Warm Homes Fund Programme Evaluation

Summary Report

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NEA
Action for Warm Homes

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Executive summary

Funded by National Grid and administered by Affordable Warmth Solutions (AWS), the Warm Homes Fund (WHF) was one of the largest fuel poverty programmes to be delivered in Great Britain, representing private sector investment of £150mn. The programme has been evaluated by a consortium made up of Newcastle University, National Energy Action (NEA), and Energy Audit Company (EAC), with support from academics at University of Bristol. This summary presents the key findings of the evaluation. The full findings of the evaluation, as well as a shorter summary report, are published separately.

Also published separately is a detailed blueprint for the future design and delivery of fuel poverty and energy efficiency programmes. This blueprint summarises the main findings of the evaluation and makes recommendations as to how fuel poverty and energy efficiency schemes should be designed in the future, including the core guiding principles that they should aim to follow.

Energy and environmental modelling

The evaluation used pre- and post-improvement Energy Performance Certificate (EPC) data and project returns data from the WHF, to produce modelling of households' fuel poverty status, required running costs, and fuel poverty gap before and after the installation of new heating systems. Where applicable, it also identified any other improvement measures provided to beneficiary homes. The total number of modelled homes was 15,690 from a total of 27,239 homes improved via the Programme, and the key findings are as follows:

- The average SAP rating of the dwellings before any improvements were made was approximately 51, corresponding to SAP band E. This is considerably lower than the national average, which is around 60. **After making improvements the average rose to 68, one point below band C**. The main effect is movement from the E, F and G bands into the C and D bands.
- **Before making improvements, 6,428 homes (41%) had annual running costs above £2,000. Post-intervention, the number of homes with over £2,000 running costs fell by over 90% to 460**. In terms of averages, the mean annual running costs dropped from £2,011 to £1,089 – in other words, **on average the installation of a new heating system saved households £922 per year**. This was based on a fuel prices figure calculated prior to the beginning of the energy crisis in October 2021.
- **Wales has the largest range of cost savings, and the highest median net cost saving per year**. Savings are also comparatively high for Orkney and North East Scotland. This potentially reflects the greater impact that can be achieved when rural communities, typically characterised by older and less efficient housing stock occupied by those on lower incomes, are targeted.
- Although there were approximately 5,500 homes (35%) that remained in fuel poverty (as defined by the Low Income Low Energy Efficiency (LILEE)[1] metric) after improvements were made, **the average fuel poverty gap (the energy bill reduction that a fuel-poor household would need in order not to be fuel poor) dropped sharply from £699 to £121. This means that on average, where a households remained fuel poor, their annual required running costs dropped by almost £600, greatly reducing the severity of fuel poverty**.
- **Average CO2 emissions per property across all modelled homes did not appreciably change. Findings show that they increased by a negligible sum of 3 kg/yr, from 2,746 kg/yr to 2,749 kg/yr.** This can be explained by the balance of measures installed through the WHF. The majority of heating systems that were replaced were electrically powered, predominantly storage and room heaters, and the majority of new systems were gas boilers. The electricity grid has decarbonised rapidly over recent years, and

1. Fuel poverty in England is measured using the Low Income Low Energy Efficiency (LILEE) indicator, which considers a household to be fuel poor if: a) it is living in a property with an energy efficiency rating of band D, E, F or G as determined by the most up-to-date Fuel Poverty Energy Efficiency Rating (FPEER) Methodology; and b) its disposable income (income after housing costs (AHC) and energy needs) would be below the poverty line.

electical systems therefore emit less carbon than gas ones. However, the match-funded installation of insulation measures and air source heat pumps (ASHPs) through the Category 2 arm of the WHF has decreased emissions, thereby counterbalancing the WHF's overall impact on average domestic CO2 emissions. **It should be noted that this is still significantly below that of the average UK home, which emits approximately 3,644 kg/yr of CO2.**

- **To improve all 5,500 remaining fuel-poor households in the modelling dataset to EPC Band C, the total required amount of investment is £33,308,058.** As this is based on a sample of 15,690 homes, and to date the WHF programme has improved 27,239 homes, the extra required spend to eliminate fuel poverty across the entire project is estimated to be £57,825,251. However, in some cases this is not cost-effective, and a more workable solution that eliminates fuel poverty for some households is to permanently increase their income or reduce their energy bills through one means or another (e.g., through increases to social security payments, or the introduction of a social tariff in the energy market).

