commitment through the Social Housing Decarbonisation Fund (SHDF) for investment up to 2030. The SHDF focuses on improving the energy performance of social housing in England.

The SHDF Demonstrator (SHDF(D)) was announced in the 2020 Summer Economic Update and awarded £62 million fund for SHLs to test innovative approaches to retrofitting at scale. Building on the SHDF(D), the SHDF Main Fund has taken a waved approach, whereby each wave of funding is designed to reflect the current context whilst also remaining focused on delivering the anticipated programme outcomes. The investment will see SHLs improve the energy performance of their properties through the installation of energy efficiency measures and low carbon technologies. This is expected to have a positive impact on residents' lives, reducing bills, improving thermal comfort, and reducing the number of residents in fuel poverty. It is also expected to help build capability in the supply chain and social housing sector, developing knowledge and capacity to deliver social housing retrofit and beyond. The first wave of the SHDF Main Fund (Wave 1) is the focus of this evaluation.

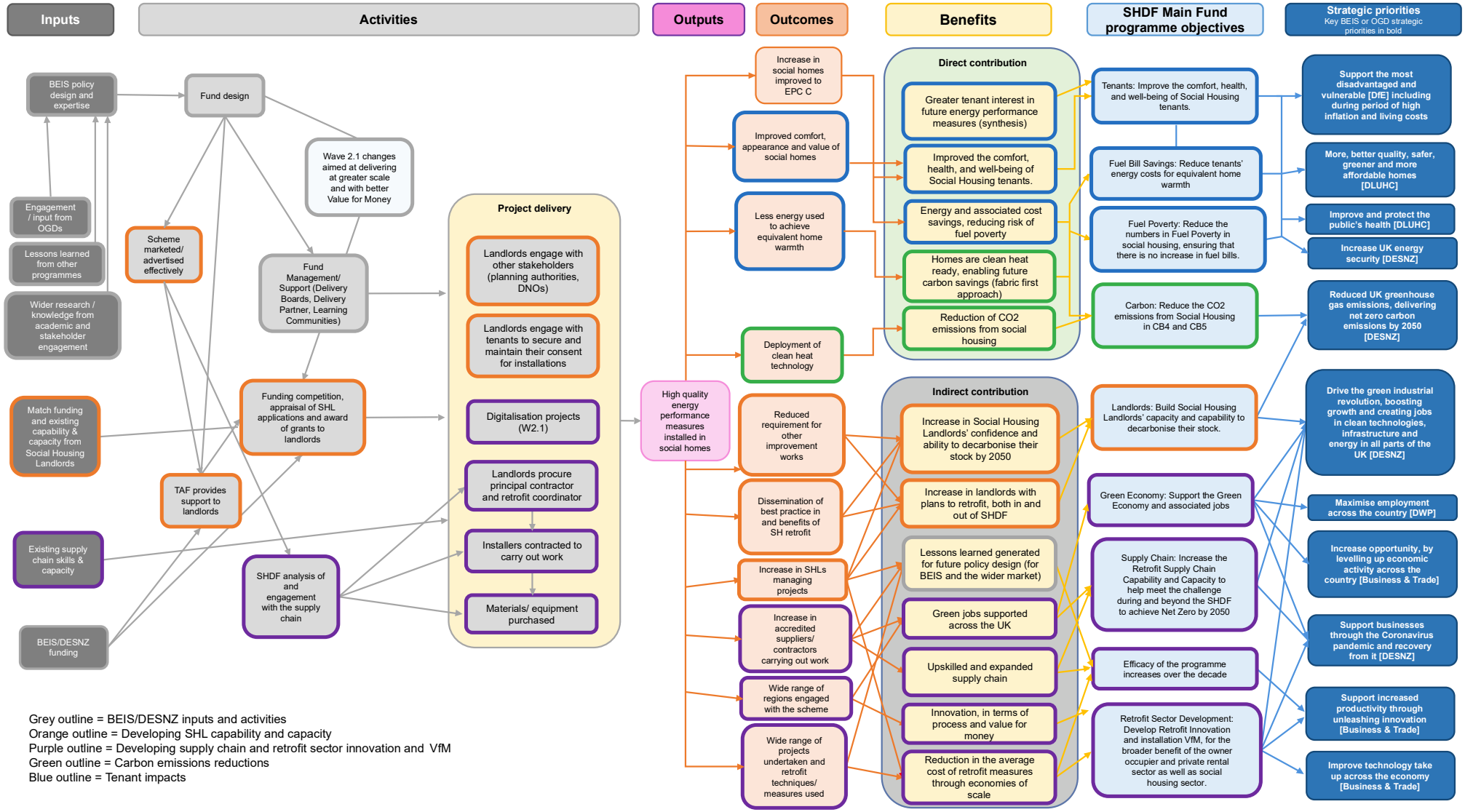
The objectives of Wave 1 are to:

- Reduce CO2 emissions from social housing in Carbon Budget (CB) CB4 and CB5.
- Improve social homes to Energy Efficiency Rating (EER) C.
- Reduce the numbers of social housing residents in fuel poverty, ensuring that there is no increase in fuel bills.
- Improve the comfort, health, and well-being of social housing residents.

- Develop the green economy and associated jobs.
- Develop retrofit innovation and installation value for money (VfM), for the broader benefit of the owner occupier and private rental sector.
- Increase the retrofit supply chain capability and capacity to help meet the challenge during and beyond the SHDF to achieve Net Zero by 2050.
- Build SHLs' capacity and capability to decarbonise their stock.

The logic models presented below set out the pathways through which impacts are expected to be achieved against the objectives of Wave 1. The narrative presented in the sections below describes this in detail.

Figure 1: Overarching logic model



Grey outline = BEIS/DESNZ inputs and activities
Orange outline = Developing SHL capability and capacity
Purple outline = Developing supply chain and retrofit sector innovation and VfM
Green outline = Carbon emissions reductions
Blue outline = Tenant impacts

3.2 Government inputs and activities: funding, design and management

The following section describes the government inputs and activities contributing to Wave 1 impacts.

Government inputs

BEIS (now DESNZ) allocated £179 million for Wave 1 in 2022, using Section 31 of the Local Government Act to provide funding. The other principal government input was the policy design and expertise of DESNZ supported by engagement with and input from other governmental departments, lessons learned from the prior SHDF(D) scheme, other domestic energy efficiency schemes and wider research and knowledge from academics and other stakeholders.

Government activity: Wave 1 design

DESNZ policy design and expertise, and learnings from the SHDF(D), were used to develop the design for Wave 1 with key features intended to maximise the impacts of the scheme. It was also expected that learnings from Wave 1 would feed into future SHDF waves (as they did for Wave 2.1) and potentially wider policy and programme design at DESNZ. Key features of the scheme design and their rationale are described in turn below.

Co-funding requirement and applicant eligibility

A co-funding requirement was set up for Wave 1 to establish accountability and ownership of projects among SHLs as well as to add to the scale of installations undertaken. SHLs were responsible for bringing in a minimum of 33% of the required funding in Wave 1. Applications had to be led by a Local Authority (LA). Registered Providers (RPs) could apply as part of a consortium bid.

Eligibility and prioritisation of properties to be retrofitted and high-quality measures to be installed

SHLs were expected to take a fabric first approach to installations to improve properties to Energy Performance Certificate (EPC) C, or EPC D where EPC C was not possible for properties which were originally at EPC F or G. Wave 1 used cost caps to provide more funding for homes with the lowest EPCs. This was intended to provide value for money.

Eligible measures under Wave 1 included low carbon heat (to contribute to carbon emissions reductions), where a fabric first approach was taken and the new heating system alone would reduce bills and separately to the installation of other measures.

In their bids, projects were allowed to include some mixed tenure properties. This was to enable retrofitting of social housing where in fill properties were present. At least seventy per cent of properties in the bid had to be social housing properties.

In order to ensure quality of work, and reduce the risk of poor performance and limited achievement of energy and carbon savings, measures had to be installed in line with PAS 2035 and installers had to be Trustmark accredited or equivalent.

Delivery window

The delivery period for Wave 1 was intended to be twelve months from January 2022. This was extended through to April 2024.

Technical Assistance Facility (TAF)

The inclusion of TAF was intended to provide support to SHLs in pre-competition stage through information and workshops to enable them to develop effective project plans and bids (as discussed in more detail in later sections). This is supported by evidence gathered in the Wave 1 process evaluation.

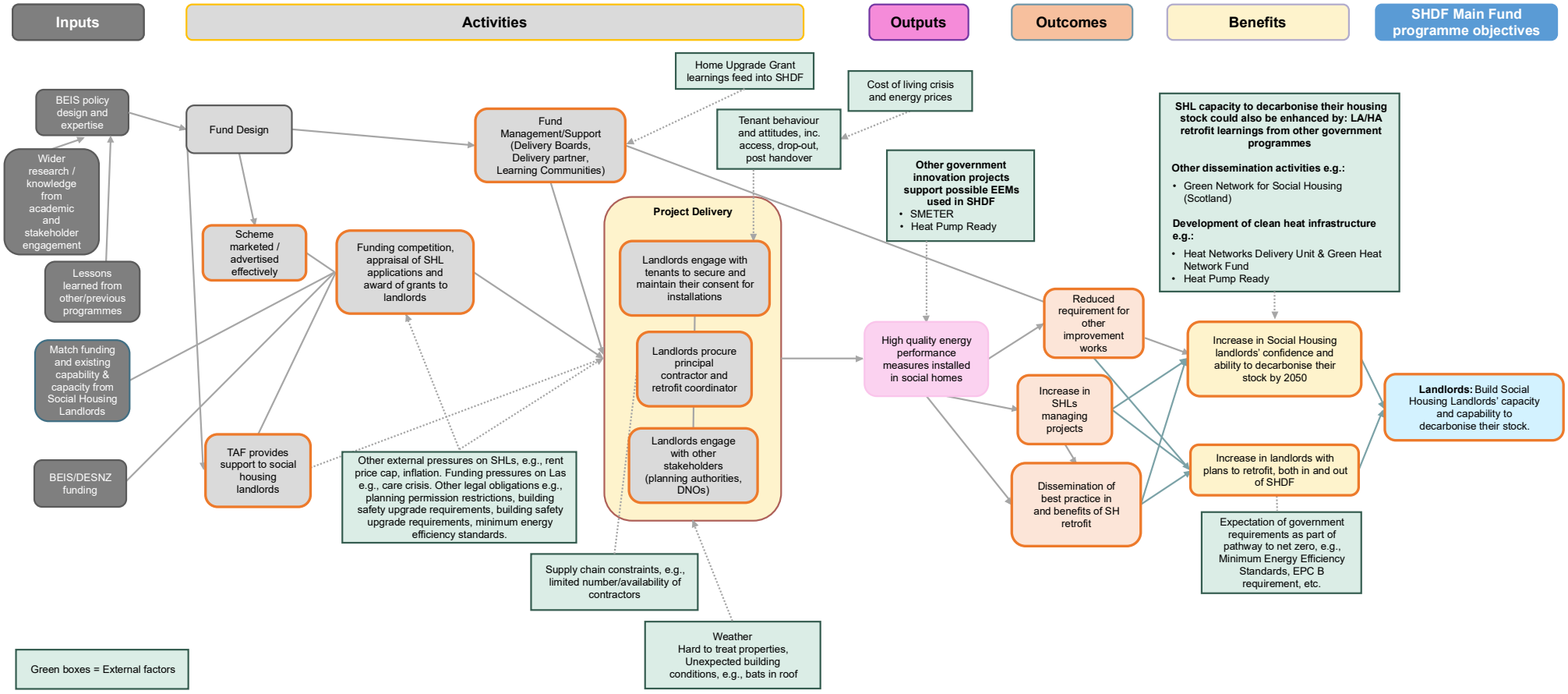
Government activity: Wave 1 management

Scheme management and support activities for SHLs were key aspects during the set up and delivery phase of projects. Scheme management included DESNZ Delivery Boards and the DP. The Delivery Board was in charge of decision making on change control and milestone payments at the DESNZ level. The DP was an externally sub-contracted agency which led regular day to day engagement with projects, and communicated progress to DESNZ, identifying underperformance, providing inputs to and assurance of critical project decisions and building action plans where things went wrong. The inputs of all these bodies and the processes they delivered were intended to support successful execution of projects thereby enabling achievement of impacts in an efficient manner.

3.3 The pathway to building SHL capacity and capability to deliver retrofit projects

A key objective of Wave 1 was to increase the capacity and capability of SHLs in decarbonising their housing stock. This section describes inputs and activities that are part of the causal pathway related to intended impacts of increasing capacity and capability of SHLs (Figure 2).

Figure 2: Building SHL capacity and capability to deliver retrofit projects



SHL Inputs

Co-funding

Co-funding from SHLs was a key input for Wave 1 (minimum of 33% of total project costs).

Assumption: SHLs are able to secure the minimum co-funding necessary to apply for bids and carry out retrofits. Evidence from the Wave 1 process evaluation shows this was the case for Wave 1 projects.

External Factor/Risk: SHLs face competing priorities and fiscal pressures which may decrease the budget available for energy performance retrofits. These include statutory and legal obligations such as for building fire safety and other ongoing maintenance requirements and investment in the development of new housing stock. SHLs also face ongoing fiscal pressures arising from the economic context and high inflation. In particular, LAs have a wide range of other competing priorities not related to housing. Evidence from the Wave 1 process evaluation shows that, despite competing priorities, SHLs were able to find the budget required for Wave 1.

External Factor/Risk: Inflation, rising material costs, and unexpected maintenance or preparatory work needs during project delivery may increase project costs. The DESNZ funding input is fixed and SHLs may have insufficient additional budget to meet unanticipated costs. Evidence from the Wave 1 process evaluation shows that some Wave 1 projects experienced rising material and labour costs, and unexpected maintenance and preparatory work needs for their housing stock during delivery.

Activities involving SHLs

Scheme marketing

Scheme marketing was an important activity to drive participation and support the formation of strong bids for Wave 1. Wave 1 included a significant launch/mobilisation event to alert and inform potential SHL bidders about the competition. Competition guidelines were published on the government website. Marketing and engagement activity consisted of a five-tiered approach to SHLs, based on level of potential interest. Both TAF (discussed below) and consortium partnerships supported SHLs in identifying suitable homes for retrofit and modelling. Evidence from the Wave 1 process evaluation shows that the marketing of Wave 1 has been generally successful.

Risk: Marketing and engagement activities do not reach enough or the appropriate SHLs to produce quality bids. Evidence from the Wave 1 process evaluation suggests this was not a significant risk was for Wave 1.

Technical Assistance Facility (TAF)

TAF provided support to SHLs in pre-competition stage through information and workshops on retrofit opportunities and technologies, procurement and supply chain engagement, resident engagement, scheme requirements (e.g. PAS 2035), and putting a bid together, to help build SHL understanding of retrofit and drive more, larger and stronger bids. TAF was also intended to help make introductions between people and organisations in the same region, potentially to develop bid consortia. Lessons from the SHDF(D) further showed the need to support SHLs

with information across these domains. Evidence from the Wave 1 process evaluation shows that the majority of successful Wave 1 projects accessed TAF support.

Assumptions: SHLs access and use TAF resources. The support is sufficient and appropriate in building SHL capacity and capability to make successful, high-quality applications. Overall, evidence from the Wave 1 process evaluation is consistent with this assumption.

Risk: The support offered by TAF does not align with the needs and knowledge of SHLs about retrofit, and therefore is not suitable for some SHLs. Evidence from the Wave 1 process evaluation suggests this risk has materialised to an extent in Wave 1.

Risk: Delay in the set-up of TAF and funding limitations on TAF limit the number of potential bidders they can support. Evidence from the Wave 1 process evaluation suggests this was not an issue in Wave 1.

External Factor: SHL capability could be enhanced through shared lessons of energy performance retrofits conducted through other government initiatives e.g. Home Upgrade Grant, Green Homes Grant. Evidence from the Wave 1 process evaluation shows many Wave 1 projects used lessons learnt from previous government funded retrofit projects.

Funding competition

The funding competition activity was the phase where SHL applications were appraised and grants were awarded to the best applications. The funding granted through this competition was used by SHLs to plan and commission energy performance installation projects in their housing stock, which they could not otherwise afford to undertake at the same pace, at the same scale or to the same level of quality.

Assumptions: Wave 1 requirements are sufficiently aligned with SHLs' wider maintenance plans for them to proceed with applications. Evidence from the Wave 1 process evaluation is consistent with this assumption.

Assumption: SHLs have sufficient and accurate data on their stock to develop effective plans for installing energy performance measures via Wave 1. Evidence from the Wave 1 process evaluation shows this was not the case for some projects, who did not have access to sufficient and accurate data for their housing stock.

Risk: SHLs have insufficient understanding of and data on their stock and therefore cannot develop appropriate and accurate bids. Evidence from the Wave 1 process evaluation shows this was an issue for some Wave 1 projects.

Risk: The bid requirements and criteria (e.g. 'worst first, fabric first', PAS 2035 and the co-funding requirement) are challenging for SHLs to understand or meet, and they cannot develop appropriate bids. Evidence from the Wave 1 process evaluation shows this was an issue for some Wave 1 projects.

Risk: The bidding window is too short for SHLs, particularly less experienced or smaller SHLs, to develop appropriate bids. Evidence from the Wave 1 process evaluation shows this was an issue for some Wave 1 potential applicants.

Risk: The bidding window was too complex for SHLs to navigate, and they could not develop appropriate bids. Evidence from the Wave 1 process evaluation shows this was an issue for some Wave 1 potential applicants.

Risk: SHLs have difficulty forming consortia and building trust between different SHLs, leading to fewer and smaller bids with peppered stock (due to mixed tenure) and poor modelling of stock (due to low LA modelling capacity). Evidence from the Wave 1 process evaluation shows that over half of successful bids in Wave 1 were from consortia, suggesting this was not a significant issue for Wave 1.

Risk: SHLs perceive the policy context as too uncertain to validate the effort and investment of energy efficiency projects. They may also be concerned that future regulation will have different requirements creating a risk that any earlier work has to be adapted/re-done and is not cost effective. Given that housing decarbonisation is at an early stage, SHLs may also prefer to wait until approaches are more established. Evidence from the Wave 1 process evaluation shows that there were more Wave 1 applications than expected, suggesting this was not a significant issue.

External factor: SHLs may also be motivated to apply to Wave 1 because they have internal commitments to reduce their carbon emissions, this addresses Environmental, Social and Governance (ESG) requirements and/or this also helps satisfy other objectives such as improving the EPCs of their housing stock, reducing mould and improving living conditions more broadly. Evidence from the Wave 1 process evaluation shows that many Wave 1 projects reported having existing commitments to decarbonisation and improving energy efficiency of their housing stock.

Scheme management

The scheme management and support activities for SHLs (discussed previously) were key aspects during the set up and delivery phase of Wave 1 projects. The DP's role included facilitating lesson learning among participating SHLs, and those taking part in HUG, and dissemination to non-participating SHLs.

Assumption: SHLs engage fully with the DP and opportunities for cross-learning. The support is sufficient and appropriate in building SHL capacity and capability in delivery processes. Evidence from the Wave 1 process evaluation suggests that the DP has effectively supported Wave 1 project delivery.

Risk: The individuals appointed from the DP to support projects do not have the technical expertise to appropriately support the projects during delivery. Evidence from the Wave 1 process evaluation suggests this was an issue for some Wave 1 projects.

Project delivery

The following describes activities undertaken by Wave 1 projects within the delivery phase.

Resident engagement and consent

SHLs engaged with residents to secure and maintain their consent for installations. SHL engagement was mostly undertaken via resident liaison officers and retrofit coordinators though some smaller SHLs do not have dedicated individuals. In many cases, resident

engagement plans drew upon with TAF/DP guidance and lessons learned. Buy in and consent for installation of energy performance measures was achieved because residents understood the potential benefits including reduction in energy costs and improved comfort and property. They saw these as outweighing the potential risks/challenges, for example, disruption of installation or use of new technology. Evidence from the Wave 1 process evaluation shows that many SHLs experienced challenges when trying to engage residents to take part in their project.

Assumptions: Residents continue to provide consent for installation of energy efficiency measures because these are organised alongside other maintenance works and/or generally in a way that minimises disruption. Evidence from the Wave 1 process evaluation is largely consistent with this assumption, however some Wave 1 projects experienced a few instances of tenant dropouts after delivery began.

Risk: Resident resistance to or difficulties experienced during works reduces the number of projects moving forward. Evidence from the Wave 1 process evaluation suggests this was not a significant issue for Wave 1 projects.

Risk: Existing negative relationships with residents or residents' perceptions of their SHLs could discourage them from taking part. Evidence from the Wave 1 process evaluation suggests this was not a significant issue for Wave 1 projects.

External Factor: The cost-of-living crisis could encourage residents to consent to energy performance measures because they expect to save money. However, the crisis could also cause stress increasing resident resistance to change.

External Factor/Risk: Residents could have existing concerns over certain retrofit measures due to negative media coverage (e.g. for ventilation or heat pumps) and be resistant to receiving installations. Evidence from the Wave 1 process evaluation shows this was an issue for some Wave 1 projects.

Procurement of a principal contractor and retrofit coordinator

SHLs procured a principal contractor and retrofit coordinator. The TAF pre-bidding support was meant to guide SHLs on the channels and process of contracting retrofit coordinators, with plans in place pre-bid. PAS 2035 guidelines required under the grant also outlined the steps SHLs could expect to undergo through the retrofit process. Once contractors were appointed, SHLs were expected to manage the projects, risks and delivery with the contractors. TAF provided insight into project management prior to applications, and the DP provided ongoing technical support to SHLs. SHLs were expected to develop risk logs and project plans to mitigate issues. The use of a principal contractor added value by bringing together and managing a consortium of suppliers and installers. This reduced the administration and transaction costs for SHLs as they only needed to manage the principal contractor. It also potentially offered economies of scale in coordination of works and improved value for money. Evidence from the Wave 1 process evaluation shows that some projects experienced challenges securing access to the supply chain.

Assumption: TAF pre-bid support and DP in-delivery support are sufficient in enabling SHLs to connect with and contract retrofit coordinators. Evidence from the Wave 1 process evaluation shows Wave 1 projects experienced challenges contracting retrofit coordinators.

Risk: The supply chain is not sufficiently developed to meet the needs of SHLs (discussed further in the next section on the supply chain). Evidence from the Wave 1 process evaluation shows that some Wave 1 projects found it difficult to procure members of the supply chain as a result of capacity issues within the retrofit supply chain (as well as external factors such as the UK's exit from the EU, Covid-19 and inflation).

External Factor/Risk: Due to the high demand for retrofit services, SHLs struggle to find contractors with availability to take part in their SHDF project. Evidence from the Wave 1 process evaluation suggests this was an issue for some Wave 1 projects.

Risk: The requirements for SHDF installations (e.g. PAS 2035 and Trustmark accreditation) result in SHLs struggling to find contractors to take part in their project. Evidence from the Wave 1 process evaluation suggests this was not a significant issue for most Wave 1 projects.

Risk: The requirements for SHDF installations (e.g. PAS 2035 and Trustmark accreditation) lead to delays in project delivery because suppliers have to get the required accreditation before starting works. Evidence from the Wave 1 process evaluation suggests this occurred for some Wave 1 projects.

External Factor/Risk: Inflation and rising costs of labour result in SHLs struggling to find affordable contractors. Evidence from the Wave 1 process evaluation shows this was an issue for some Wave 1 projects.

SHLs engage with other stakeholders

SHLs also needed to engage with other key retrofit stakeholders e.g. planning authorities and Distribution Network Operator (DNOs) to execute projects successfully.

Assumptions: SHLs are aware of the need to engage with these stakeholders, have the capability and capacity to do so, and/or are provided with support through the DP. Evidence from the Wave 1 process evaluation is consistent with this assumption.

Risks: Poor engagement from DNOs (e.g. for power cable access) and difficulties with planning permission lead to project delays. Planning permission may particularly be an issue where the intention is to install external wall insulation. Evidence from the Wave 1 process evaluation shows this was an issue for some Wave 1 projects.

Output: As for the main diagram, the installation of high-quality energy performance measures in social homes is the key output of Wave 1. Evidence from the Wave 1 impact report shows that energy performance measures were installed in compliance with PAS 2035 in social homes.

Risk: Poor weather conditions, or unexpected risks (bats in roof, preliminary work) can cause delays, require extra budget, or reduce the number of projects moving forward. Evidence from the Wave 1 process evaluation shows that this was an issue for some Wave 1 projects.

Outcomes for SHLs

Increase in SHLs managing high-quality energy performance retrofit projects

The increased capacity of SHLs to manage high-quality energy performance retrofit projects is a key outcome for Wave 1, and is driven by the availability of funding, enabling a larger volume of high-quality energy performance works to be carried out in a more efficient manner than otherwise. In addition, the above activities explain how gaps in SHL capabilities were overcome to facilitate delivery of these projects. Evidence from the impact evaluation suggests that Wave 1 has resulted in a higher number of properties reaching EPC C than would have occurred otherwise, as it allowed SHLs to expand the scale, scope, and quality of their retrofit projects.

Dissemination of best practice in and benefits of social housing retrofit

Another important outcome is increased sharing of knowledge provided through TAF and the DP, via the online knowledge sharing platform Social Housing Retrofit Accelerator (SHRA) and case study reports on best and cost-effective practices. Knowledge sharing can also reach those not currently participating in Wave 1. Evidence from the impact evaluation shows that Wave 1 has supported SHL learning on retrofit practices.

Reduced requirement for other improvement works

An additional outcome is a potential reduction in requirements for other improvement works, for example, to deal with condensation and damp, from homes that are improved through Wave 1. These homes are expected to have better insulation as well as ventilation, thus decreasing the prevalence of mould and degradation due to dampness. This increases the home's value and available budget for further measures or other retrofits across the SHL's housing stock. Evidence from the impact evaluation shows that Wave 1 has reduced mould and damp in homes, but a minority of residents noted problems with mould or mildew had worsened.

Risk: Residents have reservations around certain measures (e.g. ventilation, heat pumps), and therefore refuse these measures. Evidence from the Wave 1 process evaluation shows this was an issue for some Wave 1 projects.

Benefits for SHLs

The above outcomes lead to two of the key benefits provided by Wave 1:

An increase in SHL confidence and ability to decarbonise their stock

SHL confidence and ability to decarbonise their stock is improved through staff learning and the development of new processes and resources on their funded project. It is also likely to be enhanced by cross-learning with other projects and HUG. Evidence from the impact report shows that most SHLs learnt from and gained specific skills from their Wave 1 projects.

An increase in SHL plans to retrofit

The learning and confidence building derived from undertaking projects is expected to increase the plans of SHLs to retrofit. Evidence from the impact report shows that most Wave 1 SHLs have plans to conduct future retrofit projects.

External factor: Currently or in the future, there may be an expectation amongst SHLs that government will introduce new regulations on the energy performance of social housing as part of the pathway to net zero, for example, minimum energy efficiency standards, EPC C requirement, etc. This may motivate SHLs to undertake activity independently thereby potentially reducing the additionality of Wave 1. Evidence from the impact report shows that regardless of motivation for retrofit, many SHLs needed government funding to be able to undertake large-scale retrofits.

External Factor: SHL capacity and capability to decarbonise their housing stock could also be built through other government or housing sector initiatives. However, SHLs were not directly accessing other government energy efficiency schemes in significant numbers. Other stakeholder housing sector organisations may also disseminate information on decarbonisation of social housing stock. Government support for clean heat infrastructure and initiatives will also facilitate future decarbonisation of social housing stock. There was limited evidence in the impact evaluation of SHLs developing the capacity and capability to decarbonise their housing stock through other means.

Table 2: Contribution Claims relating to SHL outcomes and impacts: Strength of evidence and causality

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
1a The SHDF funding contribution stimulates and enables SHLs to pay for energy performance (EE) retrofits at a larger scale than otherwise. This is because it provides budget which SHLs otherwise lack to cover the substantial costs of retrofit, and acts as motivation for SHLs to invest via match funding.	**Moderate** The energy efficiency retrofits reflect a chronology that is consistent with Wave 1 funding. There is triangulated evidence indicating that Wave 1 stimulated and enabled SHLs to conduct energy efficiency retrofit within their housing stock, including interviews with participating and non-participating SHLs and scheme monitoring data (an authoritative source). However, there remain inconsistencies within triangulated data, with some, limited evidence of non-participating SHLs in England undertaking work of a similar scale at the same time as Wave 1.	**Level of causality: 3** We can reasonably conclude that SHDF Wave 1 stimulated and enabled SHLs to pay for energy efficiency retrofit in their house stock, and in many cases the funding enabled SHLs to increase the scale of their retrofit plans and the number of properties included in the retrofit project. However, other sources of government funding for retrofit and internal funding were both found to be enablers for retrofit works in social housing stock at a similar scale to Wave 1 and during the same period as Wave 1 retrofits. Therefore, we conclude that level of causality is 3.
1b SHLs use funding from other government energy efficiency programmes (for example, Green Homes Grant Local Authority Delivery Scheme) or invest their own funds to deliver EE retrofits at a larger scale because this places fewer administrative requirements and scheme design requirements (for example, for PAS 2035 accreditation) on SHLs.	**Moderate** There is triangulated evidence (but based on small samples) and chronologically consistent, authoritative evidence showing that SHLs have used other sources of government funding and have invested their own internal funds in order to complete energy efficiency retrofits to their housing stock, at the same time as Wave 1. Evidence is also chronologically consistent, in that non-participating landlords were funded via other sources in the same or similar time periods to Wave 1.	**Level of causality: 3** We can reasonably conclude that SHDF Wave 1 stimulated and enabled SHLs to pay for energy efficiency retrofit in their house stock, and in many cases the funding enabled SHLs to increase the scale of their retrofit plans and the number of properties included in the retrofit project. However, other sources of government funding for retrofit and internal funding were both found to be enablers for retrofit works in social housing stock at a similar scale to Wave 1 and during the same period as Wave 1 retrofits. Therefore, we conclude that level of causality is 3.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
1c Other government energy efficiency programmes, for example, ECO4 deliver energy performance retrofits in social housing at a larger scale and more quickly than previously because they provide the stimulus and funding for this.	**Moderate** There is authoritative evidence showing that ECO 3 and ECO 4 resulted in energy efficiency measures being installed in social homes at a similar or large scale. This evidence is chronologically consistent in that these took place at a similar time to Wave 1.	**Level of causality: 3** We can reasonably conclude that SHDF Wave 1 stimulated and enabled SHLs to pay for energy efficiency retrofit in their house stock, and in many cases the funding enabled SHLs to increase the scale of their retrofit plans and the number of properties included in the retrofit project. However, other sources of government funding for retrofit and internal funding were both found to be enablers for retrofit works in social housing stock at a similar scale to Wave 1 and during the same period as Wave 1 retrofits. Therefore, we conclude that level of causality is 3.
2a SHDF support (via TAF and the Delivery Partner, DP) with bid applications and technical and project management enables SHLs to understand their stock, identify appropriate and cost effective retrofit measures, and engage effectively with residents and the supply chain to develop and undertake high quality energy performance projects because it compensates for SHL lack of in-house technical expertise and experience.	**Moderate** There is strong evidence showing that support via TAF and the DP supported SHLs in developing their application, resident engagement and project delivery. This includes signature evidence, as scheme delivery representatives noted a marked increase in bid quality following TAF support, and evidence chronologically consistent with the timings of TAF support. Further, there is triangulated, chronologically consistent evidence that residents felt satisfied with the installation process and the quality of measures. However, there are some inconsistencies in Monitoring and Delivery Officers (MDOs) supporting project delivery. Evidence suggests that residents felt they were not well supported by SHLs after measures were installed.	**Level of causality: 2** There is strong evidence that support provided through SHDF Wave 1, including through TAF and through the Delivery Partner, allowed SHLs to undertake high quality energy efficiency retrofit projects. However, there is some evidence suggesting that SHLs were able to access support from other sources, and some evidence that residents did not feel well supported by SHLs after measures were installed. Therefore, we conclude that the level of causality is 2.