- **Affordable Warmth Benefits and Fuel Poverty pathways were the most successful at targeting fuel-poor households**, whereas ECO Flex, which is defined by local authorities and consequently varies across different geographical administrations, and Index of Multiple Deprivation (IMD) pathways, were much less successful, as shown below.[2]

Eligibility criteria	Fuel poor (LILEE)	Not fuel poor (LILEE)
Affordable Warmth Benefits	96%	4%
ECO Flex	32%	68%
Fuel Poverty	87%	13%
IMD	31%	69%

Social, economic, and health impacts of the programme

The outputs of the energy modelling analysis were used to inform an analysis of the WHF's broader economic impact. Using a Social Accounting Matrix developed by researchers at Strathclyde University, the evaluation team were able to conduct modelling of the economic impact of a) the transfer of capital from National Grid into the housing, construction and installer sector, as well as the support services sector; and b) the spending of any additional income obtained by households through reductions in their required running costs and subsequent energy bills. The movement of homes into higher SAP bands post-intervention was also used to calculate the savings to the National Health Service (NHS) due to WHF-led improvements, using the Building Research Establishment's Housing Health Cost Calculator.

The main findings of this analysis are:

- Economic modelling shows that from the initial £150mn investment in the construction, retrofit and installer sector, and the support services sector, **an additional £200mn of demand was stimulated in the economy**. This produced a total economic demand stimulus of £350mn. **This means that for every £1 invested in the WHF, a further £1.34 was stimulated in the wider economy.**

- **The total energy bill savings generated by the WHF**, which can be regarded as an increase in household disposable income, **was £10.8mn**. As this money was re-spent by households, a **further £14.4mn of spending took place**, demonstrating the positive economic impact of energy bill reductions on the wider economy.

- **Targeting low-income households** produces a larger economic impact. By targeting low-income households, the WHF grants produced a greater boost in demand across the economy than if the funding had been targeted at middle-income households. Analysis shows that **approximately £2mn more demand has been created by targeting low-income households; this arguably justifies spending on fuel poverty alleviation as a means of boosting economic growth**.

- The **total NHS cost savings generated by the WHF are estimated to be £2,491,381 per annum, while the wider societal benefits are estimated at £41,854,679 per annum**.

Impact on beneficiaries

Based on quantitative and qualitative research with WHF beneficiaries, which included 61 interviews with beneficiary households and 999 questionnaire responses, the programme's main impacts on households have been:

- Households reported substantial improvements to thermal comfort. **Pre-intervention, just 18% of households were able to keep their whole homes warm when it was cold outside. Post-intervention, this increased fourfold to three-quarters (76%).**

- Category 1 interventions resulted in the most substantial improvements to self-reported thermal comfort, with an increase of 73 percentage points, from 11% before intervention to 84% after intervention.

- **Changes in running costs have translated into self-reported improvements in energy affordability, especially for beneficiaries of Category 1 interventions.** Just over half (53%) of Category 1 households reported that they find their energy bills a lot easier or a little easier to afford now, compared to before the intervention. 44% of Category 2 households replied the same, as did 40% of Park Homes households and 31% of Category 3 households.

- **Four in five households were living in a home where at least one occupant had a cold-related health condition**, and over half were living in a home where at least one occupant had multiple such conditions. Over half (58%) of households agreed that not being able to keep warm at home affected their physical health, and 44% agreed that it affected their mental health.

- Post-intervention, **48% of households reported that their physical health was better than before, and 39% of respondents reported that their mental health was better**. In interviews, households reported improvements to musculoskeletal and respiratory health, mental wellbeing, and reductions in the prevalence of mould and damp in their homes. Interviews also suggested that the interventions likely prevented the development or exacerbation of health conditions for young children, enabled improvements in diet and nutrition for children and adults, and facilitated safer home environments for beneficiaries with dementia.

- **WHF interventions had a substantially positive impact on the prevalence and severity of rationing practices, such as cutting back on heating and not buying essential everyday items, such as food**; they also made beneficiaries feel that home environments were homely and safe, rather than alienating or hostile.

- **There were substantial improvements in WHF beneficiaries' ability to use and control their heating systems following their intervention, with 77% agreeing that they felt more able and confident about using and controlling their heating system.** In particular, interviewees with storage heaters in their properties frequently described them as difficult (if not impossible) to control effectively, and solid fuel fires and LPG heating systems were also discussed as near-impossible for beneficiaries to control. Accordingly, the recipients of first-time central heating installations discussed how replacing their storage heaters and solid fuel heating had dramatically improved the control they felt they had over their heating, their energy use and their homes.

- **Energy advice and capital measures interventions, delivered together as part of a single journey for households, resulted in better outcomes for recipients.**

2. The eligibility criteria used by the WHF are as follows: 1) affordable warmth benefits, whereby one or more of the household occupants is in receipt of a means-tested benefit; 2) ECO flex, whereby the household qualifies for assistance through meeting the local authority's flexible eligibility criteria; 3) fuel poverty, whereby the household has had a fuel poverty assessment carried out; 4) Index of Multiple Deprivation, whereby the household is located in a Lower Super Output Area which is in the top 25% of most deprived areas in the country. Note that the 'fuel poverty' pathway does not map exactly to the LILEE definition of fuel poverty utilised in the energy modelling analysis. This is because of the different methods used by WHF projects to calculate the eligibility for the 'fuel poverty' pathway, as well as the way in which the energy modelling analysis assumes and calculates income and energy efficiency.

Impacts on WHF projects

Finally, research with WHF projects' delivery partners highlighted four qualitative impacts on the organisations the WHF had funded. These were:

- WHF enabled delivery organisations to establish and expand internal resources, processes, delivery mechanisms, and partnerships.
- WHF contributed to, and in many cases helped, delivery organisations to achieve broader organisational priorities and strategies.
- Learnings obtained through the delivery of their projects enhanced delivery organisations' ability to undertake large-scale energy efficiency and fuel poverty projects in the future.

WHF unlocked additional resources and supported organisations in applying for and/or securing further funding for fuel poverty and energy efficiency schemes, thus further demonstrating the added value created by the WHF itself.

1. Introduction

This report presents a summary of the key findings from a programme-wide evaluation of the industry-funded Warm Homes Fund (WHF), administered by Affordable Warmth Solutions (AWS). The WHF was one of the largest fuel poverty programmes to operate across Great Britain, and represented £150mn of private sector, investment in the from National Grid. The evaluation was conducted between 2019 and 2022 by a consortium comprising Newcastle University, National Energy Action (NEA), and Energy Audit Company (EAC), with support from academics at the University of Bristol.

The evaluation involved three successive waves of research activity at different points in the WHF programme delivery, and was designed to meet the four objectives listed below.

Evaluation objectives

1. Develop appropriate input, output and impact measures, to provide a basis on which delivery performance can be assessed;

2. Determine the social and economic impacts from the WHF investment;

3. Determine the extent to which the support has reached the households most in need, and any regional differences;

4. Produce a blueprint model to inform policymakers on options for delivering future large-scale energy efficiency programmes.

To meet these objectives, the evaluation approach and research questions were structured in the following way:

- **Process evaluation:** How was the programme delivered?
- **Impact evaluation:** What was the difference made to beneficiaries?
- Return on Investment (ROI): What were the social, economic and environmental impacts of the programme?

The detailed findings and methodology underpinning the contents of this report have been published separately in a longform document. That document provides the requisite evidence to support this summary, and will enable the reader to explore the findings in greater depth.

What follows is structured into three main sections that correspond to the three research question groups above. **Section 2** introduces how the programme was delivered, based on research undertaken with recipients of WHF funding and their partner organisations. **Section 3** discusses the quantitative and qualitative findings of research with WHF beneficiary households regarding the programme's impact on their lives; it includes energy modelling analysis, to determine how the programme affected technical fuel poverty status. **Section 4** presents the findings of innovative energy, economic, and health modelling work, which together show the wider societal impact of the WHF beyond the strict domains of energy efficiency and fuel poverty. **Section 5** concludes the report by linking the findings back to the four evaluation objectives. Throughout the report, anonymised quotations from WHF beneficiaries and projects are incorporated to illustrate the points made, and to bring their voice directly to bear on the narrative of the findings.