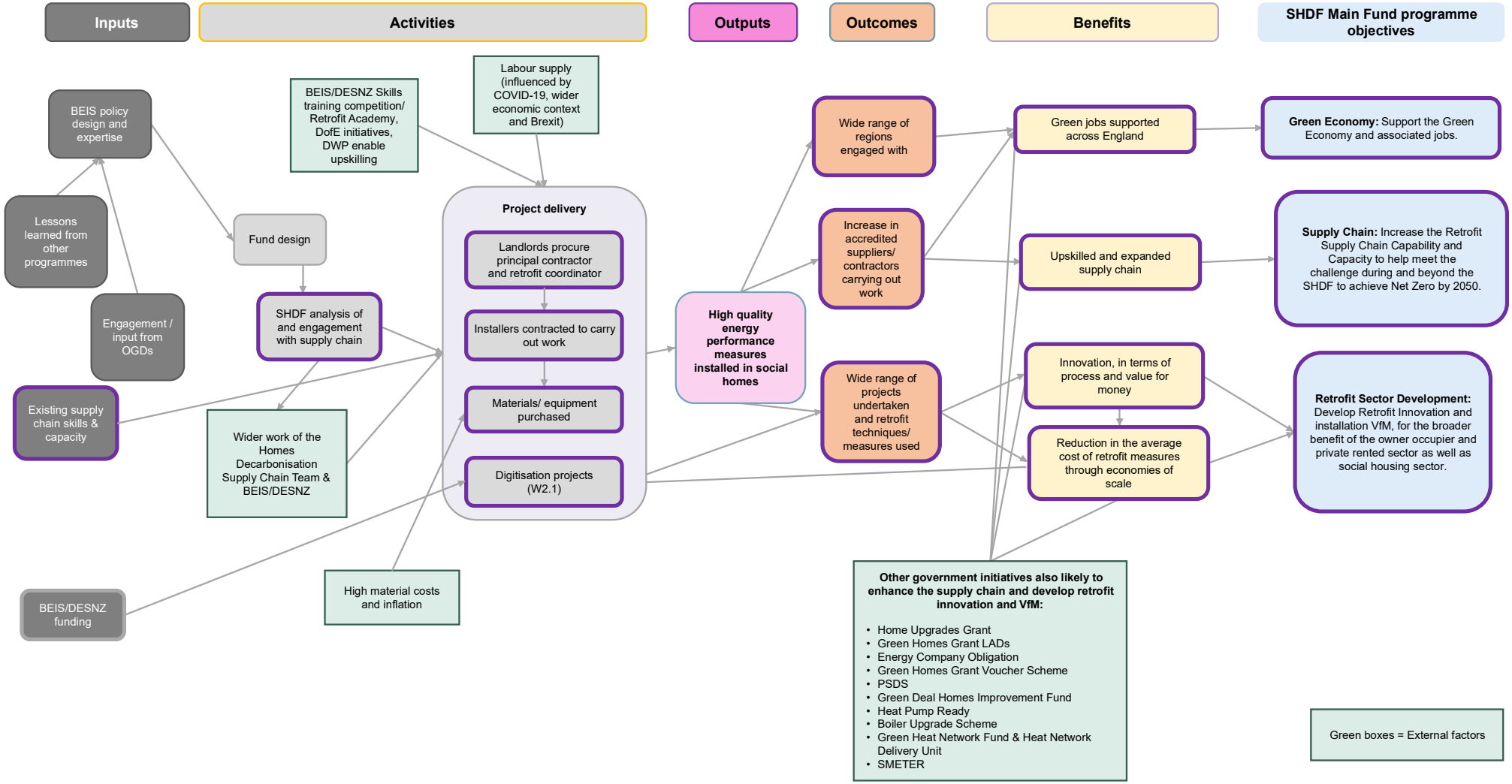
Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
2b Other external sources of support and information, for example, dissemination of learnings from landlords of private rental properties undertaking stock decarbonisation support SHLs to develop and undertake high quality energy efficiency projects because this overcomes SHL lack of technical expertise and experience in-house.	**Limited** There is some limited triangulated evidence that SHLs gathered learnings outside of Wave 1 support, however this is limited to a small number of SHLs and one scheme delivery representative. There is limited chronologically consistent evidence that SHLs gathered learnings before Wave 1 participation, and no signature evidence suggesting learnings were gathered from a particular source outside of Wave 1 support.	**Level of causality: 2** There is strong evidence that support provided through SHDF Wave 1, including through TAF and through the Delivery Partner, allowed SHLs to undertake high quality energy efficiency retrofit projects. However, there is some evidence suggesting that SHLs were able to access support from other sources, and some evidence that residents did not feel well supported by SHLs after measures were installed. Therefore, we conclude that the level of causality is 2.
3a SHL participation in SHDF develops SHL capability and capacity to undertake future retrofit projects. This occurs because participating SHLs learn from their own SHDF project experience and develop new internal processes and resources as well as cross-learning from other SHDF and HUG projects.	**Strong** There is strong evidence that SHLs have gained lessons, capabilities, and skills as a result of Wave 1. This has been triangulated across various sources including SHL and scheme delivery representatives interviews and project closure reports. Chronologically consistent and signature evidence is also present, as learnings materialised during or after Wave 1 participation. There is also strong evidence that most SHLs now have plans to conduct further energy efficiency retrofit within their housing stock, which has been triangulated across various sources including project closure reports. Further, there is triangulated evidence that SHLs now have a higher confidence in decarbonising their housing stock as a result of participation in Wave 1.	**Level of causality: 2** There is strong evidence that participation in SHDF Wave 1 has improved SHLs' capabilities and capacities to undergo future retrofit projects, through providing SHLs with learnings, skills, and motivations to train their teams. Participating SHLs have future plans for undertaking more energy efficiency retrofit in their housing stock, using lessons from Wave 1, and some SHLs have higher confidence in decarbonising their housing stock. However, there is some limited evidence that some SHLs had some existing skills and capabilities to conduct energy efficiency retrofit and/or have built these through other retrofit work. Therefore, we conclude that the level of causality is 2.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
3b SHLs' own private investment in energy performance upgrades (motivated by future expectations of government regulation to deliver net zero) develops SHL capability and capacity to undertake future retrofit projects because they learn from their own project experience and develop new internal processes and resources.	**Limited** There is limited triangulated evidence that SHLs have built capacity and learnings through energy efficiency retrofit work using other government or internal funds.	**Level of causality: 2** There is strong evidence that participation in SHDF Wave 1 has improved SHLs' capabilities and capacities to undergo future retrofit projects, through providing SHLs with learnings, skills, and motivations to train their teams. Participating SHLs have future plans for undertaking more energy efficiency retrofit in their housing stock, using lessons from Wave 1, and some SHLs have higher confidence in decarbonising their housing stock. However, there is some limited evidence that some SHLs had some existing skills and capabilities to conduct energy efficiency retrofit and/or have built these through other retrofit work. Therefore, we conclude that the level of causality is 2.

3.4 The pathway to supply chain building, retrofit innovation and Value for Money

Wave 1 of the SHDF has objectives to develop the green economy and associated jobs, to develop retrofit innovation and value for money, and to increase the retrofit supply chain capability and capacity. This section describes inputs and activities that are part of the causal pathway related to these benefits (Figure 3).

Figure 3: Supply chain capacity and capability building, retrofit innovation and value for money



Supply chain inputs

Existing supply chain skills and capacity

In addition to the inputs already described, there is an existing body of expertise and knowledge within the retrofit supply chain to support delivery of the decarbonisation of the UK housing sector. However, there has been a significant gap in labour skills and capacity in terms of what is required to meet the burgeoning demand from this and other housing retrofit initiatives on the pathway to net zero. The large Wave 1 investment and subsequent substantial pipeline of retrofit measure requirements are intended to signal to the supply chain market the case for investing in upskilling and capacity building. Evidence from the Wave 1 process evaluation suggests that members of the supply chain in Wave 1 projects have enhanced their capacity for future retrofit projects.

Activities involving the supply chain

Supply chain analysis

Over the course of the SHDF Main Fund, there have been two strands of analysis to map and understand supply chain capabilities and constraints. The first strand involved partner analysis of the successful 69 bids in Wave 1. The second strand focused on the wider supply chain market and included a data led assessment of market capacity based on existing data available across all energy efficiency economic stimulus scheme in Wave 1. These exercises highlighted a range of pressing challenges in the supply chain including rising material and labour costs, shortage of qualified installers and retrofit coordinators and the need for policy certainty in government investment to support supply chain activity.

Supply chain engagement

Wave 1 implemented engagement plans and strategies to ensure the supply chain market was aware of the financial opportunities available. These activities aimed to instil confidence to invest in expanding capacity in material and labour supply. Following key trade body engagements and the review of Wave 1 bids, a taxonomy of SHDF supply chain was developed including labour, skills, materials, contractors and leadership and sponsorship (SHLs). A range of stakeholders were mapped against the taxonomy and engaged to gather sector specific insights. Evidence from the Wave 1 process evaluation shows DESNZ undertook a range of engagement activities with the supply chain prior to the commencement Wave 1.

Project delivery

Thanks to the SHDF team engagement and wider DESNZ interaction with the supply chain, SHLs were able to appoint retrofit coordinators. These coordinators were then also able to secure accredited installers and source high-quality materials to install energy performance measures.

Assumption: The different individuals and organisations within the supply chain are able to work effectively together to deliver the installations as required. Evidence from the Wave 1 process evaluation is consistent with this assumption.

External factor/risk: Price inflation resulting in high costs of materials and/or labour costs may delay projects or reduce the number of installations. Evidence from the Wave 1 process evaluation shows this was an issue for most Wave 1 projects.

External factor: SHDF team interaction with the wider work of the Homes Decarbonisation Supply Chain Team and DESNZ informs the Wave 1 supply chain engagement approaches and facilitates cross-learnings. Other DESNZ programmes like the Skills Training Competition/the Retrofit Academy and Department of Education initiatives provide upskilling opportunities for installers and retrofit coordinators. Evidence from the Wave 1 process evaluation suggests that some Wave 1 projects have struggled to find contractors to take part in their SHDF project due to high demand for retrofit services.

Risk: Parallel portfolio-level energy efficiency schemes run the risk of cross-cannibalising supply chain resources leading to delays and cost overruns. No evidence of this risk emerged from the Wave 1 process evaluation.

External factor/risk: The supply chain finds new build work and/or other private sector opportunities more attractive than those of Wave 1. Evidence from the Wave 1 process evaluation suggests this was not a significant issue for Wave 1 projects.

Output: The key output for Wave 1 is the installation of high-quality energy performance measures in social homes. Evidence from the Wave 1 impact report shows that energy performance measures were installed in compliance with PAS 2035 in social homes.

Outcomes relating to the supply chain

The installation of measures leads to a number of outcomes relating to the supply chain and retrofit sector.

Wide range of regions engaged with

Energy performance measures are installed in regions across England.

Assumption: Projects are awarded in a relatively balanced way across the regions. Evidence from the Wave 1 process evaluation is largely consistent with this assumption.

Risk: Supply chain constraints in specific areas limit achievement of this outcome. The Wave 1 impact evaluation shows higher costs for measures in London, the South West and the West Midlands. This possibly indicates supply chain constraints, suggesting some regional pressure, but other factors may also influence these costs.

Increase in accredited suppliers/contractors carrying out work

In response to the large pipeline of Wave 1 projects and SHDF team engagement with the supply chain, the supply chain expands capacity and capability such that retrofit coordinators, installers and materials are available for use on projects. The requirement for Trustmark/MCS drives suppliers to invest in achieving accreditation. Evidence from the Wave 1 impact evaluation shows that Wave 1 contracts led to supply chain accreditation, training and upskilling.

Assumption: Sufficient numbers of installers/suppliers have the resource to achieve Trustmark and MCS accreditation. The supply chain can identify an ongoing business case for providing retrofit services to justify this investment. This holds true regionally to enable projects in different areas to progress successfully. Evidence from the Wave 1 impact evaluation is consistent with this assumption.

Risk: Suppliers choose not to become involved because PAS 2035 adds significant administrative and reporting burden. There is evidence from the Wave 1 process evaluation that PAS 2035 created significant administrative and reporting burden for some participating suppliers. It is not known if this prevented some suppliers from becoming involved with the scheme.

Risk: Suppliers choose not to undertake MSC accreditation and to install clean heat measures because this is too much of an additional cost on top of PAS 2035/Trustmark. There was evidence from the Wave 1 evaluation that some supply chain stakeholders did not diversify into measures such as heat pumps and solar because it was perceived that government and consumer support was lower or more likely to change.

Risk: A perceived lack of long-term policy certainty reduces supply chain appetite to invest in accreditation and upskilling. Evidence from the Wave 1 impact evaluation suggests this was not an issue.

Risk: SHLs decide to rely on large national supply chain organisations, as they have the required capacity to carry out work in the required timescales. As a result, smaller and more local organisations are not able to expand their capacity and capability for retrofit. Evidence from the Wave 1 process evaluation suggests this was an issue for some Wave 1 projects.

Wide range of projects undertaken and retrofit techniques/measures used

A diversity of social housing retrofit projects varying in archetype, tenure mix and resident type were undertaken and involved installation of a wide range of retrofit techniques/measures.

Benefits relating to the supply chain and retrofit innovation and value for money

Green jobs supported across England

Installation of energy performance measures in social homes across the English regions leads to an increase in the creation, maintenance and upskilling of both direct and indirect green jobs and apprenticeships amongst retrofit coordinators, retrofit assessors and installers. This contributes to delivery of the levelling-up agenda. The Wave 1 impact evaluation provides evidence supporting Wave 1 contribution to this benefit.

Upskilled and expanded supply chain

The requirement for Trustmark/MCS and PAS certification has driven suppliers to invest in achieving accreditation thereby increasing the overall number of certified installers. The pipeline of work is also expected to have increased capacity and capability amongst retrofit coordinators and manufacturers of required materials. The Wave 1 coordination of different measures to be installed in multiple homes in one location plus the scale of the works provides a valuable opportunity to the supply chain. The Wave 1 impact evaluation provides evidence supporting Wave 1 contribution to this benefit.

Innovation in process and VfM

Whilst Wave 1 did not require innovation or use of new technologies, undertaking large-scale retrofitting inherently spurs some innovation in processes. Enabling innovation (in both process and product) can drive down retrofit costs and improve value for money. The innovation is expected not only in retrofit technologies, but also in relation to procurement and collaboration between actors. The Wave 1 impact evaluation provides some limited evidence of innovative retrofit techniques and project processes being used.

External Factor: Other schemes (Green Homes Grant, energy innovation schemes: SMETER, Heat Pump Ready etcetera) may support the projects through novel technologies and processes, including digitalisation and efficient heat systems. Evidence from the Wave 1 impact report shows SHL learnings from participation in previous government schemes being built upon within Wave 1 projects.

Reduction in average cost of retrofit measures

Wider implementation of retrofit measures can benefit from economies of scale leading to reduction in the average cost and time of retrofitting. The Wave 1 impact evaluation provides evidence supporting Wave 1 contribution to this benefit.

External factor: High levels of inflation will affect the average cost of retrofit measures. The Wave 1 impact evaluation provides evidence of this.

Wave 1 scheme objectives

Upskilled and expanded supply chain

SHDF project-based exposure leads to learning and improvement in processes and methods, consequently increasing supply chain capabilities across retrofit coordinators, installers and manufacturers. Positive experience and learning on Wave 1 drive participating suppliers' interest and confidence in expanding capabilities and capacities further. The Wave 1 impact evaluation provides evidence supporting Wave 1 contribution to this benefit.

Development of the retrofit sector

Innovation in retrofit and reduced average cost of measures support wider development of the retrofit sector for the broader benefit of the owner occupier and private rental sector as well as the social housing sector. Knowledge creation and learning from the projects enables replicability and scaling up of innovative retrofitting measures. Evidence from the Wave 1 impact evaluation suggests that use of PAS 2035 in Wave 1 (and other government schemes) has set expectations and practice about standards and quality in the retrofit industry. There is a gap in evidence in terms of the impacts for the wider sector as the evaluation did not directly engage with stakeholders not involved in Wave 1.

External factor: Other government initiatives are also likely to influence the supply chain, development of retrofit sector and VfM. These include: Home Upgrades Grant, Local Authority Delivery Scheme, Energy Company Obligation, Green Homes Grant Voucher Scheme, PSDS, Green Deal Homes Improvement Fund, Heat Pump Ready, Boiler Upgrade Scheme, Green Heat Network Fund and Heat Network Delivery Unit. Evidence from the Wave 1 impact evaluation suggests that for the supply chain who participated in the scheme, Wave 1 was a more significant contributor to their development than other government initiatives.

Table 3: Contribution Claims relating to Supply Chain outcomes and impacts: Strength of evidence and causality

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
4a SHDF Wave 1 team analysis of and engagement with the supply chain facilitates the availability of accredited supply chain and materials to deliver the Wave 1 energy performance project in a timely and cost effective manner. This is because Wave 1 communications encourage supply chain participation and feed into wider government initiatives to develop the supply chain.	**Moderate** There is strong triangulated and chronologically consistent evidence that the supply chain shows a good understanding of SHDF and that DESNZ representatives have engaged with the supply chain. There is further authoritative evidence that Wave 1 projects have delivered retrofits and engaged with suppliers. However, there is evidence that issues with supply chain capacity (among other issues) may still have resulted in fewer properties receiving measures than initially planned. This includes shortages in materials, labour, and contractors in the market.	**Level of causality: 2** We can reasonably conclude that engagement of the SHDF Wave 1 team with the supply chain supported the supply chain to deliver Wave 1 projects. There is strong evidence that the supply chain had a good understanding of SHDF and that DESNZ engaged with them, including support and funding for upskilling. There is, however, evidence to suggest that lack of supply chain capacity contributed to fewer properties receiving measures than planned in Wave 1 (amongst other factors). Furthermore, there is some limited evidence that the supply chain is resistant to invest fully in upskilling in specific parts of the retrofit sector (e.g. heat pumps) as a result of uncertainty of future government direction. Therefore, we conclude that the level of causality is 2, as the intervention contributed in a necessary way to the results.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
4b The absence of confirmed plans for future SHDF waves and wider uncertainty about relevant government policy and regulation limits the availability of accredited supply chain and materials to deliver SHDF energy performance projects in a timely and cost effective manner because the market perceives the immediate opportunity as limited and the longer term opportunity as uncertain.	**Limited** There is limited evidence that some supply chain stakeholders were resistant to training in specific areas such as heat pumps, due to uncertainties over future government direction. However, there was no evidence that supply chain engagement was held back as a result of unconfirmed plans for future waves of SHDF. Future waves are now confirmed and underway.	**Level of causality: 2** We can reasonably conclude that engagement of the SHDF Wave 1 team with the supply chain supported the supply chain to deliver Wave 1 projects. There is strong evidence that the supply chain had a good understanding of SHDF and that DESNZ engaged with them, including support and funding for upskilling. There is, however, evidence to suggest that lack of supply chain capacity contributed to fewer properties receiving measures than planned in Wave 1 (amongst other factors). Furthermore, there is some limited evidence that the supply chain is resistant to invest fully in upskilling in specific parts of the retrofit sector (e.g. heat pumps) as a result of uncertainty of future government direction. Therefore, we conclude that the level of causality is 2, as the intervention contributed in a necessary way to the results.
5a Wave 1 energy performance project contributes to better Value for Money in retrofit. This occurs because the increased volume of retrofits being undertaken creates economies of scale thereby reducing costs. In addition, Wave 1 encourages early investment from SHLs in advance of future regulations.	**Moderate** There is strong signature and chronologically consistent evidence that the supply chain experienced economies of scale through Wave 1. This is supported by limited evidence from SHLs of economies of scale. Data on costs is also limited.	**Level of causality: 2** We can reasonably conclude that Wave 1 projects have resulted in improvement to Value for Money in retrofit, through economies of scale. However, there was also evidence that high inflation in construction materials and costs limited Value for Money. Therefore, we conclude that the level of causality is 2, as the intervention contributed in a necessary way to the outcome.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
5b DESNZ programmes, including SHDF Wave 1, compete with each other for the supply chain limiting retrofit Value for Money because prices are pushed up by competing demand for limited supply.	**Limited** There is triangulated evidence that Wave 1 projects faced some difficulties accessing or affording the supply chain. However, there is no evidence that this was directly due to use of the supply chain on other DESNZ programmes.	**Level of causality: 2** We can reasonably conclude that Wave 1 projects have resulted in improvement to Value for Money in retrofit, through economies of scale. However, there was also evidence that high inflation in construction materials and costs limited Value for Money. Therefore, we conclude that the level of causality is 2, as the intervention contributed in a necessary way to the outcome.
5c High inflation limits retrofit Value for Money because the prices of materials and labour rise.	**Strong** There is authoritative, chronologically consistent evidence of high inflation affecting the price of materials and labour in the construction industry. This is triangulated with evidence of inflationary pressures from the supply chain and scheme management.	**Level of causality: 2** We can reasonably conclude that Wave 1 projects have resulted in improvement to Value for Money in retrofit, through economies of scale. However, there was also evidence that high inflation in construction materials and costs limited Value for Money. Therefore, we conclude that the level of causality is 2, as the intervention contributed in a necessary way to the outcome.
6a Wave 1 retrofit project contributes to innovation and improvement in retrofit processes. This occurs because the PAS 2035 requirement encourages quality improvement and there is an active programme of learning management across projects.	**Strong** There is strong triangulated, signature and chronologically consistent evidence that the supply chain has improved their processes as a result of Wave 1 involvement and the PAS 2035 requirements, and that they had engaged in learning. However, there is some evidence that learning could have been more of a focus.	**Level of causality: 2** We can reasonably conclude that Wave 1 projects have resulted in improvement to the retrofit processes, as a result of PAS 2035 requirements. Evidence from the supply chain indicates their processes have improved, and many stakeholders reported learnings. However, there was limited evidence of learnings being shared. Therefore, we conclude that the level of causality is 2, as the intervention contributed in a necessary way to the outcome.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
7a Wave 1 contributes to the wider development of the supply chain's capability and capacity including creation of new jobs. This occurs because the supply chain expands to take advantage of this large-scale, coordinated opportunity. In addition, the supply chain invests in upskilling to fulfil Wave 1 accreditation requirements, and develops skills and processes through the project experience itself.	**Strong** There is strong triangulated and chronologically consistent evidence that supply chain stakeholders have enhanced capacity and capability as a result of Wave 1 and its requirements. There is signature evidence of new accreditations, and chronological evidence of other new skills gained. There is also triangulated evidence that Wave 1 supported new green jobs.	**Level of causality: 2** There is strong evidence that Wave 1 has enhanced the supply chain's capacity, capability, and skills, resulting in learning, job creation, training, and accreditation. There is also evidence that green jobs have been supported through newly accredited installers and apprenticeships. While there is some evidence that supply chain stakeholders took part in other schemes, they felt that impacts were attributable to Wave 1. There is limited evidence that Wave 1 requirements impacted the profitability of project delivery for supply chain stakeholders. However, the experience was still regarded as beneficial. All supply chain stakeholders reported an expanded interest in the sector as a result of Wave 1. Therefore, we conclude that the level of causality is 2, as the intervention was essential, but other factors may also have had some influence.

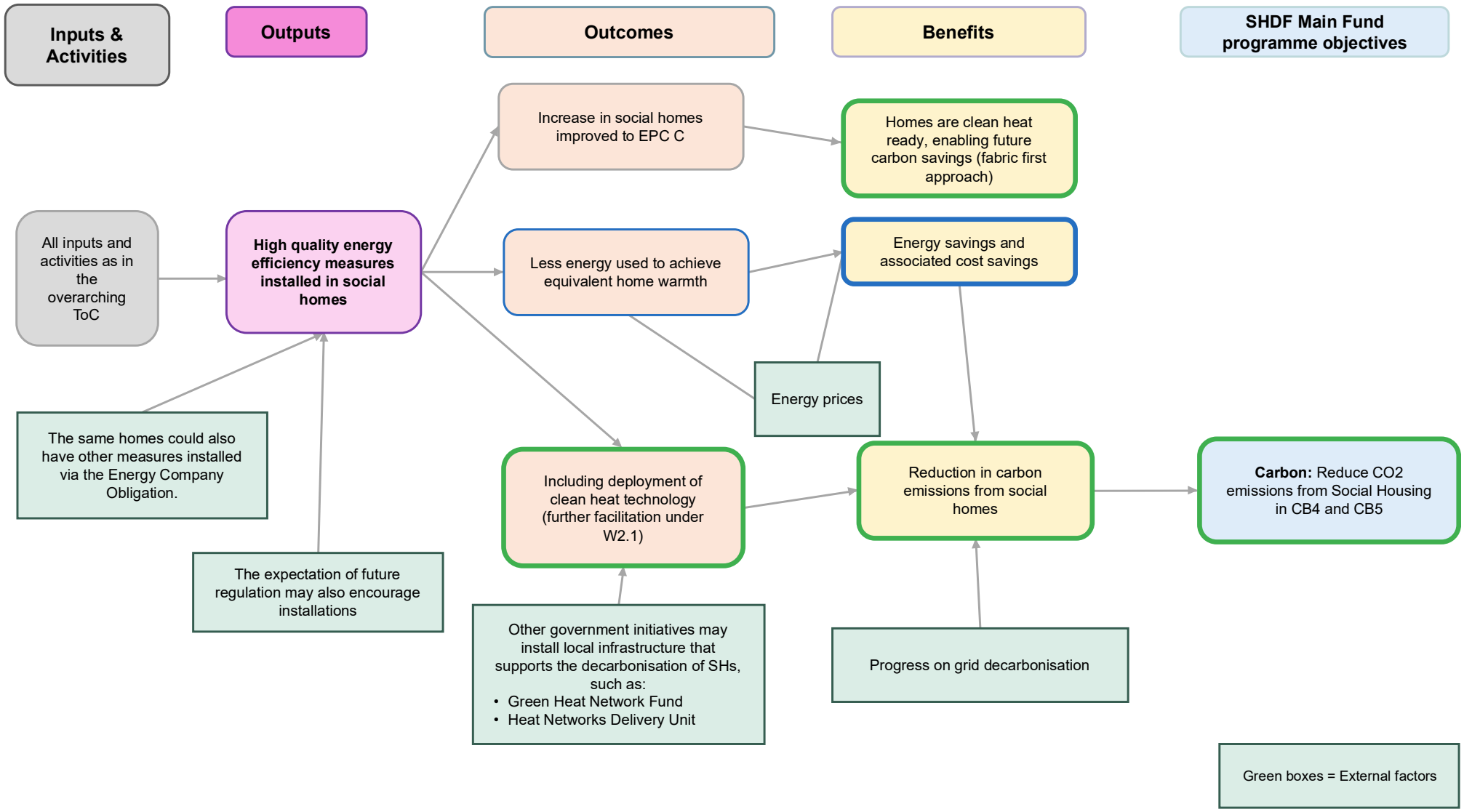
Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
7b Other DESNZ energy efficiency initiatives (including ECO, HUG etc.) contribute to each of the above impacts (5, 6, and 7) as a result of the same mechanisms within those programmes.	**Limited** There is evidence that the supply chain stakeholders consulted also took part in other schemes. However, they felt that impacts were mostly attributable to Wave 1 as this was larger in scale and in value of contracts.	**Level of causality: 2** There is strong evidence that Wave 1 has enhanced the supply chain's capacity, capability, and skills, resulting in learning, job creation, training, and accreditation. There is also evidence that green jobs have been supported through newly accredited installers and apprenticeships. While there is some evidence that supply chain stakeholders took part in other schemes, they felt that impacts were attributable to Wave 1. There is limited evidence that Wave 1 requirements impacted the profitability of project delivery for supply chain stakeholders. However, the experience was still regarded as beneficial. All supply chain stakeholders reported an expanded interest in the sector as a result of Wave 1. Therefore, we conclude that the level of causality is 2, as the intervention was essential, but other factors may also have had some influence.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
7c Supply chain experience on Wave 1 limits their interest in expanding capacity and developing further skills because of the difficulty to deliver successful outcomes to the standards required for Wave 1 profitably.	**Limited** There was some limited signature and chronologically consistent evidence that Wave 1 requirements impacted the profitability of the supply chain's work. However this was felt to be beneficial anyway as it prepared them for future work. There was no evidence that supply chain stakeholders have a limited interest in the sector as a result of Wave 1.	**Level of causality: 2** There is strong evidence that Wave 1 has enhanced the supply chain's capacity, capability, and skills, resulting in learning, job creation, training, and accreditation. There is also evidence that green jobs have been supported through newly accredited installers and apprenticeships. While there is some evidence that supply chain stakeholders took part in other schemes, they felt that impacts were attributable to Wave 1. There is limited evidence that Wave 1 requirements impacted the profitability of project delivery for supply chain stakeholders. However, the experience was still regarded as beneficial. All supply chain stakeholders reported an expanded interest in the sector as a result of Wave 1. Therefore, we conclude that the level of causality is 2, as the intervention was essential, but other factors may also have had some influence.