Methodologically, this report is based on a complex mixed-methods evaluation, encompassing the following elements: quantitative and qualitative research conducted with beneficiary households and the projects that supported them; energy, economic, and health modelling analysis; indoor environmental monitoring of beneficiary homes; and socio-spatial analysis of energy modelling outputs. The full methodology of the evaluation is not reproduced here, but can be found in detail in the methodology annex of the main report. Finally, the findings of the evaluation discussed hereafter have informed the development and design of a blueprint for the future delivery of fuel poverty and energy efficiency schemes. In the blueprint, which is published separately, readers will find the main recommendations of the evaluation.

2. How was the programme delivered?

This section first examines how the WHF was delivered by recipients of funding (delivery partners). It is split into five themes, covering partnerships and the germinations of WHF projects; funding and finance; targeting processes and eligibility criteria; challenges and problem-solving; and finally, the outcomes and impacts of the scheme for delivery partners. Throughout, findings from surveys undertaken with delivery partners are used to demonstrate key themes and patterns in the data, and illustrative quotations are also presented, extracted from interviews with delivery partners and their collaborators.

2.1. Partnerships and the germinations of WHF projects

The first subsection examines the roots and beginnings of WHF projects, and the key role of historic relationships and partnership-working in their formation and delivery. In discussions about bid development, most projects described how their WHF applications aimed to continue, expand, or branch pre-existing fuel poverty and energy efficiency schemes. These projects had been running multifaceted programmes over consecutive years, and described WHF funding as an opportunity to consolidate and continue this delivery. The ways in which projects approached WHF funding were typically dependent on the focus, scale and scope of their pre-existing programmes. For example, some projects included long-standing schemes focusing on insulation and other energy efficiency measures, but had less capital available for first-time central heating systems; whereas others were running ongoing heating upgrade schemes that were appropriately supplemented by WHF funding.

"Obviously, its origins sit in providing affordable warmth for our customers, so reviewing the energy efficiency of our homes and seeing how we can upgrade them and also support the government's road map to Net Zero eventually. That's where it came from, and a desire to get into our own road map of energy efficiency for our home and set our own journey out."

Furthermore, projects discussed two primary drivers for their WHF applications and their broader work on fuel poverty and energy efficiency. Most understandably, the first driver of bidding for WHF support was organisational policies and strategies relating to fuel poverty. The second driver was specific local issues that had been identified in one way or another over the course of previous work. Notably, projects tended to discuss this in terms of intersecting or overlapping vulnerabilities that they had pinpointed as important to address. For instance, geographical factors – especially differing levels of urbanity and rurality – grouped different vulnerabilities together to increase fuel poverty risk and prevalence.

"The majority of our other properties are in rural locations […] we're dealing with probably a couple of different factors. We're dealing with factors with relatively low pay in some of these areas […] also we have quite an ageing population and we have people who have not very efficient heating systems. We've got properties that aren't particularly well insulated and that manifests itself."

Two further important themes were identified in interviews with project staff about the development of their applications. Firstly, **it is clear that the WHF has also supported organisations that previously had little or no experience of delivering fuel poverty schemes**. Several WHF projects did not have significant track records in delivering fuel poverty schemes, or pre-existing programmes set up to support households' energy efficiency. In a competitive funding landscape, this can arguably lead to what could be called a 'two tier' structure in grant application successes, whereby organisations with the requisite experience and track record in delivery are successful precisely for these reasons, while inexperienced organisations cannot demonstrate a history of effective delivery, and are therefore perceived as risky. The evidence shows that WHF funding overcame these barriers and gave these more inexperienced organisations a foundation for future delivery. Concurrently, **it is likely that the WHF contributed to capacity-building for the delivery of fuel poverty and energy efficiency schemes across Great Britain, thereby reducing regional inequalities in the accessing and delivery of funding streams in the future**.

"We were in a difficult situation […] we needed grant funding to make [the project] work. That was without a doubt because we couldn't have done it on our own […] but then again, as a small organisation, we didn't have a great … I don't have a track record in this sort of grant funding, nobody else did in the business."

Secondly, external consultants played a critical role in identifying and supporting lead WHF project partners. These findings point to the importance of external consultants in spotting and facilitating opportunities for local authorities and RSLs. Evidently, external consultants usually had a financial interest in helping lead organisations to apply for WHF funding, especially when they were also involved as project partners in managing or supporting delivery. But the evidence here suggests that they play a critical role in the delivery of energy efficiency schemes.

"So, I can't remember how we found [them], but we approached [the external consultant] to support us with the application process, who do have a track record with Warm Homes Fund and other funding streams. So, they were our partner in, you know, applying for the funding."

In both the preparation and delivery of WHF projects, partnership-working was flagged by almost all WHF projects as key. **A wide range of partners were involved in WHF projects, including charities, energy network companies, energy retail companies, health and social care actors, contractors and installers.** Evidence from the project surveys and interviews demonstrates that **the majority of WHF partnerships were firmly based on historical foundations, and often took the form of personal relationships between individuals that had developed over several years**.

However, despite the evidence indicating a predominance of existing of WHF delivery partnerships, **WHF funding enabled the development of new partnerships and ways of working.** This was especially evident in interviews with participants in Category 3 projects, many of whom had submitted bids to the WHF based on developing and expanding networks of energy advice and support. Category 3 projects also had different starting points in this process. Some were looking to expand comprehensive pre-existing referral networks even further, as shown in the quotation below, while others were attempting to set up services and partnerships more or less from scratch. Developing relationships with partners other than what could be termed the 'usual suspects' of energy advice delivery was also a prominent theme in interviews with Category 3 projects – most notably health and social care actors, but also schools and emergency services (e.g. Fire and Rescue).

"I think as a result of the Cat 3 money, have we made new partnerships? I think we've made new partnerships with communities […] the big areas of new partnerships have been where the Cat 3 funding has allowed [us] to make links with the local parishes, over 60s clubs, women's institutes, those kinds of groups on the ground."

More broadly, when asked to reflect on the question of why partnerships were or were not beneficial and desirable for the delivery of fuel poverty and energy efficiency projects, interviewees were unanimous that partnership-working added significant value to their work. What counted as 'value' in this respect was conceptualised in multiple ways by projects. In terms of financial value, evidence from project interviews shows that partnership-working unlocked access to additional match or gap funding; delivered additional financial benefits to beneficiaries through linking first-time central heating system recipients to income maximisation services; and reduced project costs through enabling more efficient working practices, data sharing and problem resolution – all of which have implications for staff time.

2.2. Funding and finance

On the subject of funding and finance, the WHF eligibility criteria were designed to mirror those of the Energy Company Obligation (ECO) and the Fuel Poverty Network Extension Scheme (FPNES). Accordingly, it is not surprising that most projects, especially local authorities working in privately owned properties, discussed these funding streams. With regard to FPNES funding, which was unlocked by the confirmation of a first- time gas central heating system via Category 1 of the WHF, it is notable that many projects considered it almost unworthy of discussion; it was often seen as a smooth, unintrusive part of the funding process that was accessed without significant issues. ECO, on the other hand, was experienced by projects in a far more mixed way: it was more often than not discussed as a challenge that had caused considerable difficulties to their WHF delivery. Almost always, this was narrated as being due to the perceived complexities and bureaucracy associated with ECO itself, as well as its changing

nature (i.e. changes within ECO3 and in the transition from ECO3 to ECO4). Nonetheless, it is also clear that some projects – usually through partnerships with energy suppliers and/or contractors that were experienced with new and forthcoming ECO regulations – were able to use ECO successfully and straightforwardly. In future, projects looking to deliver ECO should replicate these arrangements to the greatest degree possible.

"It's a very long process to put a property through ECO [...] I'd think twice before trying to build ECO into any sort of business case or funding model in the future, just because from ECO theoretically being available, there's a big gap between it actually turning up."

Beyond ECO and FPNES, projects made use of an eclectic range of other funding sources, especially funding from health and social care actors (e.g. Clinical Commissioning Groups (CCGs)), UK Government and/or Ofgem schemes (e.g. Warm Home Discount Industry Initiatives, Energy Redress Fund), internal capital budgets, and miscellaneous sources (e.g. funding through the Gas Safety Trust or the European Union). The uses of match and gap funding were not always consistent across projects; some projects used funding from the same source for different purposes, and others employed funding from different sources to provide similar services. These uses of funding can be split into four primary types:

- **Ensuring basic project viability and business case.**
- **Enabling WHF funding to go further,** primarily used in specific circumstances to offset or reduce the WHF contribution required for certain interventions in a beneficiary home.
- **Enhancing the customer offer,** such as being able to provide solar PV in addition to a new heating system.
- **Providing enabling works and engagement,** such as loft clearances or extra 'handholding' for very vulnerable households.