3.5 Pathway to Energy and Carbon Savings

The inputs and activities already described in the previous sections were expected to lead to the installation of high-quality energy performance measures in social homes as the principal output of Wave 1. This next section describes the pathway through which installation of these measures leads to environmental benefits in the form of energy and carbon savings. This ultimately feeds into the overarching objective of the SHDF Main Fund to reduce CO2 emissions from social housing in the fourth and fifth Carbon Budgets (Figure 4).

Figure 4: Pathway to energy and carbon savings



Outputs: The principal output of Wave 1 is to install high-quality energy performance measures in social homes. These measures can include any energy efficiency and heating measures which are compatible with the Standard Assessment Procedure (SAP) 2012. For example, wall, loft and underfloor insulation and heat pumps. Evidence from the Wave 1 impact report shows that energy performance measures were installed in compliance with PAS 2035 in social homes.

Assumption: Any installations and retrofits are made in line with expectations and are up to standard. Eligible installers must be TrustMark accredited (or equivalent) or MCS accredited (or equivalent) where relevant. Any installations should be in compliance with PAS 2035 specifications for whole-house retrofit. SHLs must adhere to all relevant building safety and construction product regulations and requirements. Upon the completion or works, properties involved are expected to reach at least EPC Band C (or Band D, where this is not possible for properties originally at EPC F or G), with a space heating demand target of 90 kWh/m2/year. Evidence from the Wave 1 process evaluation is consistent with this assumption.

External factor: It is possible that SHLs access other public funding (Home Upgrades Grant or the Green Homes Grant) to install energy performance measures directly or that some measures could also be installed by energy suppliers in social housing via the government ECO schemes. However, it is intended that the main government support scheme used in social housing will be the SHDF Main Fund. Evidence from the Wave 1 impact evaluation shows that energy efficiency measures were installed in social housing stock using funding from other government schemes, notably ECO.

External factor: SHL expectations about the potential for future government regulation of energy standards in social housing or internal SHL desire to contribute to net zero pathways might motivate additional investment outside Wave 1 in energy performance measures either currently or in the near future. Evidence from the Wave 1 impact evaluation suggests that while anticipation of future regulatory change focused upon energy performance of social housing may have played a role in some SHLs' motivation to retrofit, Wave 1 funding enhanced or expanded the scope of SHL's plans for retrofit.

Environmental outcomes

Increase in social homes improved to EPC C

As a result of the installations, social homes are improved to EPC Band C or higher. Where properties were originally at EPC Band F or G and it is not possible to reach EPC Band C, properties must reach Band D upon the completion of works. Evidence from the Wave 1 impact evaluation shows this has been achieved for 98.5% of properties.

Energy savings

The installation of more efficient technologies lead to energy savings. Residents can use less energy to achieve equivalent home warmth. Evidence from the Wave 1 impact evaluation suggests that residents now use less gas to heat their homes. However, there is some evidence that residents may have limited their reduction in energy due to the reduced costs of energy.

Assumption: Residents use any new equipment appropriately and effectively and can access instructions or support for this where necessary. Evidence from the Wave 1 impact evaluation suggest that less than a third of residents received support or guidance from landlords or installers following Wave 1. This indicates that residents may not know the optimal setting and usage of new equipment.

Assumption: SHLs employ sufficient monitoring and evaluation of the measures installed to ensure that any performance issues are identified and addressed. Guidance and advice from TAF and the DP is sufficient to support SHLs where their expertise is limited. No evidence was found in the Wave 1 evaluation to support or disprove this.

Risk: There is a performance gap whereby the performance of energy efficiency measures is poorer than expected, reducing the energy and carbon savings resulting from the measures. There is evidence in the Wave 1 impact evaluation that total energy and carbon savings were lower than anticipated. This was partially explained by a reduction in the number of properties with measures installed and a change in the profile of measures installed. There was very limited evidence to suggest that this was as a result of the performance of energy efficiency measures being poorer than expected.

Risk: There is a rebound effect in which residents increase their energy use because they can now afford to heat their homes to a higher temperature or use other electrical appliances for longer periods due to the cost savings arising from energy efficiency measures. However, this may be unlikely in the current context of high energy prices. There is evidence in the Wave 1 impact evaluation suggesting that this occurred in some cases.

External factor: Energy prices ultimately affect cost savings arising from reduced energy use but change in energy prices may also directly affect resident behaviour in relation to energy use. High energy prices may lead residents to reduce their energy use (with or without energy performance measures). There is evidence in the Wave 1 impact evaluation indicating that energy price inflation may have impacted average bills savings in properties included in Wave 1. However, there is no evidence that residents reduced their energy use as a result of higher prices.

Deployment of clean heat technology

Energy performance measures include the deployment of clean heat technology. Evidence from the Wave 1 impact evaluation supports this.

External factor: Other government initiatives and regulations are also expected to support the deployment of clean heat technology, for example by installing local infrastructure to support decarbonisation of social homes (e.g. the Green Heat Network Fund and the Heat Networks Delivery Unit). There is evidence in the Wave 1 impact evaluation that some clean heat measures were installed in social housing via other government initiatives, notably ECO.

Risk: SHLs may have decided not to install clean heat measures because this can lower rather than improve a property's EPC rating. SHLs may also delay decisions to install clean heat because there is uncertainty about government policy on gas boilers and on use of hydrogen versus electrification of heat. In the Wave 1 impact evaluation, there is no evidence that SHLs chose not to install clean heat measures because it lowers a property's EPC rating. However, there is some evidence that SHLs were hesitant to install clean heat measures as a result of a lack of clear messaging from the government.

Risk: SHLs may also face particular reluctance from residents to have clean heat measures installed. There is some evidence in the Wave 1 process evaluation that residents were concerned about the impact of clean heat measures upon their energy costs.

Environmental benefits

Carbon, energy and associated cost savings

Where residents reduce their energy use, this leads to reductions in energy costs. This energy saving also leads to reductions in carbon emissions together additional carbon savings arising from the deployment of clean heat technologies. There is evidence in the Wave 1 impact evaluation that residents saw a reduction in their energy bills. However, some residents saw no change and some saw an increase in their energy bills. Further, there is evidence that Wave 1 resulted in carbon emissions savings. A part of this was also the result of clean heat installations.

Homes are better prepared for clean heat installations

The improvement of social homes to EPC C through a fabric first approach is likely to make homes more suitable for the future installation of clean heat measures. This unlocks the potential for future additional carbon savings. There is evidence in the Wave 1 impact evaluation that many social homes which took part Wave 1 had fabric improvements meaning they are now more suitable for future clean heat installations. Further, Wave 1 SHLs have reported plans to conduct clean heat installations in their housing stock.

External factor: Progress on decarbonisation of the grid will also influence the carbon savings achieved. The carbon intensity of the grid has been decreasing during the period of the Wave 1 scheme.

Table 4: Contribution Claims relating to Energy and Carbon outcomes and impacts: Strength of evidence and causality

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
8a Installation of high quality energy performance measures through Wave 1 contribute to reductions in energy use because residents require less energy to achieve equivalent home warmth.	**Strong** There is chronological and triangulated evidence from interviews and surveys with residents that some use less energy to heat their homes after Wave 1 involvement. There is further authoritative evidence that energy performance measures installed under Wave 1 resulted in a reduction in gas consumption in participating properties. However, there are some inconsistencies as not all residents reported a lower energy usage and no significant change in electricity consumption was found.	**Level of causality: 2** We can reasonably conclude that the installation of energy performance measures under Wave 1 has contributed to reductions in gas usage in homes, as residents require less energy to heat their homes. However, there is some evidence that residents may have limited their reduction in energy due to reduced costs. Therefore, we conclude that the level of causality is 2, as the intervention was essential for reducing energy consumption in these homes but there may be some limiting influence from external factors, such as resident behaviour.
8b Installation of high quality energy performance measures through other government initiatives contributes to reductions in energy use because residents require less energy to achieve equivalent home warmth.	**No Evidence** There is no evidence that interviewed SHLs used other government funding on the same housing stock as in Wave 1 during the same time period. In addition, the QEA analysis excludes properties that have been treated through other government schemes from the analysis of energy savings to account for this where it does occur.	**Level of causality: 2** We can reasonably conclude that the installation of energy performance measures under Wave 1 has contributed to reductions in gas usage in homes, as residents require less energy to heat their homes. However, there is some evidence that residents may have limited their reduction in energy due to reduced costs. Therefore, we conclude that the level of causality is 2, as the intervention was essential for reducing energy consumption in these homes but there may be some limiting influence from external factors, such as resident behaviour.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
8c Following installation of high-quality energy performance measures through Wave 1, residents limit reductions in their energy use because it costs less to heat their homes.	**Moderate** There is some chronologically consistent, signature evidence that residents have limited their reduction in energy due to reduced costs.	**Level of causality: 2** We can reasonably conclude that the installation of energy performance measures under Wave 1 has contributed to reductions in gas usage in homes, as residents require less energy to heat their homes. However, there is some evidence that residents may have limited their reduction in energy due to reduced costs. Therefore, we conclude that the level of causality is 2, as the intervention was essential for reducing energy consumption in these homes but there may be some limiting influence from external factors, such as resident behaviour.
8d High energy prices, the cost of living crisis and/or environmental motivations contribute to reductions in energy use because residents actively reduce their energy use in response to these factors. The later and longer timeline of delivery for Wave 2.1 means that the external context, particularly in terms of energy prices and inflation, may have changed substantially by the time of installations. This may make alternative explanations concerned with living and energy costs more or less likely.	**Limited** There is some chronologically consistent, signature evidence that residents were reducing their energy use as a result of high energy costs prior to Wave 1. However, this would be taken into account in the parallel trends assumption in the QEA so this would not override the reduction in energy savings due to Wave 1.	**Level of causality: 2** We can reasonably conclude that the installation of energy performance measures under Wave 1 has contributed to reductions in gas usage in homes, as residents require less energy to heat their homes. However, there is some evidence that residents may have limited their reduction in energy due to reduced costs. Therefore, we conclude that the level of causality is 2, as the intervention was essential for reducing energy consumption in these homes but there may be some limiting influence from external factors, such as resident behaviour.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
9a Installation of high quality energy performance measures through Wave 1 contributes to carbon emissions reductions because energy use is reduced and, in some cases, a new lower carbon heating system or renewable energy generators (i.e. solar) are installed.	**Strong** There is authoritative and chronologically consistent evidence that energy efficiency measures have been installed in Wave 1 that have resulted in a reduction in energy consumption, which has resulted in annual carbon emissions savings. This is further triangulated by chronologically consistent, authoritative data showing that low carbon heating and solar have been installed under Wave 1.	**Level of causality: 1** There is strong evidence to suggest that the installation of energy performance measures under Wave 1 resulted in carbon emissions reductions, through reduced energy (gas) consumption and, in some cases, installation of low carbon heating measures and Solar PV. Therefore, we conclude the level of causality is 1, as the intervention alone was sufficient to reach this outcome.
10a Installation of high quality energy efficiency measures through Wave 1 facilitates future carbon emissions reductions because the fabric of social homes is improved meaning they are more suitable for future clean heat installations.	**Strong** There is triangulated and chronologically consistent evidence that homes are now better prepared for low carbon heat installations, and that some of the SHLs and residents consulted are interested in future clean heat installations, which will facilitate future carbon emissions reductions. This is further triangulated by authoritative data showing EPC ratings have now increased in homes involved in Wave 1, further suggesting these homes are more suitable for low carbon heat installations.	**Level of causality: 3** We can reasonably conclude that the installation of energy efficiency measures under Wave 1 has facilitated future carbon emissions savings as homes are now more suitable for clean heat installation. There is also evidence to suggest that there are plans to install clean heat in the homes treated under Wave 1. However, there is also evidence that other government initiatives will contribute to clean heat installations and future carbon reductions. Therefore, we conclude that the level of causality is 3, as the intervention contributed to this outcome, but there are other external factors also contributing so it was neither sufficient nor necessary.

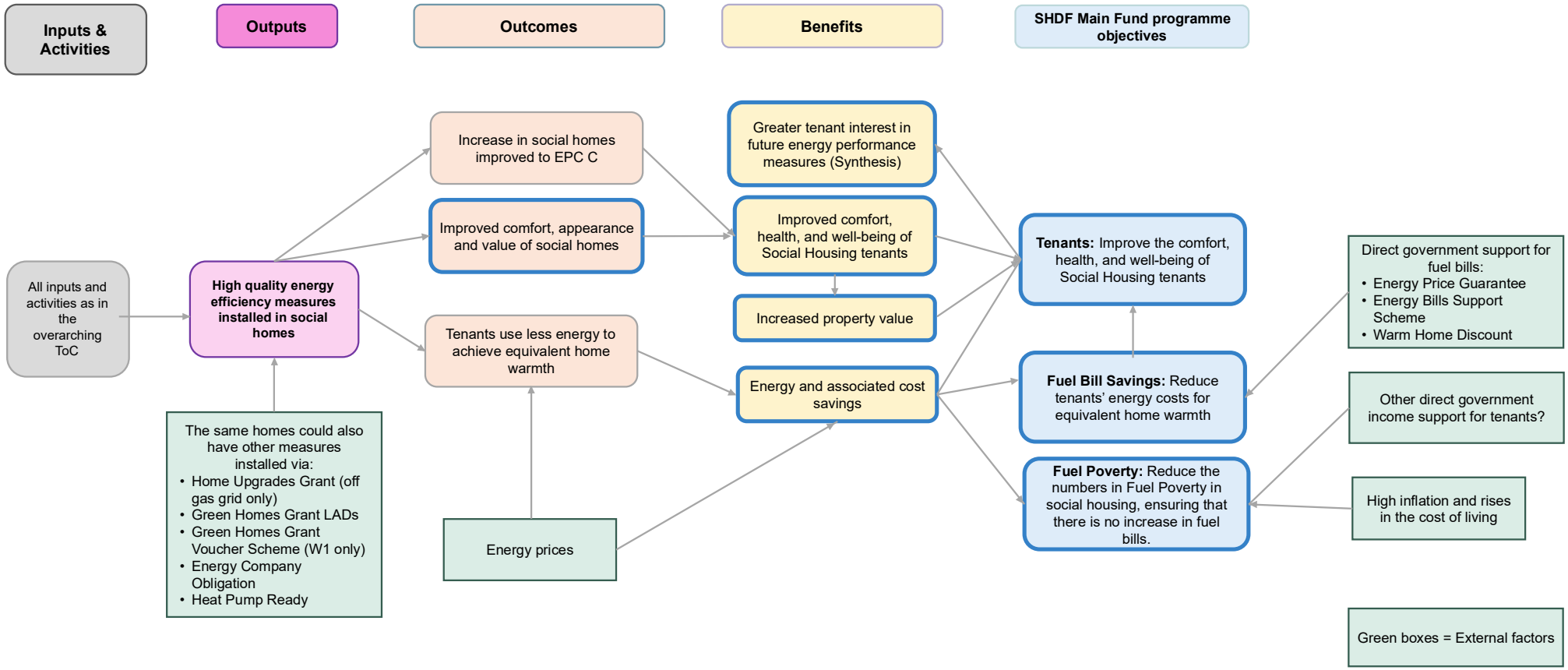
Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
10b Wider government initiatives to develop low carbon heating infrastructure contribute to carbon emissions reductions because this supports use of low carbon heating systems in social homes.	**Strong** There is authoritative evidence that other funding initiatives have supported the installation of low carbon heating measures and Solar PV in social homes at the same time as Wave 1.	**Level of causality: 3** We can reasonably conclude that the installation of energy efficiency measures under Wave 1 has facilitated future carbon emissions savings as homes are now more suitable for clean heat installation. There is also evidence to suggest that there are plans to install clean heat in the homes treated under Wave 1. However, there is also evidence that other government initiatives will contribute to clean heat installations and future carbon reductions. Therefore, we conclude that the level of causality is 3, as the intervention contributed to this outcome, but there are other external factors also contributing so it was neither sufficient nor necessary.
10c Uncertainty about future government policy and regulation on low carbon heating limits carbon emissions reductions because SHLs delay installation of low carbon heating systems.	**Limited** There is limited evidence that SHLs feel uncertainty in future government policy and have therefore delayed installation of low carbon heating measures.	**Level of causality: 3** We can reasonably conclude that the installation of energy efficiency measures under Wave 1 has facilitated future carbon emissions savings as homes are now more suitable for clean heat installation. There is also evidence to suggest that there are plans to install clean heat in the homes treated under Wave 1. However, there is also evidence that other government initiatives will contribute to clean heat installations and future carbon reductions. Therefore, we conclude that the level of causality is 3, as the intervention contributed to this outcome, but there are other external factors also contributing so it was neither sufficient nor necessary.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
10d Future government requirements for carbon emissions reductions as part of the pathway to net zero limit the future additionality of SHDF W1 installations in respect of carbon emissions because these requirements will have to be met.	**Limited** There is some limited authoritative and chronologically consistent evidence that the government intends to introduce future policies and regulations for carbon emissions reductions in social homes, which may limit the additionality of Wave 1.	**Level of causality: 3** We can reasonably conclude that the installation of energy efficiency measures under Wave 1 has facilitated future carbon emissions savings as homes are now more suitable for clean heat installation. There is also evidence to suggest that there are plans to install clean heat in the homes treated under Wave 1. However, there is also evidence that other government initiatives will contribute to clean heat installations and future carbon reductions. Therefore, we conclude that the level of causality is 3, as the intervention contributed to this outcome, but there are other external factors also contributing so it was neither sufficient nor necessary.

3.6 Resident impacts

The inputs and activities already described in the previous sections were expected to lead to the installation of high-quality energy performance measures in social homes as the principal output of Wave 1. This next section describes how installation of these measures was intended to lead to benefits for residents as per the objectives of the SHDF to: improve the comfort, health and wellbeing of social housing residents; reduce residents' energy costs for equivalent home warmth; and reduce the numbers in fuel poverty in social housing (Figure 5).

Figure 5: Pathway to resident impacts



The inputs and activities already described in the previous sections were expected to lead to the installation of high-quality energy performance measures in social homes as the principal output of Wave 1. This next section describes how installation of these measures was intended to lead to benefits for residents as per the objectives of the SHDF to:

- Improve the comfort, health and wellbeing of social housing residents.
- Reduce residents' energy costs for equivalent home warmth.
- Reduce the numbers in fuel poverty in social housing.

Resident outcomes

Improved comfort, appearance and value of social homes

As a result of the installation of energy performance measures, social homes will be more comfortable and have an improved appearance. Homes could be warmer and less damp with less mould. Installation of insulation leads to improved appearance of the property structure through, for example, newly rendered internal and external walls or new doors, windows or glazing. Evidence in the Wave 1 impact evaluation indicates that Wave 1 has contributed to increased comfort for residents, with reported improvements in issues such as condensation, damp, mould and draughts. However, there is evidence that these issues remained the same or were worsened after Wave 1 for some residents. There is also evidence that more than half of residents now have more pride in their home as a result of measures such as new windows and doors.

Resident benefits

Fuel bill savings and reduced numbers in fuel poverty

Residents using less energy to heat their homes to equivalent warmth results in associated energy and cost savings (noting the assumptions, risks and external factors articulated in the previous section). Lower fuel bills are then expected to reduce the overall number of residents experiencing fuel poverty. Evidence from the Wave 1 impact evaluation shows that energy savings measures have made homes more efficient, requiring less energy to heat and homes remaining warm for longer when heating is switched off. There is also evidence that the number of residents experiencing fuel poverty has been reduced.

Assumption: Residents of different types including by age, gender, ethnicity and disability (as protected under the Public Sector Equality Duty) are able to benefit equally from installation of measures and arising benefits. Evidence from the Wave 1 process evaluation indicates that following installation of energy saving measures, disabled residents or residents with a long-term health condition were more likely to report negative effects to their health and to have more difficulty reducing their energy use overall.

Risk: Residents with protected characteristics are less able to benefit than other residents because, for example, health problems mean they are not able to accommodate the disruption or displacement associated with the installation of energy performance measures. Evidence from the Wave 1 process evaluation supports this. Vulnerable or elderly residents were more likely than others to refuse participation in Wave 1 overall.

Assumption: Fuel poverty is being measured by LILEE (Low Income Low Energy Efficiency Indicator) where someone is in fuel poverty if the property EPC is below C and after heating their home they are left with a residual income below the official poverty line (60% below median equalised income after housing costs). Evidence presented in the Wave 1 impact evaluation uses this definition of fuel poverty.

External factors: Fuel bills are also expected to be significantly affected by direct government support for fuel bills including the current Energy Price Guarantee, Energy Bills Support Scheme, Warm Home Discount and any other future support. Other direct government income support for social housing residents plus other significant changes to household income (for example, arising from inflation) would also affect their likelihood of experiencing fuel poverty using the LILEE definition. Evidence from the Wave 1 impact evaluation suggests that other government schemes and initiatives have also resulted in a reduction in fuel poverty, such as the Energy Price Guarantee, Energy Bill Support Scheme, and ECO 3 and 4.

Improved comfort, health and well-being of social housing residents

The improved comfort and appearance of social homes could lead to physical and mental health benefits from reduced risk of cold-related illnesses, mould or damp related illness, and greater pride in the home. Evidence from the Wave 1 impact evaluation indicates a limited effect of measures on the physical or mental health of residents, but it does indicate that residents now have more pride in their home.

Lower fuel bills are also expected to improve the mental well-being of residents, by reducing stress associated with having to pay bills. Evidence from the Wave 1 impact evaluation shows that some residents reported improvements in their mental health, but a similar proportion reported that their mental health had worsened.

Greater resident interest in future energy performance measures

When residents see improved comfort, health and well-being as a result of the energy performance measures installed, this could promote interest in installing other energy efficiency or low carbon heating measures in the future. The same could occur when non-participating residents see the improvements being made to other properties. Evidence from the Wave 1 impact evaluation somewhat supports this. Over 40% of surveyed residents would consider further energy efficiency or low carbon heating measures, though it is not clear whether this is a result of improved comfort, health and wellbeing. There was limited evidence to suggest that Wave 1 created interest amongst non-participating residents in energy efficiency measures.

Assumption: Benefits are visibly apparent to non-participating residents or are communicated and disseminated sufficiently by residents, SHLs and/or government. There was limited evidence to support this.

Table 5: Contribution Claims relating to Resident outcomes and impacts: Strength of evidence and causality

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
11a Installation of high quality energy performance measures through Wave 1 contributes to reductions in fuel bills through lower energy consumption.	**Strong** There is authoritative evidence showing that gas consumption and therefore energy bills reduced in properties involved in Wave 1, compared with a control group. There is further triangulating and chronologically consistent evidence showing that some residents saw a reduction in their energy bills as a result of Wave 1.	**Level of causality: 3** There is evidence that Wave 1 has resulted in a reduction in energy bills for those involved. However, there is also evidence that this reduction was not true for all residents, with some experiencing an increase in bills. Furthermore, it was found that high energy prices have limited the benefits of Wave 1 on residents' fuel bills. We can conclude that fuel bills savings identified in Wave 1 homes were small relative to wider changes in energy prices at the time of Wave 1. Therefore, we conclude that the level of causality is 3, as the intervention was neither sufficient nor necessary to the outcome, but it did have some impact on reducing fuel bills.
11b High energy prices limit the beneficial impact of SHDF retrofits on fuel bills.	**Moderate** There is authoritative evidence that the fuel bill savings identified in Wave 1 homes were small relative to wider changes in energy prices. Further, there is some limited triangulated evidence from resident surveys suggesting that for some, energy bills increased, which was sometimes put down to increases in energy prices.	**Level of causality: 3** There is evidence that Wave 1 has resulted in a reduction in energy bills for those involved. However, there is also evidence that this reduction was not true for all residents, with some experiencing an increase in bills. Furthermore, it was found that high energy prices have limited the benefits of Wave 1 on residents' fuel bills. We can conclude that fuel bills savings identified in Wave 1 homes were small relative to wider changes in energy prices at the time of Wave 1. Therefore, we conclude that the level of causality is 3, as the intervention was neither sufficient nor necessary to the outcome, but it did have some impact on reducing fuel bills.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
12a Installation of high quality energy performance measures through Wave 1 contributes to improvements in the dwelling's energy efficiency and/or reductions in fuel bills reduce the number of residents at risk of fuel poverty.	**Strong** There is chronologically consistent, authoritative evidence that almost all of the Wave 1 homes previously in fuel poverty were taken out of fuel poverty.	**Level of causality: 2** There is strong evidence that the majority of homes involved in Wave 1 were lifted out of fuel poverty through reaching at least EPC C as a result of the energy efficiency measures installed as part of Wave 1. However, in a small number of homes the measures installed were insufficient for the property to reach EPC C. There is some evidence that other government schemes (such as ECO and Ofgem's energy price caps) have resulted in a reduction in fuel poverty. There is also some evidence that overall fuel poverty reductions (for properties below EPC C) were limited due to rising energy prices. Therefore, we conclude that the level of causality is 2, as the intervention was essential but not sufficient on its own. There were other contributing factors to the outcome.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
12b Other government energy bill initiatives such as the Energy Price Guarantee and Energy Bills Support Scheme plus wider government initiatives to support low-income households contribute to reductions in the risk of fuel poverty because the cost of energy is reduced and household incomes are supported.	**Moderate** There is authoritative evidence that other government schemes and initiatives have resulted in a reduction in fuel poverty. This includes the Energy Price Guarantee, Energy Bill Support Scheme, as well as ECO3 and ECO4.	**Level of causality: 2** There is strong evidence that the majority of homes involved in Wave 1 were lifted out of fuel poverty through reaching at least EPC C as a result of the energy efficiency measures installed as part of Wave 1. However, in a small number of homes the measures installed were insufficient for the property to reach EPC C. There is some evidence that other government schemes (such as ECO and Ofgem's energy price caps) have resulted in a reduction in fuel poverty. There is also some evidence that overall fuel poverty reductions (for properties below EPC C) were limited due to rising energy prices. Therefore, we conclude that the level of causality is 2, as the intervention was essential but not sufficient on its own. There were other contributing factors to the outcome.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
12c High energy prices limit the beneficial impact of SHDF retrofits on the risk of fuel poverty because energy bills are still unaffordable within household incomes. (Only applicable where homes are improved to less than EPC C.)	**Moderate** There is authoritative evidence that fuel poverty reductions have been limited due to rising energy prices. This would only apply to Wave 1 homes that were not improved to EPC C and may not have affected all of them, hence this would have played a small role.	**Level of causality: 2** There is strong evidence that the majority of homes involved in Wave 1 were lifted out of fuel poverty through reaching at least EPC C as a result of the energy efficiency measures installed as part of Wave 1. However, in a small number of homes the measures installed were insufficient for the property to reach EPC C. There is some evidence that other government schemes (such as ECO and Ofgem's energy price caps) have resulted in a reduction in fuel poverty. There is also some evidence that overall fuel poverty reductions (for properties below EPC C) were limited due to rising energy prices. Therefore, we conclude that the level of causality is 2, as the intervention was essential but not sufficient on its own. There were other contributing factors to the outcome.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
13a Installation of high quality energy performance measures through Wave 1 contributes to increased resident comfort, health and wellbeing because: • **Fuel bills are reduced thereby reducing financial stress and/or enabling residents to heat their homes to more comfortable levels.** • **There is lower incidence of cold home related illness.** • **Dangers arising from lower temperatures such as damp and mould are reduced.** • **Homes are more aesthetically pleasing providing greater pride in place.**	**Strong** There is triangulated, signature and chronologically consistent evidence that some residents have experienced increased comfort as a result of Wave 1, with further evidence that Wave 1 has improved physical and mental wellbeing amongst some residents involved. There is also triangulated, signature and chronologically consistent evidence that residents are now prouder of their homes.	**Level of causality: 3** We can reasonably conclude that some residents in Wave 1 homes have experienced enhanced comfort as a result of the interventions, though not all. Further, there is some evidence that the installations have resulted in enhanced mental or physical wellbeing in some residents involved in Wave 1, though a similar proportion reported they have seen negative change in mental or physical wellbeing. An equal proportion of residents are now less worried and more worried about paying their energy bills following Wave 1, indicating some financial stress over energy bills remains. In some cases, residents have reported that their fuel bills have increased, which is thought to be as a result of higher energy prices overall. Therefore, we conclude the level of causality is 3, as the intervention was neither sufficient nor necessary to result in the outcomes, but it has contributed in some cases.

Contribution claims/alternative explanations	Overall score on strength of evidence for contribution claim	Conclusions on causality (necessity and sufficiency)
13b High energy prices, high inflation and rises in the cost of living limit the beneficial impact of Wave 1 retrofits on resident comfort, health and wellbeing because residents still experience financial stress and therefore have to limit their energy use and home warmth because energy bills remain unaffordable.	**Moderate** There is some triangulated evidence that not all residents have experienced energy bill reductions, find energy use affordable and have reduced anxiety about paying bills.	**Level of causality: 3** We can reasonably conclude that some residents in Wave 1 homes have experienced enhanced comfort as a result of the interventions, though not all. Further, there is some evidence that the installations have resulted in enhanced mental or physical wellbeing in some residents involved in Wave 1, though a similar proportion reported they have seen negative change in mental or physical wellbeing. An equal proportion of residents are now less worried and more worried about paying their energy bills following Wave 1, indicating some financial stress over energy bills remains. In some cases, residents have reported that their fuel bills have increased, which is thought to be as a result of higher energy prices overall. Therefore, we conclude the level of causality is 3, as the intervention was neither sufficient nor necessary to result in the outcomes, but it has contributed in some cases.