When asked to reflect on the general ease with which they were able to blend WHF funding with parallel funding streams, three key themes were discussed by projects. Firstly, **projects reflected on the extent to which applying for and securing WHF funding unlocked investment that would otherwise not have been accessible**. Although some projects disagreed, noting that their projects would have continued without WHF funding, albeit at a smaller scale, the majority of interviewees noted that their projects (and the match funding they secured to do it) would not have been possible without the WHF.

"We wouldn't have done that programme at that time without the Warm Homes Fund funding. After the picture shifting, so now with more emphasis on decarbonisation, EPC band C, things like that. I couldn't really say for certain because we're not in that situation. But at that time this programme wouldn't have happened without the external funding."

Secondly, **projects reflected on the multiple benefits and added value of merging funding streams offering heating upgrades, insulation, as well as energy advice and support**. Mirroring the findings in Section 3.7, projects observed how their Category 1 and/or 2 interventions were substantially strengthened by their ability to offer households Category 3-funded advice and support subsequent to their intervention. This was because it **enabled the provision of a holistic service to households that focused on the installation of new heating systems and tackling other drivers of fuel poverty (e.g. low income, debt) simultaneously**.

"I've got a figure here; around about £700 was the average debt that got written off. It was in thousands, I think, for some properties. Yes, a big difference to some of the guys. Especially when ... If a debt is hanging over them, they always feel – you don't feel as if you can get out from underneath it. I think that's a major benefit for the tenants. They suddenly get a new gas central heating system that can heat the property, and they're not having to worry about their debts."

Finally, projects reflected on one of the perennial difficulties of blending funding streams, that of synchronising different funding cycles to ensure the continuation of projects over several years. Interestingly, the WHF was often seen positively in this respect by projects, having provided funding over a number of years, especially to Category 3 projects. More broadly, it was clear that **funding streams that offered long-term certainty to local authorities and social landlords** were seen as important for ensuring that fuel poverty programmes could continue to be delivered for households.

2.3.Targeting processes and WHF eligibility criteria

At their simplest, the WHF eligibility criteria were fourfold:

- **Affordable Warmth Benefits**, whereby one or more of the household occupants is in receipt of a means-tested benefit.
- **ECO Flex**, whereby the household qualifies for assistance through meeting the local authority's flexible eligibility criteria.
- **Fuel Poverty**, whereby the household has had a fuel poverty assessment carried out.
- **Index of Multiple Deprivation (IMD)**, whereby the household is in a Lower Super Output Area (LSOA) which is among the top 25% of most deprived areas in the country.

The WHF criteria were designed primarily to mirror those used in other government fuel poverty schemes, primarily FPNES and ECO. However, findings from the energy modelling research show that each pathway did not equally confer eligibility on households defined as technically fuel poor under the LILEE indicator. Table 1 below shows that the **Affordable Warmth Benefits and Fuel Poverty pathways were the most successful at targeting fuel-poor households, but that ECO Flex and IMD were much less successful.**

Eligibility criteria	Fuel poor (LILEE)	Not fuel poor (LILEE)
Affordable Warmth Benefits	96%	4%
ECO Flex	32%	68%
Fuel Poverty	87%	13%
IMD	31%	69%

Table 1: Modelled fuel poverty status of beneficiaries for all WHF eligibility criteria.

Regarding project experiences, **survey data shows that the majority of projects considered the WHF eligibility criteria to be effective**. Of the 32 projects that answered this question,

- 14 said that project eligibility criteria worked or were working extremely well;
- 15 said they worked or were working fairly well;
- Three said they worked or were working OK.

Affordable Warmth Benefits was the most successful type of eligibility criteria for targeting households technically defined as fuel poor, and projects operationalised these criteria in two main ways. Firstly, **they used initial household contact points to enquire as to whether an occupant was in receipt of means-tested benefits, before gathering evidence (e.g. a DWP letter, bank statement) to verify that they were**. Secondly, and more rarely, **projects utilised data-matching with government or regulator records, to establish that a particular address was in receipt of means-tested benefits**. The Affordable Warmth Benefits criteria were designed to mirror the benefits eligibility in ECO, in order to simplify the process by which households could receive support from both the WHF and ECO. Projects who commented on this generally found this process **simple and beneficial**; they sometimes used Affordable Warmth Benefits and ECO Flex interchangeably, and often did not see a practical difference between the two. Interestingly, some respondents believed that an income cap or a tightening of the benefits defined as Affordable Warmth Benefits would help to ensure this criterion targeted fuel-poor households – although this proposal does not seem necessary, considering its success in targeting such households.

"If it was just benefits [eligibility criteria], it would miss such a huge number of people who are on a low income, in fuel poverty, vulnerable, are suffering, but not quite hitting the threshold to claim the benefits."

ECO Flex criteria were linked closely to Affordable Warmth Benefits, but were also used by projects in far more varied ways. The majority of projects that used this pathway and discussed it in an interview were complimentary about its utility and focus. Perhaps unsurprisingly, its flexibility was often highlighted as its main strength, particularly as ECO Flex statements could be adapted to meet the aims and objectives of a project while still conferring eligibility for ECO itself. Other projects had deliberately included area-based criteria in their ECO Flex statements, to target specific wards or areas of high multiple deprivation; or to ensure that blocks of flats where half of households were eligible through an alternative pathway could all receive an installation, thereby improving the economies of scale and making the works viable. These are a handful of projects' many observations regarding the weaknesses or limitations of ECO Flex, but some

projects had faced challenges in administering it as an eligibility pathway.

"I've got to do a fuel poverty calculation [...] that's quite complex because it asks for things like current expenditure, month expenditure on energy and different outgoings. And there is a lot of information to obtain from a customer, which is not necessarily available."

Although the fuel poverty pathway was relatively successful at targeting and conferring eligibility on households modelled in the evaluation analysis as fuel poor, projects that discussed it in interviews tended to focus on its practical challenges. Projects using this pathway typically tried multiple different kinds of calculation to determine if a household was technically fuel poor, which ranged from 'back of the envelope' calculations of fuel poverty status, to the use of online or external fuel poverty modelling consultants. However, the overriding experience of projects using this pathway was that conferring eligibility was complex and difficult. The most commonly cited reason was that obtaining all of the household information necessary to conduct an accurate fuel poverty assessment was challenging, especially when it had to be acquired from a vulnerable person. Projects also faced challenges in working according to changing definitions of fuel poverty (e.g. the change from Low Income High Cost to LILEE in England), or differences in devolved government definitions in Scotland and Wales.

"I think they're very good criteria because they give you a number of options, that make it easier to set up a geographical-based scheme. And sometimes, you just need to target the area to get an effect. I mean, you can go down the route of trying to target things as closely as possible, but then, you lose the ability to really do a whole area, and do the work efficiently, if you see what I mean, in some cases."

Finally, the IMD criteria polarised WHF projects. Projects were generally acutely aware that households living in the top 25% of deprived LSOAs were not necessarily fuel poor, and some refused outright to consider it as an eligibility criterion for this reason, even if they could not take a household through their project in any other way. Instead, several projects used IMD as an entry point for targeting fuel-poor households, before using an alternative eligibility pathway to satisfy themselves that the individual required support. However, other projects made different arguments in favour of using IMD as an eligibility criterion. Aside from it being simple to manage and implement, some projects were insistent that IMD was essential for setting up area-based schemes in areas of high deprivation and vulnerability, such as in older council estates or tenement blocks. Others argued that area-based schemes and eligibility criteria were connected to broader social objectives related to regeneration, community enhancement, and quality of life. In other words, area-based schemes, facilitated by IMD, were seen as creating social value for places, over and above the impacts on household fuel poverty levels, which outweighed the issue of occasionally conferring eligibility on a higher-income household.

In terms of how projects attempted to target and recruit households into their schemes, **the most targeted groups of households by projects were fuel-poor households in general, and households on low incomes and/or means-tested benefits. Projects were also targeting homes with low energy efficiency standards**. Beyond these key groups, projects also targeted by tenure, and by specific vulnerabilities such as age, disability, ill-health, and households with children. In order to reach these households, the majority of projects made use of three separate but interlinked pathways:

- **Data analysis**, to attempt to identify and understand the locations of potentially eligible households. A starting point for many projects was publicly available statistics on fuel poverty and deprivation, published in different ways by the national and devolved governments of England, Scotland, and Wales, and which were typically overlain with other forms of data, such as internal asset management database outputs or benefits data.