4. Detailed evaluation questions

Table 6: Evaluation sub-questions and where they are covered in the Process and Impact Evaluation Reports

n	Evaluation questions and sub-questions	Chapter of Process Evaluation Report	Chapter of Impact Evaluation Report
1	**How effectively have the SHDF Wave 1 programmes been implemented and delivered?**	**-**	**-**
1.1	What were the drivers and barriers to successful SHL applications to Wave 1?	Chapter 3: Design and application process	-
1.2	How effective and timely was the marketing of Wave 1, including SHRA activity, in successfully reaching and engaging SHLs?	Chapter 3: Design and application process	-
1.3	How effective was Wave 1 support, including SHRA, in enabling SHLs to make successful funding applications? Including in: • Supporting applicants to form consortia to add value to bids. • Supporting SHLs to develop appropriate, cost-effective plans for improving the energy efficiency of their stock in their bid. • Providing SHLs with information and guidance needed to prepare effective bids.	Chapter 3: Design and application process	-
1.4	To what extent did the number, scale and profile of successful bids for Wave 1 reflect the scale and profile of outcomes the scheme is intended to achieve? To what extent, did the application and assessment process support this?	Chapter 3: Design and application process	-
1.5	How effectively has project delivery and performance been managed in Wave 1? Including in terms of: • The ongoing monitoring of project performance • Use of the change control process • Use of the clawback process • Scheme governance • Risk management	Chapter 4: Delivery	-

n	Evaluation questions and sub-questions	Chapter of Process Evaluation Report	Chapter of Impact Evaluation Report
1.6	To what extent has the Scheme Administrator (DP) fulfilled the requirements outlined in the Delivery Model Assessments for Wave 1? Why/why not?	Chapter 4: Delivery	-
1.7	Question omitted (relevant for SHDF Wave 2.1 evaluation only)	Relevant for SHDF Wave 2.1 evaluation only	-
1.8	How effective was Wave 1, including the DP, in providing ongoing support to SHLs to enable successful project delivery? Including in terms of: • Supporting procurement and management of contractors • Supporting interaction with other stakeholders such as DNOs and planning authorities • Supporting cross-learning from other SHDF projects, HUG and other government energy efficiency schemes	Chapter 4: Delivery Chapter 5: Developing and managing the supply chain	-
1.9	How effective was Wave 1 in analysing and engaging with the supply chain to enable successful project delivery? Including in terms of: • Making the case for upskilling and increasing capacity in the supply chain to deliver Wave 1 • Identifying and minimising potential supply chain disruptions to project delivery • Feeding into and benefitting from wider DESNZ supply chain analysis and engagement	Chapter 5: Developing and managing the supply chain	-
1.10	How effective was Wave 1 support for post measure installation activity to support realisation of benefits, including supporting SHLs to advise and guide residents as needed to use any new equipment appropriately and effectively?	-	Chapter 6: Resident Outcomes and Impacts
1.11	How efficiently have Wave 1 been managed including in terms of application and scheme management and support processes and the appointed sub-contractors delivering these functions?	Chapter 3: Design and application process Chapter 4: Delivery	-

n	Evaluation questions and sub-questions	Chapter of Process Evaluation Report	Chapter of Impact Evaluation Report
2	**To what extent and how have Wave 1 projects performed as intended?**	**-**	**-**
2.1	Have Wave 1 projects delivered: • At the intended scale? • On time? • Cost effectively? • Installations of high quality? • Positive resident experience of and satisfaction with the installation process? • In line with the fabric first approach? • In line with the 'lowest regrets' approach? • As originally intended? • Why/why not?	Chapter 4: Delivery	-
2.2	What variation has there been in project delivery in Wave 1? For example, by retrofit measure, archetype, tenure type, region, project lead/consortia type, resident profile.	Chapter 4: Delivery	-
2.3	What have been the critical success factors for and barriers to project performance in Wave 1? Including in relation to: • Resident engagement (including those at risk of fuel poverty) • Supply chain procurement and management • Cost and risk management	Chapter 4: Delivery	-
2.4	How have external factors influenced project success in Wave 1? Including: • Covid • High inflation • Brexit	Chapter 4: Delivery	-
2.5	What, if any, other sources of support and guidance are SHLs using other than that provided through SHDF?	-	-

n	Evaluation questions and sub-questions	Chapter of Process Evaluation Report	Chapter of Impact Evaluation Report
3	**To what extent and how have Wave 1 incorporated lessons learned from other DESNZ energy efficiency schemes and the SHDF(D) to inform the design and delivery of waves?**	**-**	**-**
3.1	How effectively have learnings from the SHDF(D) been incorporated into the design and/or delivery of Waves 1?	Chapter 3: Design and application process	-
3.2	How effectively are learnings being collated and used to adjust delivery within and for future SHDF waves? Including to new emerging risks or opportunities?	Chapter 4: Delivery	-
3.3	Have projects in Wave 1 successfully validated evidence and learning about the deliverability of retrofit at scale, and how? To what extent and how has this been shared within and outside of Wave 1?	Chapter 4: Delivery	-
4	**To what extent and how was the design of Wave 1 effectively supported both wave-level and overall SHDF achievements?**	**-**	**-**
4.1	Requirements for prioritisation of measures and/or properties including: the 'Worst first, fabric first, no regrets' criteria, minimum proportion of properties starting with an EPC lower than C, improving properties to EPC C (except where they started at F/G), cost cap structure. Did this lead to improved targeting of measures?	Chapter 3: Design and application process	-
4.2	PAS 2035 quality requirements for installations and use of Trustmark (or equivalent) certified installers (and MSC or equivalent for low carbon heating). To what extent did this contribute to achieve high-quality installations? To what extent did PAS 2035 requirements influence the ability of SHLs to retrofit at scale?	Chapter 4: Delivery Chapter 5: Developing and managing the supply chain	-
4.3	Requirements regarding facilitation of low carbon heating?	Chapter 3: Design and application process	-
4.4	Eligible applicant type (restricted to consortia led by LAs in Wave 1)?	Chapter 3: Design and application process	-

n	Evaluation questions and sub-questions	Chapter of Process Evaluation Report	Chapter of Impact Evaluation Report
4.5	Delivery period (12 months for Wave 1)?	Chapter 3: Design and application process	-
4.6	Minimum level of co-funding (33% in Wave 1)?	Chapter 3: Design and application process	-
4.7	Infill tenure policy. To what extent and how has this been an enabler or barrier to achieving Wave aims?	Chapter 3: Design and application process	-
4.8	Proportion of funding that can be allocated to administration and ancillary costs. Was this appropriate?	Chapter 3: Design and application process	-
4.9	Question omitted (relevant for SHDF Wave 2.1 evaluation only)	Relevant for SHDF Wave 2.1 evaluation only	-
5	**To what extent, and how, have Wave 1 delivered benefits for social housing residents, including delivering warm, energy-efficient homes, improved resident health and wellbeing outcomes, and reduced risk of fuel poverty?**	**-**	**-**
5.1	To what extent have residents been satisfied with the energy performance measures installed?	Chapter 7: Early resident benefits	Chapter 6: Resident Outcomes and Impacts
5.2	To what extent, and how, have Wave 1 contributed to delivering more comfortable homes for residents? Including in terms of warmth and aesthetic appearance.	Chapter 7: Early resident benefits	Chapter 6: Resident Outcomes and Impacts
5.3	To what extent, and how, have Wave 1 contributed to reducing the risk of fuel poverty amongst scheme beneficiaries? How important has this been in comparison to other government initiatives such as the Energy Price Guarantee and Energy Bills Support Scheme?	-	Chapter 6: Resident Outcomes and Impacts
5.4	To what extent, and how, has Wave 1 contributed to change in resident physical health including, for example, through reducing the incidence of cold home related physical illness and dangers arising from lower temperatures such as damp and mould?	Chapter 7: Early resident benefits	Chapter 6: Resident Outcomes and Impacts

n	Evaluation questions and sub-questions	Chapter of Process Evaluation Report	Chapter of Impact Evaluation Report
5.5	To what extent, and how, has Wave 1 contributed to change in resident mental health and wellbeing?	-	Chapter 6: Resident Outcomes and Impacts
5.6	To what extent, and how, has Wave 1 contributed to change in residents' interest in future energy efficiency or low carbon heating works?	-	Chapter 6: Resident Outcomes and Impacts
5.7	To what extent, and how, has Wave 1 contributed to change in residents' behaviours and attitudes in relation to energy use?	-	Chapter 6: Resident Outcomes and Impacts
5.8	How have these impacts varied by resident type including by household composition, those at risk of fuel poverty, incidence of disability and ill-health, age, gender and ethnicity? How have these impacts varied by measure mix/installation type?	-	Chapter 6: Resident Outcomes and Impacts
5.9	To what extent has Wave 1 contributed towards the above benefits over and above other government (or internally SHL funded) initiatives to support the energy performance of social housing?	-	Chapter 3: Building Social Housing Landlord capability and capacity
6	**To what extent, and how, have Wave 1 improved social housing landlords' capacity and capability to decarbonise their housing stock?**	**-**	**-**
6.1	How many of the energy performance improvements funded by Wave 1 would SHLs have undertaken without DESNZ funding to the same timescale? Would more improvements have been made over a longer timescale? Would these have been undertaken to the same quality?	Chapter 3: Design and application process	-

n	Evaluation questions and sub-questions	Chapter of Process Evaluation Report	Chapter of Impact Evaluation Report
6.2	What skills and resources have SHLs developed through participation in Wave 1? How have these been developed? Including in terms of: • Awareness and knowledge about a. the energy performance of their housing stock and b. energy performance measures to decarbonise their housing stock. • Confidence in and ability to procure and deliver energy performance installations. • Ability to produce high-quality applications for future government funded retrofit schemes.	-	Chapter 3: Building Social Housing Landlord capability and capacity
6.3	To what extent and how, has participation in Wave 1 and Wave 2.1 contributed to increasing the size, scale or quality of SHLs' future plans for decarbonisation of their stock?	-	Chapter 3: Building Social Housing Landlord capability and capacity
6.4	How have these impacts varied by SHL type including by type of organisation, size of stock and nature of stock?	-	Chapter 3: Building Social Housing Landlord capability and capacity
6.5	What interaction has there been between SHL participation and capability and capacity development through SHDF and other initiatives or private investment?	-	Chapter 3: Building Social Housing Landlord capability and capacity
6.6	To what extent, and how, have Wave 1 and Wave 2.1 contributed to improving the financial value of social housing?	-	Chapter 3: Building Social Housing Landlord capability and capacity

n	Evaluation questions and sub-questions	Chapter of Process Evaluation Report	Chapter of Impact Evaluation Report
7	**How effectively have Wave 1 delivered intended environmental and cost benefits, specifically energy, carbon and bill savings?**	**-**	**-**
7.1	How many social homes have had upgraded EPCs including specifically to EPC C due to installation of energy performance measures in Wave 1?	Chapter 4: Delivery	-
7.2	What energy savings have been generated by the installation of energy efficiency measures in Wave 1?	-	Chapter 5: Energy, bill and carbon savings
7.3	To what extent has the installation of energy performance measures in Wave 1 delivered a reduction in fuel bills?	-	Chapter 5: Energy, bill and carbon savings
7.4	What carbon emission reductions has the installation of energy performance measures in Wave 1? What role has the installation of clean heat measures played in this?	-	Chapter 5: Energy, bill and carbon savings
7.5	How have these impacts varied by building archetype and/or measure mix?	-	Chapter 5: Energy, bill and carbon savings
7.6	To what extent has the installation of energy performance measures prepared the fabric of social homes so that it is suitable for future clean heat installations (thereby potentially delivering further energy and carbon savings)?	-	Chapter 5: Energy, bill and carbon savings
7.7	To what extent are anticipated future changes, such as regulation of the energy performance of social housing, likely to reduce the necessity and/or impact of Wave 1 outcomes?	-	Chapter 3: Building Social Housing Landlord capability and capacity

n	Evaluation questions and sub-questions	Chapter of Process Evaluation Report	Chapter of Impact Evaluation Report
8	**To what extent and how did Wave 1 deliver retrofit installations which were high quality and represent good value for money for DESNZ?**	**-**	**-**
8.1	To what extent and how, has Wave 1 contributed to greater value for money for a. DESNZ and b. in the retrofit sector through economies of scale? Including via future cost reductions in retrofit improvements due to efficiency gains and technical improvements? To what extent has the rate of observed cost reductions, e.g. in the average cost of retrofit per home, if any, changed across Wave 1?	Chapter 4: Delivery Chapter 5: Developing and managing the supply chain	Chapter 7: Value for Money
8.2	What variation has there been in installation costs and value for money for a. different types of installations and measure mixes b. in different archetypes and c. in different regions?	Chapter 4: Delivery	Chapter 7: Value for Money
8.3	To what extent have SHLs used SHDF funding to target hardest-to-treat stock and how has this affected value for money in Wave 1?	-	Chapter 7: Value for Money
8.4	To what extent and how, did Wave 1 lead to innovation in the products or methods used in retrofit?	Chapter 5: Developing and managing the supply chain	-
8.5	To what extent and how has innovation contributed to improvement in value for money?	-	Chapter 7: Value for Money
8.6	Question omitted (relevant for SHDF Wave 2.1 evaluation only)	Relevant for SHDF Wave 2.1 evaluation only	-
8.7	Question omitted (relevant for SHDF Wave 2.1 evaluation only)	Relevant for SHDF Wave 2.1 evaluation only	-
8.8	Question omitted (relevant for SHDF Wave 2.1 evaluation only)	Relevant for SHDF Wave 2.1 evaluation only	-

n	Evaluation questions and sub-questions	Chapter of Process Evaluation Report	Chapter of Impact Evaluation Report
8.9	To what extent, and how, has Wave 1 contributed to improvements in building standards and safety?	-	Chapter 3: Building Social Housing Landlord capability and capacity
8.10	To what extent, and how, has Wave 1 contributed to any unintended or negative impacts? Including for residents, SHLs, the supply chain, government and/or wider society.	-	Chapter 6: Resident Outcomes and Impacts
9	**To what extent and how has Wave 1 contributed towards intended wider impacts, including supporting the green economy and supply chain for retrofitting social housing?**	**-**	**-**
9.1	To what extent and how, has Wave 1 contributed to upskilling in the supply chain? Including increased levels of Trustmark & MCS certification amongst installers and greater experience of and confidence in installing to PAS 2035 quality standards.	-	Chapter 4: Development of the supply chain
9.2	To what extent and how, has Wave 1 contributed to building capacity in the supply chain? Including number of companies and jobs and apprenticeships sustained or created across England amongst retrofit coordinators, installers, and manufacturers.	-	Chapter 4: Development of the supply chain
9.3	What barriers still exist to the capability and capacity of the supply chain to deliver the decarbonisation of social housing?	-	Chapter 4: Development of the supply chain
9.4	How well has use of the supply chain been coordinated with other DESNZ energy efficiency schemes?	-	Chapter 4: Development of the supply chain
9.5	To what extent has Wave 1 contributed towards supporting an increased supply chain over and above other government (or external) initiatives?	-	Chapter 4: Development of the supply chain

5. Primary fieldwork

5.1 Resident post-installation survey

The following section outlines the methodology and data sources used to assess resident experiences of energy saving measures post installation. Findings primarily draw from the post-installation resident survey, conducted as a follow-up survey with respondents who had previously completed the during-installation survey.

A total of 1,498 residents took part in the 'during installation' resident survey (29% response rate). The survey was split in three tranches (conducted between May 2023 and February 2024), to account for different installation times across Wave 1 properties. Further details on the during-installation survey are available in the separate Technical Annex to the process evaluation report, published in 2024.[4]

Resident survey overview

A total of 537 residents who had energy saving measures installed in their homes across 45 Wave 1 projects took part in the post-installation survey. All participants had previously completed the during-installation survey, which focused on their experience of the installation process. At the time of the post-installation survey, all residents had experienced at least one winter season since the measures were installed. This follow-up survey focused on the outcomes of measures, including exploring residents' experiences of heating their homes, any changes in their use of energy and heating systems, and any wider impacts of the measures installed. Respondents completed the survey either online or by telephone.

Resident survey sample

A total of 1,498 residents across 45 Wave 1 projects participated in the during-installation resident survey. Of these, 1,124 residents across 45 projects consented to be contacted for follow-up survey participation. A census approach was adopted for the follow-up survey, inviting all eligible residents who had agreed to be recontacted.

The original target for the post-installation survey was to achieve 800 responses from residents who had previously taken part in the during-installation survey. However, this was revised to 562 to reflect the smaller starting sample and an estimated 50% response rate.[5]

[4] DESNZ (2024) 'Social Housing Decarbonisation Fund Wave 1: process evaluation report - technical annex'
[5] The during-installation survey originally had a response target of 2,000 respondents.

Resident survey fieldwork

Survey fieldwork was conducted in February 2025. All eligible residents were sent an invitation letter by email to take part in a 10-to-15-minute online survey via a unique link or QR code. Residents that did not respond following the invitation letter were sent up to three reminder emails and up to two reminder letters.[6] Residents that could not complete the survey online were contacted by telephone and offered the option to complete the survey over the phone with an interviewer. Respondents received a £10 e-voucher or a physical shopping voucher as a thank you for taking part.

In total, 537 residents across 45 projects completed the post-installation survey (48% response rate), 53% via telephone and 47% online. This resulted in a maximum error margin of +/-5.2% at the 95% confidence level.

Resident survey questionnaire

The post-installation survey covered the following topics:

- Types of heating used by residents
- Issues experienced in home before the installation of energy saving measures
- Installation process
- Confidence using energy saving measures
- Outcomes following the installation of energy saving measures
- Views on further energy saving measures

Table 24 in Chapter 9 outlines individual survey questions and the evaluation questions addressed.

Weighting adjustments

The post-installation survey was a direct follow-up to the during-installation resident survey, recontacting the same respondents who had given their consent without resampling. As such, we applied the same weighting approach used for data from the during-installation survey to ensure consistency across both datasets. This approach was designed to align the respondent profile with the broader population of residents receiving measures under Wave 1 (based on our understanding from the Wave 1 management information (MI) data).

We applied a post-stratification weighting adjustment to reduce potential bias in the survey estimates caused by over or under-representation of particular groups more or less likely to respond. This adjustment aimed to make the characteristics of survey respondents as close as possible to the known profile of residents participating in Wave 1 of the scheme.

[6] 168 residents in the recontact sample did not provide an email address and were invited by letter only.

The weighting involved the following post-stratification variables:

- Region
- Type of property (whether a flat, house or bungalow)
- The number of properties being retrofitted in the project that the resident's property was part of

Further details on how the weighting variables were selected can be found in the in the separate technical annex to the process evaluation report.[7]

As was the case with the during-installation survey data, a small number of respondents were assigned weights between 3 and 4 indicating that their region, property type or project size were under-represented. Although large weighting adjustments can reduce bias in our estimates, they also reduce the precision of the estimates considerably, meaning the confidence intervals (CI) around these estimates becomes very large. As is commonly practiced in survey analysis, and consistent with the during-installation survey approach, we therefore trimmed any weights greater than 3 back to 3. As a result of this weighting and trimming process, the weighted base for the post-installation survey is 531, slightly lower than the unweighted base of 537.

We also explored whether additional weighting was needed to correct for differential response likelihood in the post-installation survey, based on a range of demographics and responses to survey questions about the experience of the installation. This included gender, age, working status, disability status, type of measure installed, and satisfaction with both the installation process and quality of the measures. The post-installation survey sample closely matched the during-installation sample across all these characteristics, with differences mostly no greater than ±3%.[8] As a result, no further weighting adjustments were deemed necessary to address potential non-response bias in the recontact sample.

In total, therefore, each survey respondent was assigned an adjustment according to their region, type of property and project size to make the final weighted sample more representative of all properties in Wave 1.

Table 7 shows the distribution of the post-installation weighting adjustment variable that was created using the Random Iterative Method (RIM) weighting approach.[9] Due to the high proportion of respondents having been assigned a weight of less than 0.5 (41.3%), the 'effective sample size' was reduced to 349 after making the weighting adjustment.

[7] DESNZ (2024) 'Social Housing Decarbonisation Fund Wave 1: process evaluation report - technical annex'
[8] The smallest difference was 0%, and the largest difference was a 6% reduction in respondents saying 'it's too soon to say' in response to question G5 regarding satisfaction with quality. There were two differences of 4%: reduction in the proportion of female respondents and an increase in those aged 55-64.
[9] This is an iterative procedure to create a single numerical weight for each respondent from a group of variables in a statistically efficient way. For a discussion of the approach see Sharot, T. (1986) 'Weighting survey results'. Journal of the Market Research Society, 28 (3), pg. 269-284.

Table 7: Distribution of Wave 1 weights across survey respondents

Weight value	Number of respondents	Proportion of all respondents
0 to <0.5	222	41.3%
0.5 to <1	153	28.5%
1 to <2	66	12.3%
2 to <3	87	16.2%
3	9	1.7%
Total	537	100%

Resident survey data production and analysis

A set of unweighted and weighted aggregated data tables in Excel and a clean CSV anonymised raw dataset were provided to DESNZ. Relevant sub-groups were included as cross-breaks to the tables along with significance testing. Cross-breaks in the data tables included project variables, such as region, property type and measures installed, as well as resident demographic variables e.g. age, gender and ethnicity, and other key survey variables such as resident health conditions, satisfaction with installation process, and problems experienced in the home prior to installation.

Only findings with a base of 50 or more respondents were reported. Differences between and within sub-groups were only highlighted within the report if they were statistically significant at the 95 percent confidence level (i.e. statistically we can be 95% confident that the differences are 'real' differences and not due to chance) unless otherwise stated.

Unweighted and weighted demographic profile of resident survey

Table 8: Unweighted and weighted gender profile of resident survey

Gender	Unweighted base	%	Weighted base	%
Male	175	32.6%	170	32%
Female	331	61.6%	325	61.3%
Prefer not to say / missing	31	5.8%	36	6.7%
Total	537	100%	531	100%

Table 9: Unweighted and weighted age profile of resident survey

Age	Unweighted base	%	Weighted base	%
18-34	40	7.4%	45	8.6%
35-54	153	28.5%	169	31.7%
55-74	261	48.6%	244	45.8%
75+	66	12.3%	54	10.2%
Prefer not to say / Missing	17	3.2%	19	3.6%
Total	537	100%	531	100%

Table 10: Unweighted and weighted ethnicity profile of resident survey

Ethnicity	Unweighted base	%	Weighted base	%
Asian/Asian British	12	2.2%	16	3%
Black/African/Caribbean/Black British	18	3.4%	28	5.3%
Mixed/Multiple ethnic groups	12	2.2%	13	2.4%
White	486	90.5%	461	86.9%
Other ethnic group	13	0.6%	7	1.4%
Prefer not to say / Missing	6	1.1%	6	1.1%
Total	537	100%	531	100%

Table 11: Unweighted and weighted disability profile of resident survey

Disability	Unweighted base	%	Weighted base	%
Yes, limits activities all of the time	211	39.3%	194	36.6%
Yes, limits activities some of the time	114	21.2%	118	22.3%
Yes, but does not limit activities	31	5.8%	30	5.7%
No	151	28.1%	157	26.6%
Prefer not to say / Don’t know / Missing	30	5.6%	32	5.8%
Total	537	100%	531	100%

Table 12: Unweighted and weighted working status profile of resident survey

Working status	Unweighted base	%	Weighted base	%
Full-time paid work	111	20.7%	119	22.4%
Part-time paid work	60	11.2%	54	10.3%
Long term sick leave	57	10.6%	57	10.7%
School or education	3	0.6%	3	0.5%
Unemployed / Not in paid employment / Maternity, paternity or parental leave	123	22.9%	114	21.5%
Retired	151	28.1%	142	26.8%
Prefer not to say / Don't know / Missing	22	12.2%	41	5.6%
Total	537	100%	531	100%

Resident survey limitations

Key limitations of the post-installation survey, and the efforts taken to mitigate these, are listed below:

- The volume of contact details for Wave 1 residents available was lower than anticipated, which led to a lower achieved sample size than planned in the during-installation survey (1,498 compared to a target of 2,000). This, in turn, meant we had a smaller sample than anticipated to recruit from in the post-installation survey, leading to a smaller sample size than planned (527 compared to 800). This reduced the statistical robustness of the survey.
- Furthermore, 20 of the 65 projects were not represented in the resident survey (due to them not supplying data in time for fieldwork), while other projects were under-represented relative to the number of properties they retrofitted. This meant that our achieved sample was unlikely to be representative of the Wave 1 population. There may be a difference in the nature of delivery (and therefore resident experience) between projects who supplied data and those who did not, although the extent and nature of this difference is unknown. We applied weighting to the survey data to mitigate this issue.
- There can be a bias related to people who are willing and able to respond to surveys of this kind. For example, less digitally literate or capable individuals may be less likely to complete online surveys. To mitigate this, residents were invited via postal invite, email and telephone (where possible), the survey was hosted both online and over the telephone, and a £10 incentive was offered to all those who completed. Non-response weighting also helped reduce this bias.

- Another important consideration in the research design was the extended period over which installation works were carried out. Due to varying delivery timelines across projects, some residents had their measures installed significantly earlier than others. As a result, residents had experienced the measures for different lengths of time, with some having had more time for the measures to have an impact. Additionally, these differing timelines could introduce recall bias, as residents who received installations earlier may have had more difficulty accurately recalling their experiences.

5.2 Resident post-installation focus groups

Resident focus groups overview

Following the post-installation survey, we conducted five qualitative focus groups with Wave 1 residents who had taken part in both the during-installation and post-installation resident surveys.

The focus groups were conducted via Teams in groups of four to six respondents and lasted approximately 90 minutes, with a break included. Respondents received a £50 e-voucher or a physical shopping voucher as a thank you for taking part.

Resident focus group sample

Residents were drawn from the pool of 303 residents that had completed the post-installation survey and agreed to be recontacted to take part in a focus group. The groups were organised primarily around the types of measures installed in residents' homes. This allowed us to explore the experiences of having specific measures installed in more depth. These included:

- Group 1: Participants who had at least one insulation measure installed
- Group 2: Participants who had solar panels installed
- Group 3: Participants who had a heat pump installed (including ground source, air source and other types of heat pumps)
- Groups 4 and 5: Participants who had more than one measure installed

When selecting individuals for the focus groups, recruiters also aimed to ensure a spread across the following key characteristics and attitudes (which can affect experience of installation and impact of measures) to capture a diverse range of residents:

- Property type/size/age
- Resident characteristics including age, gender, ethnicity and disability status
- Residents who were satisfied or dissatisfied with the works conducted
- Whether residents agreed or disagreed that the measures have had an impact

IFF's recruitment executive team contacted individuals initially by phone to encourage participation.

Resident focus group fieldwork

Fieldwork for the five qualitative focus groups took place in March 2025.

Resident focus group topic guide

The aim of the resident focus groups was to provide further context and detail to the responses from the post-installation survey, primarily focusing on resident outcomes, i.e. how the energy saving measures had impacted them and their home. A single topic guide was used across all focus groups to ensure consistency in the themes explored, with tailored prompts where relevant to reflect specific group experiences. The topic guide covered the following broad topics:

- Information about household
- Experience of the installation process
- Outcomes after the installation of energy saving measures
- Confidence using the energy saving measures
- Awareness and attitudes towards energy saving measures

Table 25 in Chapter 9 outlines the evaluation questions addressed by each section of the topic guide. After the first focus group, the topic guide was amended to improve the flow and ensure that higher priority sections were asked sooner in the guide. However, the main focus of the guide did not change.

Resident focus group analysis

With consent, resident focus groups were recorded, and detailed interview notes produced. For analysis, focus group notes were entered into an analysis framework, organised by topic. They were then coded in more detail to bring out emergent themes. An initial coding structure was developed, and inductive coding was used within topics to respond to the specific points raised in focus groups. This was then used to produce summary thematic analysis against the key evaluation questions, including verbatim quotes to provide more illustrative detail to themes.

Resident focus group limitations

Some limitations of the resident focus groups, and the efforts taken to mitigate these, are listed below:

- Focus group participants self-selected to respond to the resident survey and take part in a follow-up discussion and were therefore more likely to be and to represent ‘engaged’ residents who are willing to take part in voluntary research. We initially aimed to address this bias for the survey sample by offering an incentive, inviting respondents via letter, and conducting telephone chasing, as described in previous sections. We also offered an incentive for participation in the follow-up focus groups.
- Issues relating to sample data provision, and the timing of the data collection as outlined in the ‘Resident survey limitations’ section also applied to the resident focus groups.

5.3 Qualitative interviews with supply chain stakeholders

Supply chain stakeholder interviews overview

Qualitative in-depth interviews were carried out with 39 supply chain stakeholders who were involved in the installation of energy efficiency measures for Wave 1 of the SHDF. Interviews were conducted via Teams or phone, each lasting between 35 and 80 minutes. All respondents were offered £50 (via PayPal, Wise or as a charity donation) as a thank you for their time.

Supply chain stakeholder interviews sampling

Interviewees were selected based on project-based case studies (information about case studies is included in Chapter 1.3 (Case study approach). However, owing to low sample availability, scope was widened to include supply chain stakeholders from thematic case studies as well as not from case studies. Of the 39 interviews completed, 10 were with supply chain stakeholders in project-based case study areas, two were from the thematic case study on installing measures in hard-to-treat properties and the remaining 27 were not case study specific.

Selected case study projects covered a mix of: measures installed; building archetypes; regions; companies employed as principal contractors and retrofit coordinators; and whether the retrofit coordinator was employed in-house or not. This ensured a varied range of supply chain stakeholders, with a range of experiences, were interviewed.

A mixture of the following sources or methods were used to generate contacts for participation:

- Contacts provided by Wave 1 projects as part of their monthly monitoring information (MI) data submissions, filtered by those that belonged to selected case studies
- Using snowballing techniques with these initial contacts to determine the identities and contacts of other stakeholders and organisations involved in the installation process
- Asking SHLs that took part in interviews to provide contact details of supply chain stakeholders who worked on their projects
- When contact details were inaccurate or missing in the MI data, desk research was undertaken by searching company names that participated in the scheme
- Using the EPC certificate checker website (to obtain assessor details) and the Trustmark register of accredited businesses who took part in the research

Overall, 302 installation stakeholder contacts were collated (80 from project-based case studies, 41 from projects feeding into the thematic case study on hard-to-treat properties, and 181 from non-case study projects). Across two tranches, 39 interviews were conducted resulting in a 12.6% response rate overall.

Supply chain stakeholder interviews topic guide

Supply chain stakeholders were categorised into four main groups to assist with topic guide design and data analysis, as shown in Table 13.

Table 13: Supply chain stakeholder job roles and descriptions

Supply chain stakeholder role	Description
Person/team installing measures	Usually a sub-contractor to the lead contractor, potentially freelance or small company, potentially directly employed by lead contractor organisation or even in-house. Often several for each project.
Manager of installation teams	Person managing the team installing measures within a project. Most likely a site manager at a lead contractor, potentially could be employed in-house, or could be acting as a sub-contractor to an organisation managing multiple sites. May manage on one or multiple sites within the project.
Senior managers at principal contractors	Managing the resourcing and planning of installations. Can be an installation company director, HR manager / chief at a lead contractor, can be a consultant, can be employed in-house.
Retrofit coordinators	Bringing together / sourcing teams installing different measures. May sit at a consultant level or in-house.

The topic guide drew upon on the ToC, contribution claims and evaluation questions. Four overall objectives for the evaluation's research on supply chain stakeholders were created:

1. How do the installation stakeholders view installations as part of Wave 1 in terms of: attractiveness of the work compared to other potential jobs; need for the work in the properties; quality of installations; efficiency of staffing, materials, and resources used; adequate timescale to carry out works; and value for money? Could any of these be improved?
2. To what extent did external factors affect the delivery of the installations?
3. How do the installation stakeholders feel the certification requirements (PAS 2035, Trustmark, and MCS certification) of participating in Wave 1 activities impacted the installation process in terms of cost, resourcing, quality, and timeliness?
4. How has Wave 1, and the anticipation of future government SHDF waves, impacted the installation stakeholders' decision-making in terms of business growth, energy focused business diversification, upskilling the workforce, and obtaining accreditations?

Owing to the diverse roles involved throughout the installation process, each supply chain stakeholder had a different understanding of the information required to answer the relevant evaluation questions. The relevance of specific roles in addressing relevant evaluation questions was mapped in advance of interviewing, based on desk research and experience on previous research with this audience, as shown in Table 14.

Table 14: Supply chain stakeholder objectives mapped to job roles

Objectives	Person/team installing team(s)	Manager of installation/assessor team(s)	Senior managers at principal contractors	Retrofit coordinators
1	Fully relevant	Fully relevant	Partly relevant	Partly relevant
2	Partly relevant	Fully relevant	Fully relevant	Partly relevant
3	Partly relevant	Fully relevant	Fully relevant	Partly relevant
4	Partly relevant	Fully relevant	Fully relevant	Partly relevant

The topic guide was constructed building on the objectives outlined above, on the roles of supply chain stakeholders involved in installations, and on evaluation questions. Table 15 below shows the range of interview questions mapped against the relevant audience and objectives. For tranche 1, specific questions were only asked to the relevant audience. For tranche 2, some questions intended for installers were also asked to retrofit co-ordinators and senior managers, to ensure sufficient insight was captured (despite the small number of installers taking part in interviews).

The topic guide covered the following broad topics:

- Background on role and responsibilities within their own business
- Understanding of SHDF and reasons for involvement
- Activities being conducted as part of SHDF
- Communications with SHL
- Challenges and barriers to delivery of installations
- Perceived quality of work
- Capacity, training and accreditation
- Value for money
- External factors
- Realisation of project benefits
- Broader view on government schemes and support options

Table 27 in Chapter 9 outlines individual interview questions and the evaluation questions the guide addressed.

Supply chain stakeholder interviews fieldwork

Fieldwork for the 39 interviews took place across 2 tranches (tranche 1: between July and September 2023 and tranche 2: between September 2023 and February 2024). Table 15 and Table 16 show the distribution of the 39 interviews by case study projects and job role.

Table 15: Supply chain stakeholder interviews by case study projects

Case Study Type	Number of completed interviews
Durham County Council	2
Coventry City Council	5
Norwich City Council	1
London Borough of Waltham Forest	2
Hard-to-treat case study	2
Non-Case Study	27
Total	**39**

Table 16: Supply chain stakeholder interviews by interviewee role

Job role	Number of completed interviews
Person / team installing measures	4
Manager of installation teams	13
Senior managers at principal contractors	16
Retrofit coordinators	6
Total	**39**

Supply chain stakeholder interviews analysis

With consent, supply chain stakeholder interviews were recorded, and detailed interview notes produced. For analysis, interview notes were entered into an analysis framework, organised by topic. They were then coded in more detail to bring out emergent themes. An initial coding structure was developed, and inductive coding was used within topics to respond to the specific points raised in interviews. This was then used to produce summary thematic analysis against the key evaluation questions, including verbatim quotes to provide more illustrative detail to themes.

Supply chain stakeholder interviews limitations

Some limitations of supply chain stakeholder interviews, and the efforts taken to mitigate these, are listed below:

- Supply chain stakeholders interviewed self-selected to take part in an interview, thus representing those more likely to take part in research. This limitation was partially reduced by offering a £50 incentive (payment or charity) for participation in the interviews.
- Much of the sample was gathered from the MI data supplied by SHLs, and from snowballing. Projects that had more resource may have been more likely to submit full and up to date MI data and therefore be overrepresented in the sample. Similarly, SHLs that had a good relationship with their lead contractor may have been more likely to share their contact details. Interviewing supply chain stakeholders from various project sizes and areas helped address this to some extent. Other sampling approaches used (Trustmark data and EPC certificates) were less successful in generating contacts for interviews, and were therefore less helpful to mitigate this issue.
- The ability to generalise the findings from interviews with 39 installation stakeholders across 17 projects is limited, given the small sample available and low participation in interviews. On the other hand, though not representative of the Wave 1 installation stakeholder audience as a whole, non-case study interviews provided greater variety of projects to analyse. The greater coverage of senior contractors and retrofit coordinators also had more knowledge of challenges across all projects as a whole.

5.4 Qualitative data collection with other stakeholders

Overview of qualitative data collection with scheme delivery stakeholders

Four semi-structured interviews were undertaken with four senior DESNZ staff members with roles covering senior oversight, delivery and analysis. Selection of individuals was discussed with the DESNZ evaluation team. A single topic guide was developed for interviews with DESNZ staff, with some bespoke questions developed for the representative from the analysis team. However, interviews were conducted flexibly such that individuals only answered questions relevant to their role and experience on Wave 1. These interview guides covered the Wave 1 scheme from beginning to end. Topics included lessons informing scheme design, pre-competition engagement, the application and appraisal process, project delivery, scheme management, and early/anticipated outcomes and impacts. These interviews were undertaken in October 2023.

Four focus group discussions were held with representatives of: the DESNZ IDT team; the TAF; and the DP (at two separate points in time). Tailored topic guides were developed for each group. The TAF focus group and first DP focus group were held in July 2023 and lasted approximately 45 minutes each. These focused upon Wave 1 applications and appraisal processes. The DESNZ IDT focus group and the second DP focus group were held in October 2023 and November 2023 and lasted approximately 90 minutes each. Both of these focus groups covered project delivery, scheme management, and early/anticipated outcomes and impacts, and the IDT focus group also covered competition processes.

Interviews and focus groups were all recorded. Recordings and transcripts were used to write up detailed notes. For analysis, interview and focus group notes were first organised by topic. They were then coded in more detail using NVivo. An initial coding structure was developed, but inductive coding was used within topics to respond to the specific points raised in interviews and discussion groups.

Detailed topics covered in scheme delivery stakeholder data collection

Table 28 in Chapter 9 details the topics covered in DESNZ senior management interviews and in the TAF, DP and DESNZ delivery team focus groups, and the evaluation questions the guides addressed. In summary, the following broad topics were covered:

- Analysis of economic case
- Learnings built into Wave 1
- Pre-competition/competition process and support
- Delivery
- Scheme management
- Early outcomes and impacts (including for SHLs)
- Supply chain outcomes
- Additionality

5.5 Qualitative data collection with SHLs

Case study SHL interviews

Six semi-structured interviews were undertaken individually with representatives of the lead organisation for each case study project. In some cases, consortium partner members joined the interview. The interview guide covered pre-existing retrofit plans and activity of projects, the Wave 1 application process, project delivery (enablers, barriers, support sources), project monitoring, early/anticipated outcomes and impacts. The interview with representatives of the lead organisation was intended to last about 90 minutes, but actual interviews varied from 50 minutes to 120 minutes in length. This reflected the different nature of the projects, the level of complexity and variation in the project organisations and the types of installations involved.

Project leads were asked to provide contact details for other project representatives who could address any gaps in the original interview and provide specific insight into resident engagement and supply chain procurement and installation management. From this, eight separate follow up interviews were also completed across the case study projects (consisting of one additional interview for four projects, and two additional interviews for the other two projects). These interviews were held with representatives from partner organisations, with one exception where a follow up interview was held with a separate representative of the project lead organisation. Interview length varied from 30 minutes to 110 minutes.

These interviews were undertaken in two tranches each covering three of the case study projects, one from 31 May 2023 to 10 July 2023, and one from 18 September 2023 to 23 November 2023. The timing coincided with when projects were close to completion in order that SHLs could reflect on their overall project experience.

Additional SHL interviews

In addition to the interviews with case study SHLs, a further 15 interviews were undertaken with other Wave 1 project lead organisations. To ensure a range of SHL projects were included, the SHL sample was selected to ensure minimum, representational coverage of the following characteristics:

- The different geographical regions in which projects were based
- Inclusion of mixed tenure in project applications
- Inclusion of clean heat measures in project applications
- Participation in a consortium-based project
- Inclusion of properties with EPC F or G
- Previous participation in the SHDF(D)

These interviews were undertaken from 12 October 2023 to 7 November 2023. As this was towards the end of Wave 1 scheme delivery, some projects had completed and others were nearing completion. Interviews lasted approximately 45 minutes in length and had a more limited topic coverage than the case study interviews. The interview guide covered pre-existing retrofit plans and activity, project delivery enablers and challenges, DP support, and outcomes and impacts.

SHL focus group

Three thematic case studies were also developed for Wave 1. These explore a specific theme in depth. The three topics covered are: implementing PAS 2035; installing measures in hard-to-treat properties; and retrofit activity undertaken by SHLs not participating in Wave 1. One focus group was undertaken with SHLs in order to collect data specifically relating to the topics covered by two of the Wave 1 thematic case studies: PAS 2035 and hard-to-treat properties. The topic guide for the focus group covered: decision making on installing measures in hard-to-treat properties; enablers, barriers and lessons learned in installing measures in hard-to-treat properties; enablers, barriers and lessons learned in implementing PAS 2035; and the impact of PAS 2035 requirements on Wave 1 projects. Representatives of eight Wave 1 projects were invited to participate in the focus group. These eight projects were selected on the basis that:

- They were not already participating in a case study
- Their application profile suggested their project included hard-to-treat properties, i.e. with one or more of the following characteristics: lower EPC ratings (F/G), not heated via gas and therefore potentially off-the-gas grid, or high-rise flats or bungalows
- Some installed or planned to install clean heat measures (as a topic of particular interest)

Five SHL representatives of three Wave 1 projects agreed to participate in the focus group, which was held on 10 October 2023 and lasted for approximately 1 hour.

Detail of topics covered in SHL interviews

The following themes were covered in the SHL interviews. Table 29 in Chapter 9 outlines individual interview questions and the evaluation questions the guide addressed. In summary, the following broad topics were covered:

- Pre-existing retrofit plans before Wave 1 application
- Engagement with SHRA
- Application process and decision making
- Retrofit activity since engagement with SHRA/the Wave 1 application
- Project delivery including: engaging with the supply chain; resident engagement; interaction with stakeholders and post-installation support
- Anticipated outcomes and impact of Wave 1

Topic guide content of the SHL focus group was developed to feed into the thematic case studies (on implementing PAS 2035 and installing measures in hard-to-treat properties) rather than specific evaluation questions. Questions asked are summarised in Table 30 in Chapter 9.

6. Secondary data and MI analysis

6.1 Secondary data and MI data

MI data sources

Extracts from MI data were compiled by DESNZ and the DP and shared with IFF Research. These were provided in arrears, due to the need for collation and processing time and checks to be performed on data returns.

MI data used for this report was primarily sourced from the following locations:

- **Bid data** (individual spreadsheets and SHRA project bid analysis) compiled during the bid process at the start of SHDF Wave 1, and available for both successful and unsuccessful bids, at a project level, including proposed delivery profiles. Individual spreadsheets were analysed for baseline costs, including A&A (administrative) and capital costs.
- **Change Control data** (data up until end of February 2025) compiled during delivery by DESNZ when considering and approving changes in scope for individual projects. Provides project-level data, including proposed delivery and headline whole-project costs, broken down into grant and co-funding.
- **Baseline data** compiled following the selection of successful SHDF Wave 1 bid applicants, and initial modifications to bids to enable signing of contracts. Available only for successful bids, at a project level, including detailed proposed delivery and costs. This data was combined with the Change Control data for analysis.[10]
- **DP monthly project updates** including top five risks, KPIs, and narrative statements within spreadsheets, both compiled by Monitoring and Delivery Officers (MDOs), who acted as liaisons with the projects. Provided at a project level.
- **Delivery data** comprising properties retrofitted and measures installed. This was gathered by individual projects and submitted to DESNZ via the Data Management System (DMS). The data used in this report was updated to the end of February 2025. This provides data at an individual property and (after processing at IFF) at an individual measure level. Delivery data was matched to validated postcode data, enabling use of ONS regional and DLUHC urban-rural classifications.

[10] Baseline costs data will differ from data held internally at DESNZ since issues were identified in the baseline costs held in DESNZ Change Control and bid summary spreadsheets. To enable accurate measurement of cost inflation, figures were corrected by IFF in April and May 2025 through triangulation between data sources (individual bid spreadsheets for successful bids; SHRA project bid analysis; DESNZ post-application baselines; Change Control register baselines; subsequent Change Control requests; knowledge of common practice regarding VAT due on Local Authority spending; DP project liaison comments on Change Control requests).

- **Actuals data** comprising costs incurred by projects; this enables reporting of spending on A&A (administrative) and capital costs over time[11].
- The report also uses **SHDF Official Statistics** published in April 2025 (presenting latest statistics to the end of February 2025, matching other report sources). Where official statistics are available, these are used in preference to directly analysed delivery data.
- **Closure reports** submitted by projects after the end of the scheme, where available by February 2025.

This was supported by a project list, compiled from across all the quantitative data sources shown above, showing key project characteristics (i.e. all the SHLs involved in each project, consortium status, number of SHLs involved, bid size, ONS region, type of lead organisation). This list of project characteristics was matched to all the quantitative data sources above, in order to ensure consistent analysis.

MI data processing

Bid data, baseline application data, change control data and DP monthly project updates were processed in Microsoft Excel as follows:

- Information on successful and unsuccessful bids were checked against delivery MI data and updated, for example where a project had gone ahead from the reserve list.
- Names of organisations from the SHRA project bid analysis (triangulated against baseline application data, to include any rebranding and/or changes to consortia) were matched against the Housing Regulator records to add organisation types and locations.
- The locations of lead organisations for each project were checked against ONS region geography to append region variables, allowing region-by-region analysis of projects.
- A flag was added to identify projects submitting valid delivery MI data, to enable analysis of only these projects.

Delivery data was processed in Microsoft Excel as follows:

- Corrupt and test data was removed, as identified by (A) anomalous contents of fields (e.g., text where numbers were expected) or (B) lack of a valid project ID.
- Duplicate properties were removed using the unique property ID, prioritising the most recent available data regarding a property.
- Data for each project was checked against the latest Change Control data, and where the number of properties retrofitted exceeded the Change Control total, this was investigated and solutions applied on a project-by-project basis (e.g., excluding specific data returns which contained duplicate properties but with different property IDs).

[11] Unlike at Wave 2.1, spending on A&A (administration) and capital (installations) is not included in Change Control registers, and so must be derived here. We do not use this (although the data is available) to analyse grant and co-funding spending since this is a less accurate source than the Change Control register.

- Individual fields were cleaned manually to maximise the base available for analysis, for example correcting EPC ratings to consist of a single letter rather than also including a numeric SAP rating.
- Outliers were removed from costs data; all individual measure costs reported as less than £10 or over £100,000 per property were removed.

Monthly project updates and closure reports were further processed using NVivo as described below. All other data sources were analysed within Microsoft Excel using pivot tables.

Quantitative analysis of MI data

Statistics were analysed descriptively, using Microsoft Excel pivot tables relevant to the research questions. In general, statistical testing was not used for MI data because it was not required; statistical error margins are only applicable where partial data (such as a survey) is being used to draw inferences regarding a wider population.

The report includes a narrative on the data to assist the reader in drawing conclusions. Any limitations of the data are also highlighted to ensure correct interpretation of findings.

Qualitative analysis of MI data

Qualitative analysis of MI data across Wave 1 was conducted in the following ways:

- Where text responses were short (e.g., explanations of risks) but high in volume, they were referred to our dedicated coding team[12] to produce coded responses for numeric analysis.
- Where text responses were longer and more varied in their content, NVivo was used to draw out themes, primarily for analysis of monitoring officer narrative data (data source 1.4). Data was analysed under two broad headings; (a) risks and mitigations put in place, and (b) barriers and enablers to delivery.
- For case studies, individual bids and project risk registers were analysed in detail, to better understand the development of risks through the project timeline.

Qualitative data is presented in the form of narrative reporting, discussing issues emerging from the analysis thematically, supported by anonymised quotes from the sources as appropriate.

[12] The coding team receive the data in a spreadsheet, and load it into their dedicated coding software, Ascribe. They then use this to produce an interim codeframe based on a sample of the data, which is sent to the research team for QA and approval at Research Manager level. The coding is then completed, and given a second QA by the research team, checking the coding of at least 10% of the file. This QA is used to suggest final changes to the codeframe and to the coding of individual responses, before sign-off at Research Manager level. Quantitative data would be produced from the final codeframe by IFF's programming team in simple tables (using Merlin software) for analysis by the research team alongside other secondary data sources.

6.2 MI data coverage

The Change Control data, bid data and baseline data were comprehensive, and provided a detailed overview of projects' plans. The key caveat regarding this data is that many SHLs interviewed stated that their knowledge of existing stock was weak.

They stated this had been a barrier to application and had also sometimes caused significant changes to their plans for installing measures once initial inspections of individual properties had taken place. This suggests that bid data should be treated with some caution, although it remains likely that the overall stock profile is broadly correct.

Limitations of MI data

There are some limitations to the secondary data sources presented above that affected the extent of analysis possible:

- Bid data, baseline application data, actuals data and Change Control data, while all comprehensive in coverage, were aggregated to a project level (i.e., they consisted of numbers of properties and overall costs of activities for a project, without property-by-property breakdowns) and so it was not possible to combine analysis of these.[13]
- Delivery data was compiled at a property level, and a comparison against Change Control data suggests that in all cases projects had submitted records by the end of February 2025, although not always for the same number of properties that were shown as planned to be treated in the Change Control register. However, this delivery data could still contain errors in the identification of properties or their classification, which are not detectable since we do not have another data source to compare against. One project was excluded from costs analysis due to missing data.
- In delivery data, projects did not always accurately report all measures installed (e.g., reporting all measures as a single item, only reporting one measure per property, or using vague terminology which made it impossible to classify a measure), reported only part of a measure, or measures that were not SHDF funded. It was not possible to remove these from the data; 216 of 36,717 were coded as 'other' measures.
- Valid measure data was submitted as part of the delivery data by 65 projects, for a total of 20,805 properties, and for a total of 36,717 completed measures (higher than the 32,563 measures reported as planned in Change Control data across Wave 1, likely because projects split measures into sub-measures when reporting installations,[14] or because they reported the installation of auxiliary measures such as extractor fans which were not included in the Change Control data).

[13] For example, bid data shows counts of the numbers of measures of each type intended to be installed, and counts of types of properties intended to be included in the project, but because it is not property-by-property data (only headline counts of each separately), we cannot connect types of properties to types of measures using this source.

[14] For example, recording different types of insulation used in different parts of the property as separate measures, even though they are both the same broad type of insulation.

- Base sizes for costs analyses were slightly smaller; valid costs were submitted for 99% of measures (36,189 measures across all 65 projects).
- Due to the small quantity of missing data noted above, we would not expect any regional imbalances in the data, although there may be unobserved variation in data quality.[15]
- Project practices varied when dividing down costs which might have been charged by installers at an estate or block level by property. In some cases, costs were divided equally by the number of properties retrofitted in the project, and in others they were broken down in a detailed way by property.[16] For example, some projects applied all costs for roof replacement on high-rise blocks to the top layer of flats resulting in very high individual property costs, while others divided them equally across the block (resulting in properties without roofs having additional costs). The impact of this on the accuracy of aggregate data should be minimal, although it may result in understatement of variation of costs per property.[17]
- Narrative reporting and risks listed in monitoring spreadsheets were compiled via employees of the DP, and therefore solely represent their point of view in terms of risks, barriers and enablers to delivery.

[15] Data quality cannot be judged in this context, since there is no second source to check against; however, the overall scale of projects in DMS data usually closely matches the Change Control data.
[16] While this reporting of equal costs could be due to projects choosing to simplify their data for ease of reporting, it could also be due to installation being procured from sub-contractors at a fixed cost per property at a street or estate level. It is not possible to distinguish in the data between projects which have simplified costs information for ease of reporting, and projects which have correctly reported equal costs across properties.
[17] To give a simple example, if a project were to fit EWI on a terrace of houses, the SHL might be charged for those works by installation contractors as a single activity with a single total cost for the whole terrace. However, when reporting on the DMS, the SHL is required to supply property-by-property cost breakdowns. In the absence of a definitive cost for each house, the SHL might opt to attribute the cost equally to each house, even though in reality the houses at each end of the terrace would cost more to treat due to their external end walls. This would result in the correct average (mean) cost of EWI being calculated from the resulting DMS data, but would hide some real variation in the cost of EWI.

7. Estimating the change in fuel poverty status of households

7.1 Purpose of the analysis

For the Wave 1 impact evaluation, the purpose of the fuel poverty analysis was to estimate the proportion of households identified as fuel poor prior to the scheme installations who were moved out of fuel poverty as a direct result of participating in the scheme.

Fuel poor households were not a direct target for the scheme, fuel poverty status was not part of the eligibility criteria for participation in the scheme, and taking households out of fuel poverty was not a direct objective of the scheme. However, energy efficiency improvement schemes such as the SHDF indirectly help the government to reach the statutory fuel poverty target, set in December 2014 and taking households out of fuel poverty is a positive outcome for the scheme. The statutory fuel poverty target is to ensure "that as many fuel poor homes as is reasonably practicable achieve a minimum energy efficiency rating of Band C, by 2030". Improving the energy efficiency of dwellings was a key objective of the Wave 1 scheme and a reduction in energy demand will also reduce fuel poverty as a result.

7.2 Defining Fuel Poverty

The current government definition of Fuel Poverty being used in England[18] is the Low Income, Low Energy Efficiency (LILEE) metric. Under this definition, households are fuel poor if: they have a Fuel Poverty Energy Efficiency Rating (FPEER)[19] of band D or below, and the equivalised household income (income after tax, National Insurance, and housing costs) minus their required fuel costs falls below a set income threshold (defined as 60% of the national after-housing-cost (AHC[20])).

When assessing for their fuel poverty status (using the LILEE definition), households are divided into one of four quadrants, namely:

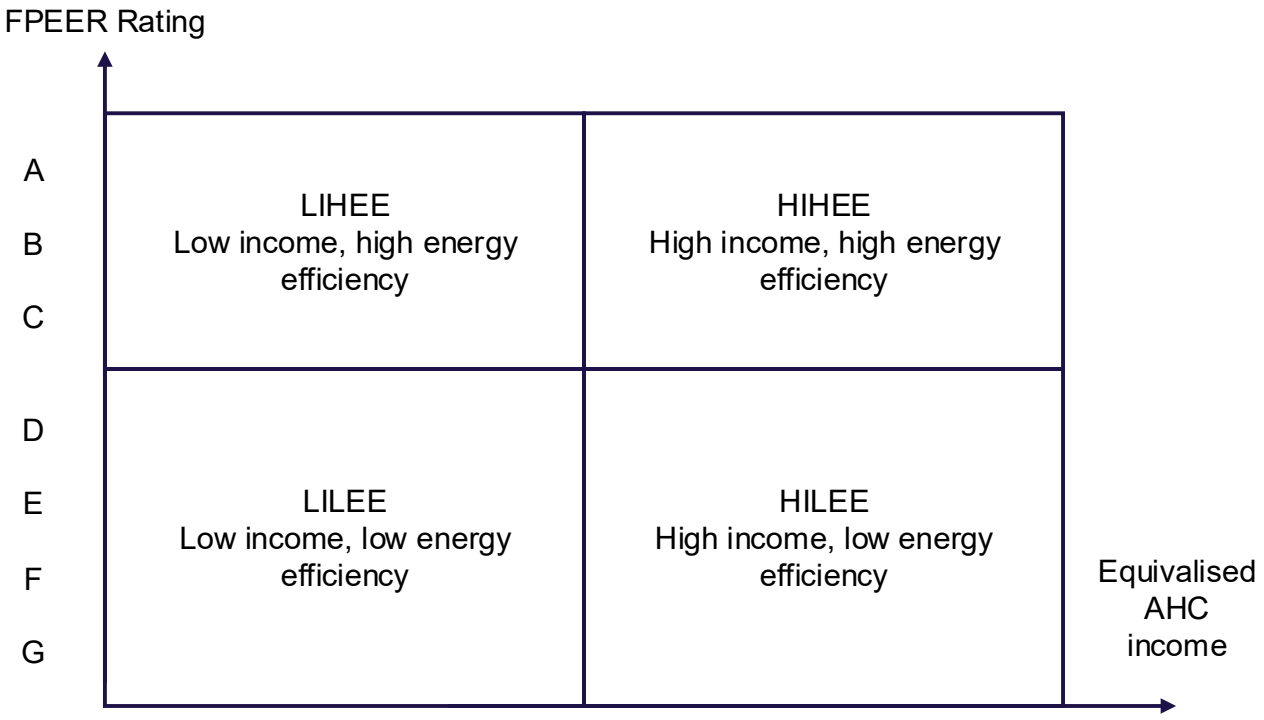
- The LILEE quadrant - households with low income and low energy efficiency. Households where the income is below the set income threshold and where the FPEER of their home is band D or below. These indicate households in fuel poverty.

[18] DESNZ, 'Fuel poverty statistics'
[19] The fuel poverty energy efficiency rating (FPEER) methodology is based on the government's Standard Assessment Procedure (SAP) for assessing the energy performance of domestic properties while taking into account the impact of policy interventions (e.g., Warm Homes Discount) that directly affect household energy costs. Like SAP, the methodology gives an energy efficiency rating from 0 (lowest) to 100 (highest), which can be translated into an energy efficiency 'Band' from G (lowest) to A (highest). The Warm Homes Discount (WHD) is applied directly to an eligible household's electricity bill.
[20] Chapters 3 and 6 of 'Fuel poverty methodology handbook (Low Income Low Energy Efficiency) 2024' provide more detail on the national methodology.

- The LIHEE quadrant - households with low income but living in a home with high energy efficiency. Households where the income is below the threshold but where the FPEER is band C or above. Although these households have low income, they are not deemed to be in fuel poverty because of their home's high energy efficiency.
- The HILEE quadrant - households with higher income and living in a home with low energy efficiency. Households where the income is above the threshold but where the FPEER is band D or below. Although these homes have low energy efficiency, households are not deemed to be in fuel poverty because of their higher income.
- The HIHEE quadrant - households with higher income and living in a home with high energy efficiency. Households where the income is above the threshold and where the FPEER is band C or above. These households are in the most favourable category and are not considered to be in fuel poverty as their homes have high energy efficiency and they have high income.

The quadrants associated with the LILEE method are shown in Figure 6, together with their associated FPEER rating and equivalised AHC income levels.

Figure 6: LILEE method associated quadrants



The (FPEER) methodology is based on the government's Standard Assessment Procedure (SAP) for assessing the energy performance of domestic properties. The SAP method is also used to generate Energy Performance Certificate (EPCs). The difference between the FPEER method and the method used to generate an EPC is that the FPEER method also takes into account the impact of policy interventions that directly affect household energy costs (e.g., Warm Homes Discount (WHD)). Receipt of the Warm Homes Discount was not collected in the resident survey and therefore it was not possible to calculate an FPEER rating. However, EPC data was available for the majority of cases.

The impact of the WHD rebate on FPEER depends on the relative size of the rebate to the total energy bill[21], however, for the purposes of estimating the fuel poverty status of the SHDF households an EPC rating was the best proxy for the FPEER band available. Receipt of WHD or similar policy interventions only impacts the fuel poverty status if the dwelling EPC rating is within a few points of the SAP 69 threshold. For these reasons EPC bands was used as a proxy for FPEER bands when estimating the likely fuel poverty status of the households.

7.3 Derivation of after housing cost income

The pre-installation resident survey collected income information which has been used to estimate if a household falls into the 'low income' category of the LILEE fuel poverty definition. Limitations of this method are set out in section 7.7. Respondents were asked to estimate the amount of money they have left after accounting for housing costs. They were asked whether their household income after housing costs is above or below a threshold which is based on the number of children (aged 13 or younger) and adults (aged 14 and over) in the household and an equivalised fuel cost. The threshold is calculated as follows:

> *SHDF income threshold = 60% median AHC equivalised income + median equivalised fuel costs*
>
> *Income threshold = £15,834[22] x (0.58[23] + (0.42 x (number of adults in household – 1)) + (0.2 x number of children in household)) + £1,620[24] x (fuel cost equivalisation factor)*

The calculation was embedded in the survey script to feed in the appropriate income threshold into the relevant question:

> *K9: Once your household has paid any [IF B9 = 1 OR 2:mortgage][IF B9 = 3, 4 OR 5:rent][IF B9 >= 6:housing costs] and service charges, would you say the money you have left each month is more than <K2_DUM> or less than this?*

The participants' response to this question was used to identify if the household was a high- or low-income household under the LILEE definition.

Analysis of the Wave 1 survey data showed that 34% of householders surveyed did not provide a response to this question (989 householders out of the 1,498 total did provide a response). To maximise the available sample size for income data, for those householders who did not respond to question K9, their responses to other income questions were considered. The response to question K8 "Is your household's total income more or less than £16,000 each year before taxes and any other deductions?", was used where we assumed "less than £16,000 a year" to be the proxy for the fuel poverty low-income threshold.

[21] For more information on the impact of the Warm Home Discount see Annex F of the 2024 Annual fuel poverty statistics report; DESNZ (2024) 'Annual fuel poverty statistics report: 2024'
[22] At the time of question development, this was the most recently published income threshold, representing 60% of the median equivalised AHC income for 2021 (EHS 2020 + EHS 2021 datasets).
[23] AHC income equivalisation factors used in the calculation of LILEE. See Table 11 in DESNZ (2026) 'Fuel poverty methodology handbook (Low Income Low Energy Efficiency) 2024' for further information.
[24] At the time of question development, this was the most recently published median equivalised fuel costs for all households in 2022 (based on projections using the EHS 2020 + EHS 2021 datasets).

Where respondents did not answer questions K9 or K8, responses provided at K6 “How much, together, is your household's income before tax?” were used. We assigned the responses in income bands 1 and 2 (<£15,999 per year) as low income (as the banding of the income questions had been designed to represent as closely as possible the fuel poverty income threshold of £15,834).

Data from question K7 (“Is anyone in your household, including yourself, currently receiving any of these benefits?”) was used if the householders did not answer questions K9, K8 or K6. Respondents answering yes to receiving any of Universal Credit, Housing Benefit, Pension Credit, Council Tax Benefit are on a low income were categorised as low income[25].

This process enabled the inference of a household’s low-income status for 86% of the Wave 1 sample (n=1,290, 86% of all survey respondents). For the remaining 14% of cases (n=208 of all survey respondents) it was not possible to compute a fuel poverty indicator and these cases were excluded from any fuel poverty analysis.

7.4 Derivation of the dwelling energy efficiency

The pre- and post-installation EPC ratings for each dwelling were supplied by Wave 1 projects, as part of their monthly monitoring data reports. The pre- and post-installation EPC ratings were based on surveys of the dwellings, before and after the installations, in line with the requirements of PAS 2035. This data was collated and cleaned by the DESNZ official statistics team before being supplied to IFF and BRE. The cleaning process for the pre-installation EPC data consisted of three steps:

Step 1: If both the EPC band (character: A - G) and SAP rating (numeric values: 1-100) had been supplied in the ‘Pre-Install’ column of the DMS reports, the EPC band was recorded as the official ‘Pre-Install’ EPC.

Step 2: If only the SAP rating had been supplied, the pre-installation EPC band was assigned following Table 14 in the SAP 2012 document[26]:

SAP points >= 1 and SAP points <21, code it as ‘G‘

SAP points >= 21 and SAP points <39, code it as ‘F‘

SAP points >= 39 and SAP points <55, code it as ‘E‘

SAP points >= 55 and SAP points <69, code it as ‘D‘

SAP points >= 69 and SAP points <81, code it as ‘C‘

SAP points >= 81 and SAP points <92, code it as ‘B‘

SAP points >= 92 and SAP points <=100, code it as ‘A‘

[25] These benefits are means-tested and as such householders will only be eligible to receive them if they are on a low income. The exact income threshold does vary for the different benefits, but in the main, receipt of any of these benefits should be a sufficient proxy for a household being below the fuel poverty low income threshold.
[26] The government’s Standard Assessment Procedure for Energy Rating of Dwellings 2012 edition. Accessed from Standard Assessment Procedure (SAP 2012) - BRE Group

Step 3: The pre-installation EPC was recorded as 'Null' (i.e. 'Unknown' in publication) for all other entries.

The cleaned and finalised EPC data was then matched to the resident survey data by IFF using UPRNs. Of the 1,498 Wave 1 survey respondents, 1,233 (82%) had a pre-installation EPC which could be matched on. For the remaining 265 properties (18%), no pre-installation EPC was found. In 61 cases this was because the property was matched but the EPC rating was absent. In 204 cases, no match was made. The two most likely causes are properties accidently reporting incorrect UPRNs, and properties being descoped from Wave 1. However, in the absence of a match, no definitive cause can be determined for individual cases.

Where both the income and EPC data was available, BRE were able to derive the pre-installation fuel poverty status of the household. The achieved sample on which the pre-installation fuel poverty status could be derived was n=1,053 (70% of all Wave 1 respondents).

7.5 Derivation of fuel poverty status

The households were classed as either 'high' or 'low' income, under the LILEE Fuel Poverty definition, based on their responses to the resident survey questions (as described in section 5.2). The homes were classified as being either 'low energy efficiency' (below band C) or 'high energy efficiency' (band C or above) based on the EPC data supplied. Combining the income and energy efficiency data enabled BRE to identify the LILEE quadrant applicable for each household and estimate the household's fuel poverty status. If a household had an equivalised AHC income of below the income threshold, and a modelled EPC band of D or below, then the household was classified as likely to be in fuel poverty.

As noted above, this is only a proxy fuel poverty status, which has been developed to represent the LILEE fuel poverty definition, currently in use in England. Differences in the data collection process, the model used to calculate energy efficiency, and the method of combining income and energy efficiency metrics due to the limited data available, means that the actual fuel poverty status of each household (were it to be calculated using a full LILEE dataset) may differ slightly.

Table 17 summarises the pre-installation achieved sample sizes for the individual components of the fuel poverty indicator and for the final derived indicator.

Table 17: Achieved sample sizes for the derivation of the pre-installation fuel poverty indicator

Resident group	Number of residents
Total respondents to resident survey	1,498
AHC income provided	1,290 (86%)
EPC data provided	1,233 (82%)
Both EPC and AHC data provided	1,053 (70%)

Table 18 shows the demographic profile of the 1,053 residents for whom both EPC and AHC data was available, and could therefore have their pre-installation fuel poverty status calculated.

Table 18: Unweighted demographic profile of residents whose fuel poverty status was calculated, based on data from the pre-installation resident survey

Gender

Demographic	n	%
Male	302	29%
Female	703	67%
Prefer not to say / missing	48	5%

Age

Demographic	n	%
18-34	106	10%
35-54	321	30%
55-74	455	43%
75+	139	13%
Prefer not to say / Missing	31	3%

Ethnicity

Demographic	n	%
Asian/Asian British	27	3%
Black/African/Caribbean/Black British	33	3%
Mixed/Multiple ethnic groups	25	2%
White	953	91%
Other ethnic group	4	0%
Prefer not to say / Missing	11	1%

Disability

Demographic	n	%
Yes, limits activities all of the time	400	38%
Yes, limits activities some of the time	245	23%
Yes, but does not limit activities	72	7%
No	299	28%
Prefer not to say / Don’t know / Missing	37	4%

7.6 Estimating the change in fuel poverty status

Of the 1,053 cases for which the pre-installation fuel poverty status could be derived, 856 were classified as fuel poor (82% weighted). As set out above, the objective of the impact analysis was to establish what proportion of these fuel poor households were taken out of fuel poverty as a direct result of the scheme installations.

To do this, BRE looked at the post installation EPC ratings of the homes to see which had moved from being classed as 'low energy efficiency' prior to the installations, to 'high energy efficiency' after the installations under the LILEE metric described in section 6.2. For 5% of this sample (39 of 856) the post-installation EPC rating was unavailable, so it was not possible to quantify the impact of the scheme improvements for these cases. However, for 95% of these cases there was both a pre and post installation EPC rating available.

Of the 293 households that were classified as fuel poor prior to receiving measures (and had a post-installation EPC rating), 97% were taken out of fuel poverty as a result of Wave 1. These were low income households who lived in homes that improved from an EPC band D or below (low energy efficiency) prior to the scheme installations, to a EPC band C or above (high energy efficiency) as a result of the scheme installation, thereby moving the householders out of fuel poverty under the LILEE fuel poverty definition.

In order to quantify the direct impact of Wave 1 on the fuel poverty status of the participating households, the AHC income and demographic makeup of the households was kept constant. Whilst the household income and the composition of the household could potentially have changed between the point in time the householder data was collected prior to the scheme installations and the point in time the measures were installed, Wave 1 had no influence on any of these potential changes. As the objective of the analysis was to evaluate the direct impact of the measures installed through Wave 1 on fuel poverty status, post installation income and demographic data was not collected in the post installation householder survey.

7.7 Limitations

For a standard fuel poverty assessment (upon which the national fuel poverty statistics are based) a huge amount of detailed information is collected regarding the household, their income (via the EHS householder survey[27] for example), their energy costs (fuel prices) and the energy efficiency of the dwelling they live in (via a detailed building survey). For the Wave 1 evaluation it was not possible to collect this level of detailed information for each participating household and therefore BRE developed a proxy fuel poverty status, based on the same LILEE method used for the national fuel poverty statistics, but using the limited available data.

[27] MHCLG, 'English Housing survey'

For the national housing surveys, the AHC income of a household is calculated based on a large number of demographic and income questions. Due to restrictions on the length of the resident surveys done as part of the Wave 1 evaluation, and the number of other topics that needed to be covered in the survey (to meet the needs of the evaluation), it was necessary to collect the relevant data with far fewer income questions (compared to the national housing surveys). This necessary approach for the analysis is likely to reduce the accuracy of the reported AHC income (in comparison to a full set of EHS questions), however it is not possible to say by how much. In particular, it should be noted that the use of questions K6[28] and K8[29] to impute the low-income flag for the 172 households that did not provide an answer to question K9[30], is likely to result in an underestimation of these households being identified as fuel poor. This is because their tax, housing costs, fuel costs and equivalisation due to household composition, were not included in the income threshold used in that question. As a result, the estimated percentage of Wave 1 households who were fuel poor prior to the installation could be slightly underestimated.

Estimated bias

This analysis is based on survey data, and therefore on a proportion of, rather than all, Wave 1 households. As reported in the Wave 1 process evaluation, of 1,053 surveyed households for which EPC and household income data was available (7% of all Wave 1 households), 831 were estimated to be in fuel poverty before installations (5% of all Wave 1 households). Of 831 households estimated to be in fuel poverty, 293 households had a post-installation EPC-rating (2% of all Wave 1 households). Of these, 284 were taken out of fuel poverty (2% of all Wave 1 households).

Pre-installation fuel poverty could not be calculated for every property; as detailed above, 445 cases either lacked the income data or the EPC data required for the calculation. Examining unweighted survey data, the group of households estimated to be in fuel poverty differed from those not in fuel poverty as follows[31]:

- More likely to have a disability which limits their activities all of the time (38% vs. 32%), or a disability which does not limit their activities at all (8% vs. 5%). Both these groups are more likely than average to be fuel poor, among those providing sufficient data
- More likely to be female (71% vs. 63%); again, female respondents are more likely than average to be fuel poor, among those providing sufficient data
- Less likely to be in full time work (20% vs. 25%); this group are less likely than average to be in fuel poverty, among those providing sufficient data

[28] [household / personal] income before tax.
[29] Whether household's total income is more or less than £16,000 each year before taxes and any other deductions.
[30] "Once your household has paid any [mortgage/rent/housing costs] and service charges, would you say the money your household has left each month to pay for other expenses (for example food, clothing or utility bills) is more than <threshold> or less than this?
[31] Tested to 95% significance, z-test. No differences of more than one percentage point were found by property type, size of household or age group. There were differences associated with not answering demographic questions (i.e., those unwilling to provide income were also likely to be unwilling to give all other types of information). These are not shown for clarity. Also for clarity, inverses of links found are not shown (e.g., if female respondents are more likely to have a fuel poverty indicator, we do not also state that male respondents are less likely, since this is inevitable)

- Less likely to be of 'other' ethnicity (0% vs 2%); no data is available on the fuel poverty of this group due to small sample size

This suggests overall that the effect of non-response and absence of EPC data is that the estimated proportion of households in fuel poverty (given as 82%, weighted, across the survey) is likely to be a slight underestimate. Only 5% of the fuel poor households (39 of 856) did not have a post installation EPC, meaning the effect of the missing EPC data on the estimate of fuel poverty change findings would be minimal.

8. Difference-in-Differences (DiD) analysis

8.1 Overview and aims of the analysis

DESNZ analysts examined the changes in household energy consumption, carbon emissions and energy bills in a sample of Wave 1 properties compared to a control group using staggered Difference-in-Differences, a quasi-experimental design that allows to estimate the impact of a scheme on household annual energy consumption compared to a counterfactual situation where households did not receive energy efficiency measures.

The primary data source for this methodology was the National Energy Efficiency Data-Framework (NEED), which includes annual data on electricity and gas consumption at a household level, as well as property characteristics, demographics, and details of energy efficiency measures installed.

The aims of this analysis were:

1. To evaluate changes in energy consumption in a sample of Wave 1 properties compared to a matched control group, using NEED data.
2. To estimate changes in carbon emissions and energy bills in these properties based on energy savings.

A Difference-in-Differences (DiD) approach was used to estimate changes in energy consumption at a household level. This worked by comparing the energy consumption in households after receiving energy efficiency measures through Wave 1 with consumption before installations. The change in consumption for households that received energy efficiency measures (the intervention group) was compared with a similar group of households that did not have energy efficiency measures installed (the control group). The impact of Wave 1 was calculated as the difference in energy consumption between the two groups after energy efficiency measures were installed.

8.2 The NEED Dataset

The National Energy Efficiency Data-Framework (NEED) is a comprehensive dataset established to collect and analyse yearly meter point data related to gas and electricity consumption for all households in the UK. It was initiated by the Department for Business, Enterprise and Regulatory Reform in 2004 with the primary goal of producing small area consumption data. Over time, NEED evolved to incorporate information on energy efficiency measures installed in households, property attributes, and household characteristics. NEED is built on a range of data sources, as set out in the next section.

The framework includes annual data on electricity and gas consumption from 2004 to the present, property characteristics (e.g., floor area, number of bedrooms, property type), household characteristics (e.g., number of adults, household income), and details of energy efficiency measures installed in properties. This allows for detailed analysis of energy usage trends, the impact of energy efficiency interventions, and the identification of energy-saving opportunities beyond the current policy framework.

8.3 Data Sources in NEED

NEED integrates various data sources to provide insights into energy consumption and the impact of energy efficiency measures on gas and electricity usage in residential properties. Table 19 describes the key data sources that make up NEED, where they come from, and what the complete dataset contains. At the time of this analysis, the latest available data on property characteristics was from 2024.

Table 19: Data sources in NEED

Data	Source	Description
Gas Meters and Gas Consumption	Xoserve, the central customer information service provider for the UK gas industry	Basic metadata about each meter (such as address) and its annualised weather-corrected gas consumption, typically measured from mid-May to mid-May the following year.
Electricity Meter Metadata	Electricity Enquiry Service	Metadata related to electricity meters such as the meter address.
Electricity Consumption	Electricity data aggregators	Annualised electricity consumption data from residential properties, spanning from 2004 to 2024, typically measured on the calendar year.
Address Information	Ordnance Survey	Geographical and address information, including Unique Property Reference Numbers (UPRNs), used for linking meter data with other property-level data.
Geographies and Area Classifications	Office for National Statistics	Information on geographical areas and classifications, providing context for property locations within the dataset.
Property Characteristics	Valuation Office Agency for properties in England and Wales	Details on property characteristics such as size, number of bedrooms, property type, and age, offering insights into the physical attributes of residential properties. At the time of this analysis, the latest available data on property characteristics was from 2024.
Energy Performance Certificate	Department for Levelling Up, Housing and Communities (England and Wales), Scottish Government (Scotland)	Ratings from EPC assessments, indicating the energy efficiency of properties and the impact of energy-saving measures.

Data	Source	Description
Household Characteristics	Experian	Modelled information on household characteristics including number of adults, household income, length of residence, and tenure, providing insights into the occupants of residential properties.
Energy Efficiency Measures Installed	SHDF scheme monitoring data	Details on energy efficiency measures installed, including type of measure and installation date.

8.4 Methods

DESNZ used staggered DiD and Coarsened Exact Matching (CEM) to compare properties that received measures as part of Wave 1 with control properties.

DiD provides a direct comparison of the impact of Wave 1 between households who received measures through the scheme (the intervention group) and those who did not (the control group). The staggered DiD approach allows to correctly estimate treatment effects accounting for the fact that households received measures at different times during Wave 1 (by separating treated households into annual cohorts).

CEM was used to improve the selection of an adequate control group, using a combination of categorical and continuous matching criteria based on the inclusion criteria for the scheme itself (i.e. property type, age of the property, region, floor area of the property, and tenure type). It helped ensure that the intervention and control groups were well matched based on shared characteristics, improving the validity of causal inferences.

8.5 Staggered Difference-in-Differences (DiD)

Difference-in-Differences

DiD estimates the causal effect of an intervention by comparing outcome changes between a treatment group and a control group. The method measures differences before and after the intervention for both groups, and calculates the impact the intervention had on the treatment group relative to the change in the control group, thereby isolating its impact from external factors that may influence energy consumption such as wider economic trends.

Critical to DiD's claim to valid causal inference is the parallel trends assumption, i.e. that given similar trends in energy consumption prior to receiving measures, energy consumption across treatment and control groups would have continued to evolve in parallel.[32] This implied counterfactual makes DiD a powerful quasi-experimental approach. Research has shown that it is second only to randomized controlled trials to identify the impact of policy changes.[33]

Accounting for multiple periods and variation in treatment timing

The simplest DiD approaches assume two time periods (pre- and post-) and that the intervention is delivered simultaneously for all units. However, in this case, the data included energy consumption measurements across multiple time periods, and measures are installed at different times (Wave 1 was delivered from 2022 to 2024).

DESNZ applied the method for staggered DiD set out by Callaway and Sant'Anna (2021).[34] This approach addresses estimation challenges associated with multiple time periods and variation in treatment timing by splitting the analysis into annual cohorts (i.e. groups of households treated in a given year). Multiple regression models then estimate average treatment effects (ATTs[35]) for all pre- and post-treatment years within each cohort, and for each cohort as a whole. Calculating a type of weighted average of these cohort effects then gives an aggregated summary treatment effect, which can be straightforwardly interpreted as overall the average treatment effect across all households included in the analysis (following Callaway and Sant'Anna).

8.6 Coarsened Exact Matching

CEM was used to create a balanced control group. CEM works by grouping continuous data into bins and then matching households exactly using these bins alongside other categorical variables to ensure balanced characteristics across the intervention and control groups.

This method addresses many of the limitations associated with traditional matching techniques. By ensuring that the matched groups are similar across several covariates (in this analysis: type of property, age of the property, region, floor area of the property, and tenure type), CEM reduces the risk of model dependence and bias that might arise from unmatched confounders (e.g. a change in the makeup of people in each household, installations of measures outside of government schemes, extensions on existing properties).[36] This method is less sensitive to common issues with large and complex datasets and has been shown to provide better balance and lower bias compared to Propensity Score Matching and other matching techniques.

[32] This assumption was tested both visually and using a statistical (Wald) test.
[33] For example: Guido Imbens and Jeffrey Wooldridge (2008) 'Recent Developments in the Econometrics of Program Evaluation', National Bureau of Economic Research, Working paper 14251
[34] Brantly Callaway & Pedro Sant'Anna (2021) 'Difference-in-differences with multiple time periods', Journal of econometrics, Volume 2, Issue 2, 200-230
[35] Average treatment effect on the treated (hence ATT rather than ATE) - i.e. the estimate is sample-specific; if, for example, scheme eligibility criteria expanded significantly or targeted different property archetypes the estimate may not be generalisable.
[36] Stefano Iacus, Gary King & Giuseppe Porro (2012) 'Causal Inference without Balance Checking: Coarsened Exact Matching' Political Analysis, 20(1), pages 1–24

8.8 Data Analysis

Step One: Preprocessing and cleaning

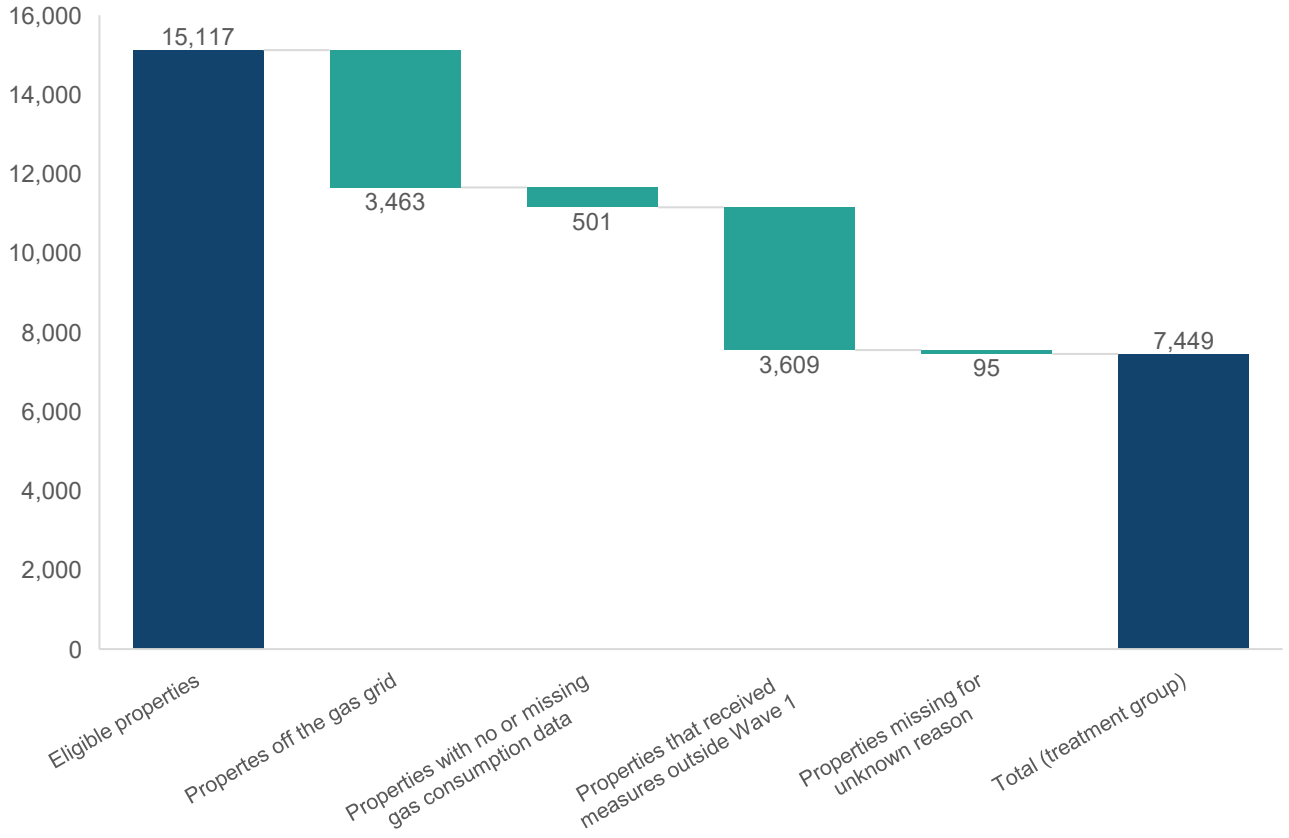
In preparation for the analysis, the data was first examined to check for missing values. Households with missing data were excluded from the analysis.

A total of 7,449 properties that received measures between March 2022 and July 2024 were included in the treatment group for the analysis on changes in gas consumption. These represent 46% of all Wave 1 properties. 15,117 properties were identified as having received measures under Wave 1 in the NEED dataset and were therefore potentially eligible for the analysis.[37] Properties were excluded from the analysis for the following reasons (illustrated in Figure 7):

- 3,463 properties were off the gas grid and therefore excluded from the analysis, as they had no metered gas consumption data
- 49 properties had no gas consumption data for the entire period of the analysis (2015 to 2024), and 452 properties had missing data for one or more years between 2015 and 2024
- 3,609 properties received measures outside Wave 1. These were mostly properties that had new boilers installed. Including these properties in the analysis would have likely overestimated the effect of Wave 1 installations on gas consumption. Therefore, to isolate the impact of Wave 1 installations as much as possible, we decided to exclude them from the analysis
- 95 properties were missing for unknown reasons

[37] This is less than the total number of properties that received measures as part of Wave 1 according to official statistics (16,056) because 939 properties did not have an associated UPRN, and therefore could not be matched to NEED data.

Figure 7: Waterfall diagram showing how many eligible properties were excluded from the analysis and for what reason*



*Orange bars represent a decrease.

As explained below, the electricity consumption of the treatment and control groups differed significantly in the years before installations, and therefore the analysis on changes in electricity consumption was not reported as it generated inconclusive results.

At this stage, DESNZ also considered whether to remove outliers. To explore whether outliers influenced the impact estimates, they carried out a sensitivity analysis, during which they ran the model several times using different numbers for the outliers. DESNZ found that the model's sensitivity to outliers was extremely low. In most instances, including outliers did not impact the results generated from the analysis, and where it did, the inclusion of outliers changed consumption figures by under 30 kWh. Moreover, there was a risk that excluding some of the outliers would have masked the true impact of the scheme. In particular, properties which received heat pumps as part of Wave 1 would have had substantially greater changes in gas consumption than other properties. As such, it is likely that these properties would have been incorrectly flagged as outliers, which would have underestimated the gas savings of the scheme.

Step Two: Data Matching and Data Organisation

Once the sample for the intervention group was established, CEM was used to match properties in the treatment group to control properties. Matching was performed using the R package “MatchIt”. The variables used for matching included the type of property (semi-detached, terraced, etc.), age of the property, region, floor area of the property, and tenure type. Of these, the only modelled variable was tenure type.

These variables were chosen after doing a sensitivity analysis, whereby the model was run several times with different combinations of variables. The aim was to find a combination of variables that resulted in the highest number of properties (i.e. minimum data loss) while satisfying the parallel trends assumption. The first run of the sensitivity analysis included all available variables (e.g. type of property, age of property, tenure, region, EPC Band, number of bedrooms, floor area of the property, number of adults in the property, and average household income). In the following runs, DESNZ dropped individual variables and also tried different combinations of variables while checking the number of properties included in the analysis and whether the parallel trends assumption was satisfied. This was repeated until they found the chosen set of variables, which was the right combination to avoid significant data loss and to satisfy the parallel trend assumption for this scheme. This approach ensured a matched sample where each property in the intervention group was paired with five properties from the control group, increasing the power of the analysis and providing a more accurate estimate of the impact of the scheme. The control group consisted of 37,245 properties.

Results from the DiD analysis may not be representative of the entire Wave 1 population, given the coverage of the NEED dataset and additional missing data. They should be interpreted as a local average treatment effect for the relevant subset of households included in the analysis (i.e. on the gas grid, with available consumption data for the duration of the period in question).

DESNZ looked at the differences in characteristics of properties in the intervention group and the overall Wave 1 population. Compared to the Wave 1 population:

- The intervention group had a lower proportion of flats (7% vs 21%), and a higher proportion of houses (74% vs 61%)
- Properties from the North East and the North West were slightly over-represented in the treatment group (22% vs 14% and 20% vs 15% respectively)
- A slightly higher proportion of loft insulations (31% vs 23%) were installed in properties from the intervention group. A lower proportion of windows and doors (16% vs 23%) were installed in the intervention group

This suggests that, overall, there are some minor differences between properties included in our analysis and those from the rest of the Wave 1 population (given only a subset of Wave 1 properties were included in the analysis), however these are unlikely to have a substantial impact on results.

DESNZ were unable to compare the difference in characteristics such as age of the property and household income between the intervention group and the Wave 1 population due to inconsistencies in how variables were classified in NEED and scheme data. Data on the demographics of households such as age and sex were not available in NEED and therefore could not be compared with the Wave 1 population.

The tables below provide a comparison of the treatment group with the Wave 1 population by property type, region and measures installed.

Table 20: Proportion of properties in the intervention group (used for analysis of gas consumption) and Wave 1 population by property type

Data on property types in the Wave 1 population was taken from scheme monitoring data as of July 2024.

Property type	Intervention group (N)	Intervention group (%)	Wave 1 population (N)	Wave 1 population (%)
Bungalow	1,396	19%	2,765	18%
Flat	539	7%	3,295	21%
House	5,514	74%	9,676	61%
Unknown	0	0%	43	0%
Total	**7,449**	**100%**	**15,779**	**100%**

Table 21: proportion of properties in the intervention group (used for analysis of gas consumption) and Wave 1 population by region

Data on regions for the Wave 1 population was taken from change control data as of March 2024.

Region	Intervention group (N)	Intervention group (%)	Wave 1 population (N)	Wave 1 population (%)
East Midlands	994	13%	2,115	13%
East of England	685	9%	1,962	12%
London	559	8%	1,870	11%
North East	1,613	22%	2,327	14%
North West	1,512	20%	2,526	15%
South East	496	7%	822	5%
South West	253	3%	830	5%
West Midlands	607	8%	2,014	12%
Yorkshire and the Humber	730	10%	2,151	13%
Total	**7,449**	**100%**	**16,617**	**100%**

Table 22: proportion of types of measures installed in properties from the intervention group (used for analysis of gas consumption) and the Wave 1 population

Data on measures installed in properties from the Wave 1 population were taken from official statistics as of February 2025.

Measure type	Intervention group (N)	Intervention group (%)	Wave 1 population (N)	Wave 1 population (%)
Loft Insulation	4,367	31%	7,410	23%
Solid Wall Insulation (External or Internal Wall Insulation)	3,513	25%	7,496	23%
Windows and Doors	2,257	16%	7,236	23%
Cavity Wall Insulation	1,293	9%	3,307	10%
Energy Efficient Lighting	682	5%	845	3%
Solar PV	1,514	11%	3,140	10%
Electric Storage Heating	11	0%	612	2%
Low Carbon Heat (Air Source Heat Pumps, Ground Source Heat Pumps)	38	0%	732	2%
Roof Insulation	50	0%	190	1%
Floor Insulation	101	1%	213	1%
Heating Controls	256	2%	512	2%
Total	**14,082**	**100%**	**31,693**	**100%**

Step Three: Difference-in-Difference Analysis

After completing the matching process, DESNZ reorganised the dataset in the “did” package in R for conducting DiD analysis. The dataset included yearly energy consumption figures for all properties that received measures as part of Wave 1 between March 2022 and July 2024 and all eligible control properties.

The first step of the analysis was to define the start and end time for the analysis. DESNZ selected the period from 2015 to 2024. This means that, given Wave 1 installations began in March 2022, DESNZ looked at energy consumption figures up to seven years before the scheme started, which was useful to test the parallel trends assumption (i.e. to confirm that the intervention and control groups had similar energy consumption before the start of Wave 1). The NEED data used for this analysis covers gas consumption up to May 2024. This was the latest available data at the time of analysis, meaning that the estimates are as precise as possible.

Table 23: Number of properties included in the intervention group, grouped by the year in which they received measures as part of Wave 1, and the period of gas and electricity consumption data available for these properties

SHDF Wave 1 Installations	N of properties	Gas Consumption Data (NEED)
March 2022 - May 2022	107	May 2015 - May 2024
May 2022 - May 2023	4,336	May 2015 - May 2024
May 2023 – May 2024	2,983	May 2015 - May 2024
May 2024 – July 2024	23	May 2015 - May 2024

Parallel trends assumption

The next step was to evaluate the parallel trends assumption and the extent to which it was met. This gives confidence in the matching process, and the resulting analysis.

The assumption was tested by looking at the difference in energy consumption between the intervention and control group in the years before Wave 1 began, starting from 2015. For each group of properties (i.e. grouped by year of installation), the analysis generated a coefficient comparing energy consumption in the intervention and control group for each year before measures were installed, starting from 2015.

In practice:

- For properties that received measures in 2022, this meant looking at the difference in energy consumption between those properties and those in the matched control group over the years 2015 to 2021.
- For properties that received measures in 2023, this meant looking at the difference in energy consumption between those properties and those in the matched control group over the years 2015 to 2022.
- For properties that received measures in 2024, this meant looking at the difference in energy consumption between those properties and those in the matched control group over the years 2015 to 2023.

DESNZ found that average annual gas consumption for households included in the treatment group was not significantly different to the control group in the years before installation. This suggests the parallel trends assumption was met. Conversely, average annual electricity consumption for households in the treatment group was significantly different to the control group in the years before installation, making results of the analysis inconclusive. For this reason, findings from the analysis on changes in electricity consumption were not reported.

Estimated average treatment effects on energy consumption

This difference-in-differences analysis used the R package implementation of the method described in Callaway and Sant'Anna (2021).[38,39] For each annual cohort of properties receiving installations, two-way fixed effects outcome regression was used to estimate the change in energy consumption attributable to the Wave 1 installations in each year, as shown in equation (1). To avoid the bias that arises when using pooled two-way fixed effects estimation where treatment timing varies across properties,[40] separate 2×2 fixed effects regression models were estimated for every year in each cohort group, yielding a series of 'group-time' effect estimates. In each of these regression models, energy consumption (y) for each household (i) in each year (t) was modelled as a function of fixed household characteristics (α_i), time-specific effects (λ_t) shared across properties (e.g. energy price fluctuations), the impact of Wave 1 measures (β), and a random error term ($\epsilon_{i,t}$). The coefficient (β) on the binary treatment indicator ($D_{i,t}$) estimates the average treatment effect of Wave 1 on treated properties in that cohort group (g) in each year (t) for which data is available – the 'group-time' effect ($\mathrm{ATT}_{g,t}$).

$$y_{i,t} = \alpha_i + \lambda_t + \beta D_{i,t} + \epsilon_{i,t} \quad (1)$$

Coefficients were estimated for both pre- and post-treatment years. Pre-treatment differences between the treatment and control group were used to test the credibility of the parallel trends assumption.

The group-time average treatment effect estimates ($\mathrm{ATT}_{g,t}$) were then aggregated into 'group effects' ($ATT_{\bar{g}}$) which averaged all post-treatment group-time estimates for each cohort group (g) over the number of post-treatment years in the data for that group ($T - g + 1$), accounting for the fact that cohorts which had been treated for longer had a larger number of estimated group-time coefficients.

$$\mathrm{ATT}_{\bar{g}} = \frac{1}{T - g + 1} \sum_{t=g}^{T} \mathrm{ATT}_{g,t} \quad (2)$$

Each group effect ($\mathrm{ATT}_{\bar{g}}$) is the average energy consumption impact of participating in Wave 1 among units in cohort group g – i.e. properties which received installations in a given gas (May-May) or electricity (February-January) metering year.

[38] Brantly Callaway & Pedro Sant'Anna (2021) 'Difference-in-difference with multiple time periods' Journal of econometrics, 225(2), pages 200-230

[39] Brantly Callaway & Pedro Sant'Anna (2021) 'did: Difference in Differences' R package version 2.3.0.

[40] This arises because pooled two way fixed effects models estimate a single regression coefficient that is a weighted average of many implicit comparisons across cohorts and periods – including comparisons that use observations for already treated units in previous periods as control units. See Andrew Goodman-Bacon (2021) 'Difference-in-differences with variation in treatment timing' Journal of econometrics, 225(2), pages 254-277

Due to the nature of the dataset, the first post-treatment year was excluded from the calculation of higher-level (group and aggregate) effect estimates. This was necessary because the timing of measure installations is binned[41] into years (reflecting the NEED metering year); however, this is a simplification, as an installation might take place at any time over the year.[42] The metered energy consumption year in NEED is unlikely to begin on the same day that each household received an installation. This means that for part of the first year (i.e. before energy efficiency measures were installed) the impact of the installed measure is not reflected in the energy consumption data. As a result, average savings for the first year will (in almost all cases) be lower than in subsequent years (which reflect a full year with an operational measure, and as such can be used to evaluate the impact of Wave 1 installations). Therefore, the first-year coefficients were excluded from all aggregate estimate calculations on this basis.

Finally, group effects were aggregated using a weighted average (by group sample size) to provide an overall average treatment effect for all properties in the sample.

$$\mathrm{ATT}^{\mathrm{overall}} = \sum_{g \in G} w_g \, \mathrm{ATT}_{\bar{g}} \tag{3}$$

Clustered standard errors (at the household level) and simultaneous confidence bands were calculated using a multiplier bootstrap procedure.[43] The exclusion of the first post-treatment year was reflected in the reported uncertainty estimates for aggregate treatment effects.

Step Four: Outputs

There are two key outputs from the DiD model shown above. First, there is a coefficient for the average treatment effect (ATT) of Wave 1 on a subset of households up to July 2024, as measured by annual energy savings in kWh per household. In simple terms, this shows the average kWh energy savings per household for metered households who participated in Wave 1 at any point between March 2022 and July 2024 (and were included in the analysis), compared with similar households who did not participate.

Second, an ATT for energy savings in kWh for households in the treatment group that received measures each year between March 2022 and May 2023 was produced (as both cohorts had more than one year of energy consumption data), which shows the savings relative to years before or after the installation (e.g. the impact of measures installed in 2022 on household energy consumption in the years before and after the installation, up to May 2024). This is useful to see trends in energy savings over time for those cohorts.

[41] Binning (sometimes referred to as bucketing) is a data preprocessing technique that groups continuous numerical data into discrete intervals, or 'bins', to simplify analysis.
[42] Relatedly, there is some uncertainty around whether logged installation dates in the NEED dataset are accurate.
[43] The simultaneous confidence bands cover the entire path of the group-time average treatment effects and account for dependency across different group-time average treatment effect estimates.

From the annual energy savings in kWh per household, DESNZ were able to derive annual carbon savings in tonnes and energy bill savings in £ per household, by multiplying energy savings by carbon intensity and energy retail cost respectively.[44]

8.9 Results

As of May 2024, households that received measures between March 2022 and July 2024 (and were included in the analysis) saved, on average, an additional 1,079.9 kWh (95% CI: -1,325.2, -834.6) in annual gas consumption compared to a matched control group.

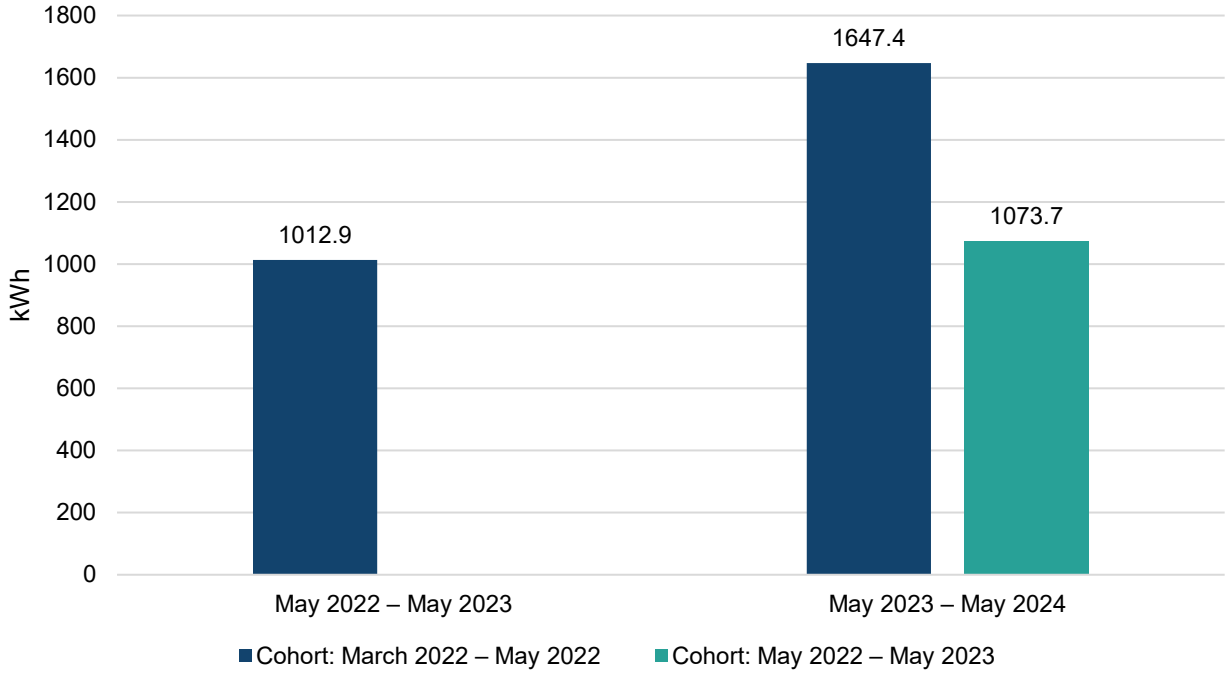
DESNZ also looked at the additional savings in annual gas consumption over time for households that received measures between 2022 and 2024 compared to a matched control group. As shown in Figure 8, the analysis found that:

- Households that received measures between March and May 2022[45] (n=107) saved on average an additional 1,012.9 kWh (95% CI: -2,212.0, 186.2) in annual gas consumption by May 2023 compared with a matched control group. Between May 2023 and May 2024, the same households saved on average 1,647.4 kWh (95% CI: -2,914.5, -380.3) compared to the control group. However, findings are indicative given the small sample size, as reflected in the relatively wide confidence intervals.
- Households that received measures between May 2022 and May 2023 (n=4,336) saved on average an additional 1,073.7 kWh (95% CI: -1,444.1, -703.4) in annual gas consumption by May 2024, compared with a matched control group.

[44] To estimate annual carbon savings per household, annual savings in gas consumption were multiplied by gas carbon intensity (kgCO2/kWh) and divided this by 1000 to convert the figure to tonnes of carbon saved. To estimate annual bill savings per household, annual savings in gas consumption were multiplied by gas retail cost (£/kWh) in the year 2025. Values were taken from the Green Book supplementary guidance, and price year set to 2025.

[45] NEED gas consumption data is reported from May to May the following year. For the year 2022 (i.e. from May 2021 to May 2022), gas consumption data from March 2022 to May 2022 was used because Wave 1 installations began in March 2022.

Figure 8: Additional savings in annual gas consumption in kWh for households that received energy efficiency measures as part of Wave 1 in 2022 (n=107) and 2023 (n=4,336), compared to a matched control group (n=37,245)



8.10 Limitations

Limitations of NEED

Below are some of the data issues and limitations of NEED:

- One of the key issues is **Address Matching Errors**. The process of matching addresses to the Unique Property Reference Numbers (UPRNs) can sometimes result in errors. Some addresses may not be confidently matched, which could lead to inaccuracies when linking property-level data across different datasets. This, in turn, could affect the overall quality of the analysis. The address matching process may have an estimated error rate of around 1% for domestic addresses. This could introduce inconsistencies in the dataset and potentially affect the reliability of results.
- Relatedly, the **reliability of data** from external sources, such as energy suppliers or government agencies, may vary. Any inaccuracies or inconsistencies from these sources could propagate through the NEED dataset, influencing the validity of the analysis outcomes. Furthermore, all data provided by Experian is modelled, and data on property characteristics is from 2024 based on the latest data available at the time of this analysis.
- **Data consistency is another challenge**. Inconsistencies in data formats, definitions, or quality standards across different sources and datasets could affect the integration and analysis of the data. This could potentially lead to discrepancies in the results.

As part of the wider domestic NEED publication, overall trends from data contained within NEED are compared against other data sources to check for consistency (Domestic NEED: Annex C).[46] In all cases, the NEED data are broadly consistent with the other sources available for comparison.

Limitations of the EESE methodology

Below are some of the key limitations of this analysis that should be considered for the correct interpretation of findings:

- **The analysis includes less than half of all properties that received measures as part of Wave 1 (46% of all Wave 1 properties)**. As a result, findings may not be representative of the overall Wave 1 population and should be interpreted accordingly.
- **Total energy and carbon savings may be underestimated as off-gas grid households were not included in the analysis**. Scheme data showed that as of February 2024, 24% of properties treated in Wave 1 were off gas grid. This means that the total reported Wave 1 energy and carbon savings may be underestimated.
- **It was not possible to track changes in energy consumption in properties that switched from gas to electricity as a result of Wave 1**. This is because measurement of gas and electricity consumption cannot be combined due to differing time periods in NEED: gas consumption is measured from mid-May to mid-May the following year, while electricity is measured from February to January. However, there is a possibility that properties that switched from gas to electricity following Wave 1 may have not disconnected their gas meter. While these properties would be included in the analysis, it is not possible to tell how many these are.
- **Properties in both the intervention and control groups may have installed measures independently and not as part of government schemes**. The dataset is not able to track installations that may have occurred outside of government funding. Therefore, it is possible that some properties in the control group independently installed energy efficiency measures or low carbon heating technologies like heat pumps or Solar PV.

Given these limitations, energy and carbon savings estimated from this analysis may be underestimated, mainly because of missing savings from off-gas grid properties. The exclusion of off-gas grid properties may mean that carbon savings were underestimated, given that several of these households are likely to transition from oil and coal to electricity.

[46] DESNZ (2025) '[National Energy Efficiency Data-Framework (NEED) report: summary of analysis 2025]', Annex C

9. Appendix: Primary data collection

9.1 Resident survey

Table 24: Core questions asked in the Wave 1 post-installation resident survey, and relevant themes, evaluation questions and contribution claims addressed

Section	Survey question	Evaluation Question
Heating status	Before receiving the energy saving measures, which of these was the main way you heated your home? Which of these other type(s) of heaters did you use in your home?	7.6
Heating status	Which of these is the main way that you currently heat your home? And which of these other type(s) of heater do you use in your home?	7.6
Heating status	Thinking about these other types of heaters, overall, do you use them more or less often since the energy saving measures were installed? Which of the following reasons is why your energy use has increased/decreased/stayed the same?	7.6, Contribution claims 8a, 8c and 8d
Heating status	Why have you increased/not reduced/decreased your use of these heaters since energy saving measures were installed?	7.6, Contribution claims 8a, 8c and 8d
Issues experienced in home	Before you received the energy saving measures, did you have any of these problems with your home? Do you currently have any of these problems with your home? (e.g. mould/mildew, condensation/steamed up windows and draughts).	5.2, 5.4
Issues experienced in home	For each problem you identified, has this got better, worse, or has there been no change since the energy saving works?	5.2, 5.4
Issues experienced in home	For each problem, did you take any other actions to solve this (apart from receiving the energy saving measures)?	5.2, 5.4
Issues experienced in home	Since the energy saving measures have been installed, have you experienced any problems in your home related to these measures?	Context to support analysis
Issues experienced in home	Why do you think the energy saving measures have led to these problems?	Context to support analysis
Installation process	Overall, how satisfied, or dissatisfied are you with the installation process?	2.1

Section	Survey question	Evaluation Question
Installation process	Overall, how satisfied, or dissatisfied are you with the quality of the energy saving measures installed?	2.1
Confidence using energy saving measures	Have you received any support or guidance about how to use the energy saving measures?	2.1
Confidence using energy saving measures	To what extent do you agree or disagree that the guidance was relevant and easy to understand?	2.1
Confidence using energy saving measures	How confident do you feel operating the equipment, cleaning the equipment and so on? What would make you feel more confident?	2.1
Confidence using energy saving measures	Has anyone been in contact with you to check if you have experienced any issues with the measures?	2.1
Confidence using energy saving measures	Did you inform them of any issues that you have experienced with measures? Have these issues been addressed?	2.1
Outcomes of measures	Overall, how satisfied are you with the energy performance measures installed?	5.1
Outcomes of measures	Have you seen any changes to your household energy bills since the work has been completed? Why do you say that?	5.3, 7.3,
Outcomes of measures	To what extent do you agree or disagree with the following statements? Its more affordable to maintain a comfortable temperature in my home, I use less gas or electricity to heat my home, I am less worried about being able to pay my energy bills, the work has made me feel more proud of my home.	5.2, 5.4, 5.5, Contribution claim 13a
Outcomes of measures	Since the energy saving measures were installed in your home, has your mental/physical health got better, worse or has there been no change?	5.2, 5.4, 5.5, Contribution claim 13a
Outcomes of measures	Do you use your heating as much as you would like in winter? When you switch the heating off during winter, does the temperature inside your home drop quickly or slowly within the first two hours?	Contribution claim 12a
Views on further energy saving installations	As a result of having energy saving measures installed, would you say you are more or less likely to consider other energy saving installations in the future? Why?	5.6, Contribution claim 10a

9.2 Resident focus groups

Topic guide coverage

Table 25: Core questions asked in the focus groups

Section	Question	Evaluation question
Information about household	To begin with, I'd like to ask a few questions about your homes before measures were installed. Were there any issues with your home, such as damp or mould, condensation, or draughts? without the heating on, was your home a comfortable temperature? How did this vary depending on the time of year? How did these issues affect you? What changes or impacts were you hoping you would experience in your home after having the energy saving measures installed?	Context, 2.2, 5.8
Installation process	First, could you please talk me through your experience of having energy saving measures installed? Would you say that the process overall was a positive or negative experience? Did you experience any disruption, issues or difficulties during the installation process?	2.1, 2.2
Outcomes of measures	Overall, how satisfied are you with the energy saving measures installed in your home? Could you please tell me a little bit about why you are/are not?	5.2 5.4 5.5 5.7 8.1 Contribution claim 8a, 8c, 8d, 12a, 12b, 13a, 13b
Outcomes of measures	Have the energy saving measures installed in your homes had any other impacts on you or your household?	5.2 5.4 5.5 5.7 8.1 Contribution claim 8a, 8c, 8d, 12a, 12b, 13a, 13b

Section	Question	Evaluation question
Outcomes of measures	Could you describe in more detail any impact the measures have had on the following areas related to energy use and cost: - Energy bills - Worries about paying energy bills. - Maintaining a comfortable temperature in your home. - Condition of the property e.g. mould/damp. - Physical health. - Mental health/wellbeing. - Pride in home.	5.2 5.4 5.5 5.7 8.1 Contribution claim 8a, 8c, 8d, 12a, 12b, 13a, 13b
Outcomes of measures	Have you experienced any other positive effects of having the energy saving measures installed in your home? Do you think that inflation and cost of living, have limited the benefits you have felt from these measures? In what ways? Why / why not? Have you experienced any issues as a result of having the energy saving measures installed in your home? How have these effects impacted you or your household?	5.2 5.4 5.5 5.7 8.1 Contribution claim 8a, 8c, 8d, 12a, 12b, 13a, 13b
Confidence with energy saving measures	How have you found using the energy saving measures…easy / challenging? Why? What, if any, guidance or support did you receive from your SHL, the installers, or from elsewhere? How helpful was this support? What other guidance or support would you have liked?	2.1 5.1 Contribution claim 13a
Confidence with energy saving measures	How confident do you feel that you understand how the measures installed in your home work/know how to use them? Why do you say that? Could you talk me through any questions you have about how the measures installed work or how you should use them? What impact does this have on you? What, if anything, could help you to better understand how the measures work and how to use them?	2.1 5.1 Contribution claim 13a
Awareness of and attitudes towards energy efficiency	How interested are you in the energy efficiency of your home? By energy efficiency, we mean the amount of energy such as gas or electricity, that is needed in your home, for example to use the heating or have the lights on. Why are you interested in how much energy is used in your home?	Context to support analysis

Section	Question	Evaluation question
Awareness of and attitudes towards energy efficiency	Have the energy saving measures installed in your home changed the way you think about energy efficiency in your home? In what way? What other energy saving measures would you be interested in having installed, if any? Why / why not? Do you have any plans for other energy saving measures to be installed in your home in the future?	2.3, 5.6 Contribution claim 10a, 10b

Focus group profile

Table 26 below shows the distribution of the 24 focus group participants by measures installed, resident characteristics and property type.

Table 26. Profile of focus group participants

Gender	n	%
Male	7	29%
Female	17	71%

Age	n	%
18-34	3	13%
35-54	9	38%
55-74	12	50%
75+	0	0%

Property size (number of bedrooms)	n	%
1-2 bedrooms	16	67%
3+ bedrooms	8	33%

Participant/household disability status	n	%
Yes – It limits my/their activities all of the time	18	75%
Yes – It does not limit my/their activities	5	21%
None	0	0%
Prefer not to say / Don’t know	1	4%

Satisfaction with installation	n	%
Very satisfied/satisfied	13	54%
Dissatisfied/very dissatisfied	7	29%
Neither satisfied nor dissatisfied	4	17%

Types of measures installed	n	%
Lighting	4	17%
Solar Panels	16	67%
Insulation	21	88%
Windows and/or doors	14	58%
Ventilation measures	17	71%
Controls for a heating system	5	21%
Heat pumps	6	25%

Type of home	n	%
House, bungalow	21	13%
Flat, apartment, or bedsit or maisonette	3	88%

Property age	n	%
Built before 1919	1	4%
Built between 1919 and 1964	12	50%
Built between 1965 and 2002	7	29%
Built from 2003 onwards	0	0%
Unknown	4	17%

Agree/disagree that measures have had an impact	n	%
Strongly agree/ agree OR a lot better/ a little better for at least 3 of the 6 statements	10	42%
Strong disagreement/ disagreement/ neutral/ health is worse on at least 3 of the 6 statements	4	17%

9.3 Qualitative interviews with supply chain stakeholders

Table 27: Supply chain stakeholder topic guide outline mapped by audience and evaluation area

Theme	Question	Audience	Evaluation area
Background on role and responsibilities within their own business	How many years of experience do you have working in the industry of retrofitting housing with energy efficiency measures?	All audiences	Context to support analysis
Background on role and responsibilities within their own business	Which area(s) of the UK does your company operate in?	All audiences	Context to support analysis
Background on role and responsibilities within their own business	What types of installations are you typically responsible for? Types of measures Domestic vs. non-domestic New build vs. existing retrofit	All audiences	Context to support analysis
Understanding of SHDF and reasons for involvement	Can you talk me through your understanding of the SHDF?	All audiences	Context to support analysis
Understanding of SHDF and reasons for involvement	How did you initially get involved in the SHDF?	All audiences	Context to support analysis
Understanding of SHDF and reasons for involvement	Why did you decide to get involved? How did you find communication from government/SHLs? What concerns, if any, did you have about participating? (Prompt on uncertainty over long term future of SHDF)	Installations managers, principal contractors, retrofit coordinators	Contribution claim 4a, 4b
Understanding of SHDF and reasons for involvement	Which other government funded initiatives are you involved in, if any?	Installations managers, principal contractors, retrofit coordinators	Context to support analysis
Activities being conducted as part of SHDF	Which of the following providers have you been working on retrofitting projects for?	All audiences	Context to support analysis

Theme	Question	Audience	Evaluation area
Activities being conducted as part of SHDF	Were you aware that these [specify relevant projects] have been funded by the SHDF?	All audiences	Context to support analysis
Activities being conducted as part of SHDF	What types of measures have you been involved with installing in the social housing properties?	All audiences	Context to support analysis
Activities being conducted as part of SHDF	What types of buildings have the measures been installed on?	All audiences	Context to support analysis
Activities being conducted as part of SHDF	Roughly what proportion of your time do the SHDF retrofitting projects take up of your total time spent working?	All audiences	Context to support analysis
Activities being conducted as part of SHDF	Were you involved in helping to select the buildings that received the retrofitting works? If so, how did you contribute to this decision? What factors were considered?	All audiences	Context to support analysis
Activities being conducted as part of SHDF	Can you talk me through who else you worked with to install these measures? E.g. other plumbers/installers, retrofit co-ordinators, social housing staff, manufacturers etc. If multiple measures were being installed on individual properties were these done around the same time or in stages?	All audiences	Context to support analysis
Communications with SHL	How did you find communication with the SHL? How clear were their expectations? What worked well? What was less useful? Were there any misunderstandings? If so what impact did these have?	All audiences	Evaluation question 2.3 Contribution claim 4a Installer objective 1

Theme	Question	Audience	Evaluation area
Communications with SHL	Was there anything the SHL requested that you were unable able to do? Why?	All audiences	Evaluation question 9.2 Installer objective 1
Communications with SHL	You mentioned previously working with others in the process of installing the measures. How did you find this process? What issues, if any, did you encounter? How did you resolve these?	All audiences	Evaluation question 9.2 Installer objective 1
Challenges and barriers to delivery of installations	To what extent have you been able to complete energy efficiency installations within the allotted timeframes and budgets set out in the scheme requirements?	All audiences	Evaluation question 2.1 Installer objective 1
Challenges and barriers to delivery of installations	Which types of energy efficiency installations do you find the most challenging to complete as part of the SHDF? Why? And how did you overcome these challenges?	All audiences	Evaluation question 8.2 and 2.2 Installer objective 1
Challenges and barriers to delivery of installations	Can you talk me through any unexpected problems or difficulties when carrying out energy efficiency installations as part of the scheme? How common were these? What was causing these issues?	All audiences	Evaluation question 9.3 Installer objective 1
Challenges and barriers to delivery of installations	Have you noticed any changes in the types of energy efficiency installations being requested by clients as a result of the SHDF scheme?	Installations managers, principal contractors, retrofit coordinators	Evaluation question 6.2 Installer objective 4
Quality of work	What feedback have you received from clients (social housing providers) and residents about the quality of work carried out as part of the SHDF? How satisfied were they with the work you undertook?	All audiences	Evaluation question 2.1, 5.1 Installer objective 1

Theme	Question	Audience	Evaluation area
Quality of work	How have you felt about the quality of the installations? What, if anything, affected the quality of the measure you were able to install?	All audiences	Evaluation questions in section 5 Installer objective 1
Quality of work	How did the PAS 2035 quality requirements impact the way you delivered this work, and the quality of the work? Why do you say that? Did the SHDF quality requirements contribute to any challenges undertaking the work? What impact did this have?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 4.2 Contribution claim 6a, 7c Installer objective 3
Quality of work	Were property improvements made in one period of time or were multiple, separate visits required to install difference measures? If the latter, why was this? What was the impact to the resident and to the contractor?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 4.3 Installer objective 1
Capacity, training and accreditation	Did you have access to the staff you needed to meet the requirements for these projects? If not, what did you do to meet these capacity needs? How did you find this process? What challenges, if any, did you encounter? What caused these and how did you overcome them?	Installation managers, principal contractors, retrofit coordinators	Contribution claim 7a, 5b
Capacity, training and accreditation	To what extent do you feel you have the sufficient skills in the following retrofitting measures? Why do you say that? What is lacking?	Installers and installation managers	Evaluation question 4.2, 9.1 Contribution claim 6a Contribution claim 7a Installer objective 3

Theme	Question	Audience	Evaluation area
Capacity, training and accreditation	Which of the following retrofitting installation measures have you attended/received training for? What skill progression, if any, have you noticed in your staff as a result of working on SHDF projects?	Installers and installation managers	Evaluation question 4.2, 9.1 Contribution claim 6a Contribution claim 7a Installer objective 3
Capacity, training and accreditation	Are there any types of retrofitting measures that you would like to be involved in delivering but currently don't do?	Installers and installation managers	Evaluation question 4.2, 9.1 Contribution claim 6a Contribution claim 7a Installer objective 3
Capacity, training and accreditation	In what way, if at all, do you think the requirement for PAS 2035 accredited businesses and Trustmark accredited businesses on SHDF projects benefits the energy efficiency retrofitting industry? Do you think existence of government funded projects with these requirements encourages more upskilling within the industry? Why, why not?	Installation managers, principal contractors and retrofit coordinators	Evaluation question 4.2, 9.1 Contribution claim 6a Contribution claim 7a Installer objective 3
Capacity, training and accreditation	Have you been engaged in learning management as part of these works? Can you describe this, and how you have used these learnings? To what extent was this driven by SHDF participation?	Installation managers, principal contractors and retrofit coordinators	Evaluation question 4.2, 9.1 Contribution claim 6a Contribution claim 7a Installer objective 3

Theme	Question	Audience	Evaluation area
Capacity, training and accreditation	How easy or difficult has it been to find sufficiently qualified installers/businesses to help deliver the project?	Installation managers, principal contractors and retrofit coordinators	Evaluation question 4.2, 9.1 Contribution claim 6a Contribution claim 7a Installer objective 3
Capacity, training and accreditation	Are there any areas (measures/regionally) where resourcing issues are particularly acute?	Installation managers, principal contractors and retrofit coordinators	Evaluation question 4.2, 9.1 Contribution claim 6a Contribution claim 7a Installer objective 3
Value for money	How appropriate do you feel the retrofitting measures installed on the project were for the buildings they were installed in? Why do you say that?	Installers and installation managers, retrofit coordinators	Evaluation question 4.1, 8.1 Installer objective 1
Value for money	How, necessary do you feel it was for these particular retrofitting measures to be installed in the buildings they were installed in? Why do you say that?	Installers and installation managers, retrofit coordinators	Evaluation question 4.1, 8.1 Installer objective 1
Value for money	Have you noticed any variation in installation costs money for different types of installations, in different building types or regions?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 8.1 Installer objective 1
Value for money	Could you talk me through any areas where you think costs ended up being higher than expected? Why did this happen? How could this be avoided on future projects?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 8.1 Installer objective 1

Theme	Question	Audience	Evaluation area
Value for money	In what way, if at all, were you able to provide value for money on these projects through any innovative techniques, processes or materials used? How did participation in SHDF drive this? (e.g. PAS requirements, active learning management or other routes). What impacts did this have? To what extent did other government initiatives separate to SHDF (including ECO or the Great British Insulation Scheme, the Home Upgrade Grant), contribute to any innovation?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 8.5 Contribution claim 6a, 7b Installer objective 1
Value for money	In what way, if at all, has this project contributed to your retrofit work becoming more cost effective due to e.g. volume of work leading to economies of scale? To what extent did other government initiatives separate to SHDF (including ECO or the Great British Insulation Scheme, the Home Upgrade Grant), contribute to this?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 8.1 Contribution claim 5a, 7b
External factors	In what way, if at all, have the impacts of Covid-19 affected project delivery?	All audiences	Evaluation question 2.4 Installer objective 2
External factors	In what way, if at all, have the impacts of the UK's exit from the EU affected project delivery?	All audiences	Evaluation question 2.4 Installer objective 2
External factors	In what way, if at all, have the impacts of high inflation affected project delivery?	All audiences	Evaluation question 2.4 Installer objective 2
External factors	Have there been any other external factors that have impacted project delivery?	All audiences	Evaluation question 2.4 Installer objective 2

Theme	Question	Audience	Evaluation area
Realisation of project benefits	How, if at all, will your experience of the SHDF affect the types of projects and the types of retrofit measures you install in future?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 9.2 Installer objective 3
Realisation of project benefits	What tangible benefits resulting from the SHDF scheme have you noticed for your business or for the industry as a whole? E.g. job creation, growth, pipeline of work, confidence in industry To what extent did other government initiatives separate to SHDF (including ECO or the Great British Insulation Scheme, the Home Upgrade Grant), contribute to this?	Installation managers, principal contractors, retrofit coordinators	Evaluation question headline question 9 Contribution claim 7a, 7b Installer objective 3
Realisation of project benefits	In what way, if at all, has the work on SHDF projects contributed to improvements in building standards and safety? To what extent did other government initiatives separate to SHDF (including ECO or the Great British Insulation Scheme, the Home Upgrade Grant), contribute to this?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 8.9 Contribution claim 7b Installer objective 3
Realisation of project benefits	In what way, if at all, have you noticed any changes in the level of interest or engagement from clients or potential clients for additional retrofitting measures as a result of the scheme?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 6.3 Installer objective 4

Theme	Question	Audience	Evaluation area
Realisation of project benefits	How has the SHDF impacted your future training priorities? How confident are you that the type of work you carried out on the SHDF project will be available in future? Are you looking to increase the availability of staff (either through taking on new employees or upskilling existing employees) for these activities? Why / why not?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 9.1-9.3 Contribution claim 7a, 4b Installer objective 4
Realisation of project benefits	Have the SHDF project(s) led you to change the way which you work in any way? This could be the way which you interact with customers and clients, communication with different members of the supply chain, types of installations undertaken, materials used. Why have you made these changes and how do they benefit your work?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 8.4 Installer objective 4
Realisation of project benefits	Have you noticed any negative impacts resulting from the SHDF on your business or the wider industry? What impact have they had? Who is this impacting? Has it affected your interest in future government schemes in any way, or in retrofit work more generally? Why?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 8.10 Contribution claim 7c Installer objective 4
Realisation of project benefits	Has your involvement in these SHDF works meant you've not done work elsewhere? What was this? Why did you make the decision to focus on SHDF works?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 8.9, 9.4, and 9.5 Installer objective 4
Realisation of project benefits	How do you think the SHDF could be improved to better realise its intended benefits?	Installation managers, principal contractors, retrofit coordinators	Evaluation question 9.3 Installer objective 4

Theme	Question	Audience	Evaluation area
Broader view on government schemes and support options	How do you feel about government investment into energy efficiency schemes? Has it helped the industry develop? Why/ why not?	Principal contractors, retrofit coordinators	Evaluation question 9.4, 9.5 Installer objective 4
Broader view on government schemes and support options	Other than the SHDF, are you aware of any other government energy efficiency schemes that support your industry? To what extent have you been involved? How do you feel about the different schemes? Is there any difficulty responding to the different needs? Are there capacity issues responding to them all?	Principal contractors, retrofit coordinators	Evaluation question 9.4, 9.5 Installer objective 4
Broader view on government schemes and support options	What challenges does the retrofit industry face in meeting the demand to decarbonise housing?	Principal contractors, retrofit coordinators	Evaluation question 9.3 Installer objective 4
Broader view on government schemes and support options	How could the retrofit industry be further supported?	Principal contractors, retrofit coordinators	Evaluation question 9.3 Installer objective 4

9.4 Qualitative data collection with stakeholders

Table 28: Topics covered in the TAF, DP and DESNZ delivery team focus groups and interviews with senior DESNZ management

Section	Question	Audience	Evaluation question
Analysis lead only	What worked well from an analytical perspective in developing a robust economic case to support the Wave 1 business case?	Senior DESNZ Management	Context to support analysis
Analysis lead only	What were the limitations or constraints in monetising key costs and benefits? What could have been improved?	Senior DESNZ Management	Context to support analysis

Section	Question	Audience	Evaluation question
Analysis lead only	If you were to put together the W1 economic case again, what would you change in the way you approached this? What were the key learnings?	Senior DESNZ Management	Context to support analysis
Analysis lead only	How, if at all, did these learnings feed into the W2.1 business case?	Senior DESNZ Management	Context to support analysis
Analysis lead only	What has worked well and what could be improved in the ongoing monitoring of benefits and costs?	Senior DESNZ Management	Context to support analysis
Learnings built into Wave 1	How, if at all, do you think lessons learnt or experiences from the SHDF(D) and/or other similar government schemes shaped the design and delivery of Wave 1?	Senior DESNZ Management	3.1, 3.4
Pre-competition/ competition	To what extent do you think that the marketing of Wave 1 was successful in reaching and engaging SHLs? What, if anything, could be improved in this?	Senior DESNZ Management	1.2
Pre-competition/ competition	To what extent, did the successful bids match up to expectations of Wave 1 ambitions in terms of number, scale and profile?	Senior DESNZ Management	1.4
Pre-competition/ competition	How do you think the scheme design, application and appraisal processes influenced this (number and profile of successful bids)?	Senior DESNZ Management	4

Section	Question	Audience	Evaluation question
Competition process and support	What was the overall quality of the bids? Were there consistent strengths/weaknesses/gaps? What were the differences between successful and unsuccessful bids? In what ways, if any, was TAF support apparent in bids? Did any of the above vary by specific project/applicant types?	DP	1.4, 1.3
Competition process and support	How well did TAF build awareness of Wave 1 opportunities amongst SHLs?	IDT, TAF	1.2
Competition process and support	In what ways did TAF contribute to building awareness of the SHDF Wave 1 opportunity amongst SHLs? How effective do you think TAF's contribution was to this? Which methods were more effective? Did this reach all kinds of SHLs? Was timing of support early enough? What could be improved?	TAF	1.2
Competition process and support	What types of TAF support were most needed and used by Wave 1 applicants? How did this vary by project type?	TAF	1.3
Competition process and support	How well did the process of TAF's targeted support post self-assessments work? (Effectiveness, VfM)	TAF	1.3

Section	Question	Audience	Evaluation question
Competition process and support	What worked well in TAF support? What could have been improved? What gaps were there?	TAF	1.3
Competition process and support	What were the impacts of TAF support for Wave 1 applicants? On their applications On their preparation for delivering the projects On delivery (if known) On Value for Money Examples?	TAF	1.3
Competition process and support	Was the TAF/SHRA sufficient to support these applications? What could have been improved? (Probe on support for consortia forming, time, bid writing, additional information to be provided to SHLs)	TAF, DP, IDT	1.3
Competition process and support	Do you feel the pre-application support from TAF was adequate to prepare the SHLs to deliver successful retrofit projects?	TAF, DP, IDT	1.1, CC2a
Competition process and support	Do you feel the scheme marketing was adequate to bring in the desired number and scope of projects to reach scheme goals?	IDT, TAF, DP	1.2
Competition process and support	How effectively did TAF support SHL in: A. Developing high-quality bids? B. Building capacity/capability to deliver projects? What could be improved?	IDT, Senior DESNZ Management	1.3

Section	Question	Audience	Evaluation question
Competition process and support	Are you aware of any other sources of support that SHLs used in the application process other than that provided by SHDF?	IDT, TAF	1.3
Competition process and support	What worked well in the following processes, and what could have been improved? Application processes Application appraisals Award/distribution of funding Mobilisation of TAF/DP	IDT, DP (not asked to TAF), Senior DESNZ Management	1.11
Competition process and support	To what extent did the types of applications received match expectations, in terms of: Scope Funding required Scale Number (of bids) Appropriate groups/SHLs Region Measure type Quality Why/why not? How did Wave 1 design influence this?	IDT	1.4
Competition process and support	Are you aware of any barriers faced by SHLs to making an application?	IDT	1.1
Competition process and support	What were the drivers and barriers to SHL applications to Wave 1? How did this vary by project/applicant type?	TAF (not asked to DP)	1.1
Delivery	What worked well in project mobilisation? What could be improved?	DP	1.5

Section	Question	Audience	Evaluation question
Delivery	In project mobilisation, how effectively did the DP liaise/work with: DESNZ? TAF? What worked well and what could be improved? What were the barriers and how were they overcome?	DP	1.5
Delivery	How well prepared were the successful applicants for project delivery? How did this vary by project type?	DP	1.3
Delivery	What lessons have been identified from Wave 1 in relation to the DP's involvement in application appraisal processes and project mobilisation? How were these captured? Are you aware of any changes being implemented as a result?	DP	1.11, 1.5
Delivery	What worked well in SHRA/DP support to project delivery? What difference has it made? What could be improved?	IDT	1.5, 1.6 - 1.11 3.1-3.4
Delivery	What worked well or could be improved in the project monitoring process? (Including risk management, views on quality of delivery and installations)	DP, IDT	1.114.2, CC2a
Delivery	How well did the internal management between DESNZ and delivery sub-contractors work? Could anything be improved?	TAF, DP, IDT	1.11
Delivery	Was there enough time/funding/support to carry out the work?	DP, IDT, TAF	4.5, 4.6, 4.8

Section	Question	Audience	Evaluation question
Delivery	How did scheme design factors affect the delivery and installations? (e.g., requirements for prioritising fabric first measures, hardest-to-treat approach, use of PAS2035 certified installers, low carbon heating, eligibility type, minimum co-funding, delivery period, etc)	DP, IDT, TAF, Senior DESNZ Management	4.1-4.6, 4.9, 1.9, 8.3, 8.7-8.10
Delivery	What key factors enabled successful scheme delivery?	Senior DESNZ Management	1.5, 2.3, 2.5
Delivery	Overall, to what extent do you think Wave 1 projects have delivered as intended? What key differences/variations have there been by project type?	IDT, Senior DESNZ Management	2.1, 2.2
Delivery	What do you think have been the enabling factors in successful project delivery?	IDT, DP, Senior DESNZ Management	2.3
Delivery	What do you think have been the barriers to successful project delivery? Did these vary by project type? How did projects overcome these? Why did some projects drop out?	IDT, DP, Senior DESNZ Management	2.3
Delivery	What, if any, actions are you aware of that SHDF team has been able to take to facilitate installation supply chain capability and capacity to support project delivery? Probe for: Intervention to address issues Coordination/competition with other government energy performance schemes	Senior DESNZ Management	1.9 important for CC 4a, 9.4, CC5b

Section	Question	Audience	Evaluation question
Delivery	What actions has the IDT taken to facilitate retrofit supply chain capability and capacity to support Wave 1 project delivery?	IDT	2.3
Delivery	What, if any, enablers and barriers are you aware of to supporting the capability and capacity of the retrofit supply chain?	IDT	2.3
Delivery	How effective was the Wave 1 engagement with supply chain for project delivery?	Senior DESNZ Management	2.5
Delivery	How effective has the DP been in fulfilling their role in Wave 1? Why/why not? What worked well? What could be improved? Were there gaps that suggested the need for a Delivery Agent (DA)?	IDT	1.6, 1.8
Delivery	How did the DP support projects? What was most useful and why? With what impact? How did this vary across projects?	DP	1.6, 1.8
Delivery	How effective has the DP been in fulfilling its remit? What has worked well and what could be improved?	Senior DESNZ Management	1.5, 1.6, 1.8
Delivery	What could have been improved or extended in the DP support provided to projects?	DP	1.6, 1.8

Section	Question	Audience	Evaluation question
Delivery	What has worked well or what could be improved in terms of overall Wave 1 scheme management by DESNZ? Probe for: Commissioning and management of the DP Risk management Scheme governance Efficiency of management and contracting	Senior DESNZ Management	1.5, 1.11
Delivery	How effective was Wave 1 scheme management in terms of processes/ structures and DESNZ oversight? Why/why not? What worked well? What could be improved?	IDT	1.5
Delivery	How well have mechanisms worked to capture learnings and knowledge for future waves?	IDT, Senior DESNZ Management	1.5, 3.1, 3.2
Delivery	Are you aware of any changes that have been implemented as a result of lessons learnt? With what impact?	IDT	1.5, 3.1, 3.2
Delivery	What other sources of support did the SHLs use to deliver their projects?	DP, Senior DESNZ Management	2.5
Delivery	Overall, how well have the projects been able to meet their expected delivery plans? In terms of: - Timing - Scale - Scope - Costs - Resident experience How has this varied between projects?	DP Post	2.1

Section	Question	Audience	Evaluation question
Scheme management	How well did project reporting work? How has the reporting contributed to understanding of scheme progress and delivery? And design of the next wave(s)? What could be improved?	DP	1.5
Scheme management	How well have other scheme processes worked? Why/why not? What could be improved?	DP	1.5
Scheme management	What has worked well in the relationship and communications between DESNZ and the DP? What could be improved?	DP	1.5
Scheme management	How have lessons been captured? How have these been shared and applied? With what impact? (DP) What, if any, lessons from the SHDF(D) were built into Wave 1? With what impact? (IDT)	DP	3.2
Scheme management	How did TAF liaise/work with the other organisations delivering SHDF? What worked well, what could be improved?	TAF	1.3
Scheme management	What, if any, lessons were identified from Wave 1 in relation to TAF and supporting SHLs? How were these captured? Are you aware of any changes being implemented?	TAF	1.3
Scheme management	Are you aware whether the SHRA website and resources were also used during project delivery? If so, how and what impact did these have?	TAF	1.3

Section	Question	Audience	Evaluation question
Early outcomes and impacts	In what ways do you think the scheme has performed well or not so well in terms of outcomes and impacts? Why?	All	6.6, 7.1-7.3
Early outcomes and impacts	Have there been any unintended or unexpected positive or negative outcomes from the project/scheme?	All	8.10 9.1-9.5
Early outcomes and impacts	What else is driving or supporting the decarbonisation of social housing?	All	5.9
Early outcomes and impacts	What are key variations in outcomes and impact by SHL type, including by type of organisation, size of stock and nature of stock?	DP, IDT	2.2, 6.4
Early outcomes and impacts	Is Wave 1 on track to deliver its goals/targets for: Energy efficiency improvements EPC upgrades Scale If not, what are the main reasons for this? How is this being measured and monitored? What have been the advantages/ disadvantages of this?	IDT, Senior DESNZ Management	2.1
Early outcomes and impacts	How and why is the profile of installations expected to have changed?	IDT	2.1
Early outcomes and impacts	To what extent, overall, do you think the scheme will be successful in delivering broader intended impacts, for example for residents, including those which are non-monetisable? How has the design of the scheme influenced this?	Senior DESNZ Management	4.1-4.9

Section	Question	Audience	Evaluation question
Early outcomes and impacts	What evidence are you aware of showing that the scheme has been successful in delivering broader intended impacts? How do you think the design of the scheme affected this?	IDT	4.1-4.9
Early outcomes and impacts	To what extent, do you think Wave 1 has provided evidence and learning about the deliverability of retrofit at scale? Has this been shared, and if so, how?	IDT, DP, Senior DESNZ Management	3.1, 3.3
Early outcomes and impacts	What evidence, if any, are you aware of that Wave 1 has led to or is expected to lead to future economies of scale in retrofit?	Senior DESNZ Management	8.1
Early outcomes and impacts	To what extent, do you think W1 installations have offered Value for Money?	IDT, DP	8
Early outcomes and impacts	What variations, if any, are you aware of in Value for Money within Wave 1 project delivery? For example, by measure type and mix, archetype, region?	Senior DESNZ Management	8.2
Early outcomes and impacts	To what extent, are you aware of SHLs focusing upon the hardest-to-treat properties and how has this affected Value for Money?	Senior DESNZ Management	8.3
Early outcomes and impacts	What innovation, if any, are you aware of within Wave 1 retrofits? How has this affected Value for Money?	Senior DESNZ Management	8.4, 8.5
Early outcomes and impacts	What evidence, if any, are you aware of that Wave 1 has affected building standards and safety?	Senior DESNZ Management	8.9
Early outcomes and impacts	What, if any, negative impacts are you aware of from Wave 1?	IDT, DP	-

Section	Question	Audience	Evaluation question
Early outcomes and impacts	What evidence, if any, are you aware that Wave 1 experience has increased SHL capacity and capability to deliver retrofit work on their stock?	DP	6
Early outcomes and impacts	What evidence are you aware of that demonstrates Wave 1's contributions to broader intended impacts?	DP	9
SHL outcomes	To what extent, do you think SHLs have developed skills and resources through participation in Wave 1?	Senior DESNZ Management	6.2
SHL outcomes	Are you aware of how SHL participation in Wave 1 has contributed to SHLs' future plans for social housing retrofit? If so, how? How has this varied by type of SHL?	Senior DESNZ Management	6.3, 6.4
Supply chain outcomes	What evidence, if any, are you aware of that Wave 1 has contributed to development of the supply chain?	Senior DESNZ Management	9.1, 9.2
Supply chain outcomes	Is this over and above the contribution of other government schemes?	Senior DESNZ Management	9.5, CC7b
Supply chain outcomes	What barriers, if any, are you aware to capability and capacity building in the supply chain?	Senior DESNZ Management	9.3
Additionality	To what extent, do you think anticipated future changes such as regulation of energy performance of social housing are likely to reduce the necessity or impact of Wave 1? Why?	Senior DESNZ Management	7.7

9.5 Qualitative data collection with SHLs

Table 29: Topics covered in SHL interviews

Section	Question	Evaluation questions	Audience
Pre-application	Please could you describe your role and involvement with Wave 1 of SHDF?	Context to support analysis	All
Pre-application	Please tell me about any other retrofit or energy performance installations prior to SHDF that your organisation carried out or planned to carry out. If had prior plans in place, why was SHDF needed? How is this funded/how would this be possible without this government support? How have Wave 1 retrofit plans differed due to the funding available? (probe on: scale, timing, quality) Had your organisation carried out or planned to carry out any retrofit or energy performance installations prior to your engagement with Wave 1 of SHDF? (unsuccessful applicants only)	5.9, 6.1, CC 1a, 1b	Applicants
Pre-application	How did your organisation/the consortium first hear about the Wave 1 funding opportunity?	1.2	All
Pre-application	What were your organisation's/consortium's motivations for applying for Wave 1? What encouraged you/put you off? (including scheme design characteristics)	1.1, 4.1-4.9	Applicants
Pre-application	Was there anything that made applying to Wave 1 less appealing or challenging to comply with?	-	Applicants
Pre-application	How did the scheme design affect the nature of your application?	4.1-4.9	Applicants
Pre-application	[If the interviewee had existing retrofit plans at the time of application] How, if at all, did your organisation/consortium's retrofit plans change as a result of SHDF W1 funding availability?	4.1-4.9	Applicants

Section	Question	Evaluation questions	Audience
Pre-application	[if the interviewee did not have existing retrofit plans at the time of application] How did the Wave 1 scheme design influence the nature of the retrofit project proposed in your application?	4.1-4.9	Applicants
Pre-application	Has your consortium/organisation accessed any other government funding to carry out additional energy performance improvements on the same housing stock? Did the Wave 1 application or funding have any influence upon this?	5.9	Successful applicants only
Engagement with SHRA	What were your consortium/organisation's motivations for early engagement with the SHRA over the Wave 1 opportunity?	1.1	Non-applicants
Engagement with SHRA	Please could you describe the nature of your engagement and interaction with Wave 1 of the SHDF?	1.3	Non-applicants
Engagement with SHRA	What, if anything, was helpful about your engagement with? Probe for: - Topics covered - Mode of delivery - Level of detail - Applicability	1.3	Non-applicants
Engagement with SHRA	What, if anything, could be improved about the SHRA support? Probe for: - Topics covered - Mode of delivery - Level of detail - Applicability What else would have been helpful?	1.3	Non-applicants
Engagement with SHRA	What, if anything, did your consortium/organisation learn as a result of your interaction with SHRA?	1.3	Non-applicants

Section	Question	Evaluation questions	Audience
Application	What worked well or could be improved in the application process?	1.1	All
Application	Did your consortium/organisation access SHRA support for help completing the application? If yes, how did SHRA help your consortium/organisation put together your application and plan your project? Please give examples. If no, why not?	1.3, 1.4, CC2a	Applicants
Application	Were there any gaps in SHRA support? What could be improved about SHRA support?	1.3	Applicants
Application	Did your consortium/organisation use any other sources of support and information to complete your application? Please give examples of how these supported your application.	1.3, CC2b	Applicants
Application	Did you understand why your application was not successful? Was the assessment process transparent? What, if anything, would you change or improve about the assessment process?	1.3	Unsuccessful applicants
Application	What, if anything, did your consortium/organisation learn as a result of the application and assessment process? What would you do differently if you applied again?	1.3	Unsuccessful applicants
Application	If your Wave 1 application had been unsuccessful, to what extent do you think your consortium/organisation would have been able to continue with your retrofit plans? How would these have been funded? How would the retrofits have differed, if at all, in terms of scale, scope, mix of measures, etc.?	6.1, CC1a-c	Successful applicants

Section	Question	Evaluation questions	Audience
Application	How prepared did your consortium/organisation feel to carry out the work? Why?	1.3	Applicants
Application decision making	What point did you reach in applying for Wave 1 of SHDF?	1.1,1.2	Unsuccessful applicants
Application decision making	Why did you decide not to make an application?	1.1,1.2	Unsuccessful applicants
Retrofit activity since engagement with SHRA/ application	Has your consortium/organisation carried out or planned to carry out any retrofit or installations of energy performance measures in the absence of SHDF funding? [If yes] Probe for: - Scale / scope (including inclusion of clean heat) - Timing - Quality - Internal resource allocated to project - Influence of other government schemes contributing to clean heat deployment and government policy on clean heat - Influence of expectations about future energy performance regulations Any other sources of support used [If yes] How is this funded/how would this be funded? [If no] Why not?	6.1	Non-applicants
Retrofit activity since engagement with SHRA/application	Has your consortium/organisation carried out or planned to carry out any retrofit or installations of energy performance measures in the absence of SHDF funding? [If yes] How does this differ to what you proposed in your application for Wave 1? [If yes] How is this funded/how would this be funded? [If no] Why not?	6.1	Unsuccessful applicants

Section	Question	Evaluation questions	Audience
Retrofit activity since engagement with SHRA/ application	[If installations have been started] What have the outcomes been from this?	6.1	Unsuccessful and non-applicants
Project delivery	For each of the following please could you discuss how this progressed and factors that you think enabled success or were challenges, and how those were overcome: Project planning and preparatory work Overall project management and delivery Resident engagement Installation supply chain procurement and management Post installation support	2.3, 2.5, 2.1, 2.2, 2.3, 2.4, 1.9, 4.1-4.9 CC5b	Successful applicants
Project delivery	(If not answered with each point) How did your consortium/organisation overcome these challenges?	2.3	Successful applicants
Project delivery	On procurement specifically, how well was your consortium/organisation able to keep costs down in the procurement, management and use of the required inputs for installations (e.g. the installers, the materials needed)? Why and how?	2.3	Successful applicants
Project delivery	With regards to resident engagement, to what extent, did your consortium/organisation experience any resident drop out?	2.1	Successful applicants
Project delivery	In addition to what has been already raised, did your consortium/organisation observe any variation within your project in terms of successes and challenges?	2.2	Successful applicants

Section	Question	Evaluation questions	Audience
Project delivery	How did your consortium/organisation find the project monitoring process implemented by DESNZ? What worked well or could be improved?	1.11, 4.2	Successful applicants
Project delivery	How did SHRA/DP support project delivery? How, if at all, did the DP (Ricardo)/SHRA support facilitate project delivery? If yes, how did this help effective delivery of the project? What additional support, if any, did your consortium/organisation need from DESNZ /DP?	1.8, 1.5, 1.6, 1.9, 1.10, 1.11 3.1-3.3, CC2a,4a	Successful applicants
Project delivery	Is your consortium/organisation using or did your consortium/organisation use other sources of information or support to carry out the projects and install the measures? Are you using/did you use other sources for information or support to carry out the projects and install the measures?	2.5, 6.5, CC2b	Successful applicants
Project delivery	In your opinion, did your consortium/organisation have sufficient resources to carry out the intended work, such as time and funding? Was the required split of funding appropriate?	4.5, 4.6	Successful applicants
Project delivery	How did scheme design, including PAS 2035 requirements, influence the delivery and final installations? (E.g., requirements for prioritising fabric first measures, hardest-to-treat approach, use of PAS2035 certified installers, low carbon heating, eligibility type, etc.)	4.1-4.4, 4.9, 1.9, 8.3, 8.7-8.10	Successful applicants

Section	Question	Evaluation questions	Audience
Project delivery	As a result of the scheme, do you think the cost of the retrofits your consortium/organisation is carrying out has increased or decreased compared to your original baseline/forecast? Do you expect this to increase or decrease for near term future retrofit projects? Why?	8.1	Successful applicants
Anticipated outcomes and impact	What learning opportunities has Wave 1 provided you with? How has participating in Wave 1 developed your skills and capacities?	CC3a, 6.2	Successful applicants
Anticipated outcomes and impact	What kinds of benefits have you seen from the scheme in terms of your housing stock? (Probe on: building standards and safety, financial value, reduced retrofit costs through economies of scale)	5.9, 6.6, 7.1-7.3,8.1, 8.9 CC5a	W1 projects
Anticipated outcomes and impact	Were any innovative approaches incorporated or developed in project delivery? What benefits have this led to?	8.4, 8.5	Successful applicants
Anticipated outcomes and impact	Does your consortium/ organisation have future plans for further retrofit? (Probe on motivations/barriers, learning from Wave 1, scale/scope, private financing, inclusion of clean heat, skills taken from Wave 1) If no, why not?	3.2, 6.2, 6.3, CC3a, 3c, 10a, 10c	Successful applicants
Anticipated outcomes and impact	Do you feel confident about undertaking future retrofit?	6.2, 6.3, CC3a	All

Section	Question	Evaluation questions	Audience
Anticipated outcomes and impact	In addition to anything already covered, how has participating in Wave 1 developed your organisation's skills, capacities and confidence to carry out retrofit projects? Please give examples including learnings. This could include learning from direct project experience, from other SHLs, from the DP/DESNZ, etc. What else has enabled you to build skills, capacity and confidence in undertaking future retrofit? (Probe on other government support including for clean heat.)	CC3b,8b,10b	All
Anticipated outcomes and impact	Has your consortium/organisation shared your learnings on retrofit (at scale) with others in and outside of Wave 1 (e.g. other LAs or housing associations, other private landlords, housing representative organisations etc.)? If so, how?	6.2	Successful applicants
Anticipated outcomes and impact	What else has enabled your consortium/organisation to build skills, capacity and confidence in undertaking future retrofit? How has this contribution differed to that made by SHDF Wave 1?	6.2	Successful applicants
Anticipated outcomes and impact	What impacts have the retrofit projects had for residents (both positive and negative)? What impacts have there been for residents? (Probe on: comfort, health, well-being, pride in place and causal mechanisms for change) How have other external factors influenced this? (Probe on high energy prices, inflation, cost of living) How are you aware of these changes?	CC12a, 12b	Successful applicants

Section	Question	Evaluation questions	Audience
Anticipated outcomes and impact	To what extent, did these outcomes relate to the energy performance measures themselves or any accompanying other upgrades to their property, such as redecoration undertaken as a necessary part of the installation of energy performance measures?	5.9	Successful applicants
Anticipated outcomes and impact	How have other external factors influenced any potential outcomes on residents?	5.9	Successful applicants
Anticipated outcomes and impact	What kinds of benefits has your consortium/organisation seen from the scheme in terms of your housing stock?	8.9	Successful applicants
Anticipated outcomes and impact	If the SHL has used other government funding for other energy performance improvements in the same stock as improved by SHDF: Please can you explain what the different contributions of the distinct funding and SHDF funding have been to outcomes from energy performance measures? For example, on overall energy reductions.	5.9	Successful applicants
Anticipated outcomes and impact	What, if any, other positive or negative outcomes has the project or Wave 1 scheme had, including anything unintended or unexpected?	8.10, 9.1-9.5	Successful applicants

Table 30: Topics covered in the SHL focus group

Section	Question
Introduction	Includes: - Research background - Data protection and how their data will be used - Confirmation of name and position - Consent to take part and permission to record
Hard-to-treat properties	Which homes do you consider hard-to-treat within your respective Wave 1 projects, and why?
Hard-to-treat properties	Why and how did you select these hard-to-treat homes for your projects?
Hard-to-treat properties	How were the energy saving measures selected for these hard-to-treat homes?
Hard-to-treat properties	What were the considerations for fabric first approaches vs clean heat? What have been the effects of these choices?
Hard-to-treat properties	When were hard-to-treat property installations undertaken within projects (first, last, other)? Why?
Hard-to-treat properties	What were the key enablers/successes of the retrofit work among these homes?
Hard-to-treat properties	What were the main barriers to the retrofit work among these homes? How and to what extent were these overcome?
Hard-to-treat properties	What were the key lessons learned from experiences within SHDF Wave 1 with hard-to-treat homes? Are you sharing these lessons with other SHLs/Supply chain/others? If so, how?
Hard-to-treat properties	Has this work through SSHDF Wave 1 enabled you to make plans/take up future retrofit of hard-to-treat homes? Please give examples.
PAS 2035	How have PAS 2035, Trustmark and MCS requirements impacted retrofit work (on all stock) including in terms of: - Quality of installations - Ability to retrofit at scale, on time and on budget - Procuring and managing the supply chain
PAS 2035	How did this vary by property and measure type? Choice of measure, fabric-first, clean heat Rural/urban, hard-to-treat, tenure type, etc.
PAS 2035	Are you aware of any increase in certifications in the supply chain to support SHDF Wave 1 projects?

Section	Question
PAS 2035	What factors enabled or hindered your ability to adhere to PAS 2035 requirements? How were these mitigated?
PAS 2035	What, if any, capabilities and capacities have been developed as a result of applying PAS 2035 requirements in your projects?
PAS 2035	To what extent, do you expect to apply PAS 2035 or learnings arising from this in other/future retrofit work?

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