- **Marketing and engagement**, including advertisement of the scheme in local radio and print media, as well as on local authority websites and social media platforms; advertising in locations or spaces which projects considered it likely that eligible households would visit, such as libraries, bus stops, community centres, schools, foodbanks, GP surgeries, and leisure centres; and finally, direct targeting, such as enclosing scheme information with council tax letters sent to lower-band households, which were perceived as more likely to be living in fuel poverty; direct mailouts to households; and simple door knocking.

- **Referral networks and partnerships**, which aimed to take advantage of the contact points multiple partner organisations had with vulnerable people, to drive referrals.

Several projects described a twin-track approach to targeting eligible households: 1) using forms of data analysis to identify and then engage with potentially eligible households; and simultaneously 2) using the knowledge, networks and reach of partner organisations to generate referrals of eligible households. As noted in Section 2.1, several different kinds of organisation were described as potential or actual referral partners, including charities, energy suppliers, health and social care services, emergency services, installers, internal departments within local authorities, and energy networks.

"I would say in terms of external partners that the relationships are really beneficial, because actually probably most of our successful referrals probably come through those external, well a bit of both, some come through council referrals. So, if there are vulnerable customers who are already working with, we get referrals that way, and the others mainly come from external partners. Even when we've done, kind of, some direct marketing, the majority of referrals, the successful ones, still come from those partners."

Although the majority of projects used all three methods of data analysis, marketing and engagement, and referral networks to identify, target and process eligible households, they appraised the relative strengths and weaknesses of these methods in different ways. Notably, **referral networks based on relationships with partner organisations were often described as the most effective way of reaching the most-in-need households**. Simultaneously, referral networks were described as challenging to construct and maintain, and the most successful of these had been built up across time by WHF projects. Working with referral partners over a number of years had germinated and enabled strong networks, defined by trust, shared determination, and interpersonal relationships between different actors. Other projects without these historical ties had to commit considerable time and resources to building referral partnerships – especially with the health and social care sector, which many projects struggled to engage effectively. An important question for future energy efficiency schemes is therefore how to balance the need for swift, reliable delivery through established referral networks, with the need to support some places to develop and sustain these networks over time.

"It's interesting in our area because we've got [this rural area] for example, that [doesn't] have any areas in the bottom 25% nationally for IMD, for example. That's where the local knowledge from the council really helps, because although there might not be an LSOA area that qualifies as being in the bottom 25%, there will be pockets of deprivation more locally than that in amongst [this area]: farmhouses where there is rural poverty, and Park Homes as well, and things like that."

Lastly, a common issue for projects, irrespective of their target tenure splits, was that the data analysis often did not match the situations they encountered 'on the ground'. To address this issue, **projects were often insistent that data analysis must be paired with different forms of experiential and qualitative knowledge, including engagement with local actors such as council officers, charities, community groups, and installers, as described above**. Accordingly, projects supplemented and qualified their data analysis with other forms of knowledge. In some cases, projects were wary of the "blunt" nature of fuel poverty, multiple deprivation, and other area-based statistics, and attempted to gain a more nuanced understanding using experiential, qualitative forms of knowledge. These forms of knowledge were described as emanating from actors that were active in communities, especially long-standing council employees and installers. **A key learning to take forward, especially for local authorities targeting owner-occupiers and the private rented sector, is that iterative processes of appraising data alongside local knowledges is important, to ensure that fuel poverty programmes are effectively and efficiently targeted at eligible households.**

2.4. Challenges and problem solving

This subsection examines some of the challenges encountered by WHF projects during the delivery of their work, including some of the ways in which they mitigated and attempted to overcome them.

Figure 1 below shows the main challenges that were encountered by WHF projects, as collected through the consolidated project survey. **Managing installation delays was the most frequently reported challenge, followed by issues with contractors and the supply chain; there were also challenges relating to the Covid-19 pandemic; identifying suitable households; engaging with residents; project administration; and the range of measures permissible under the programme.**

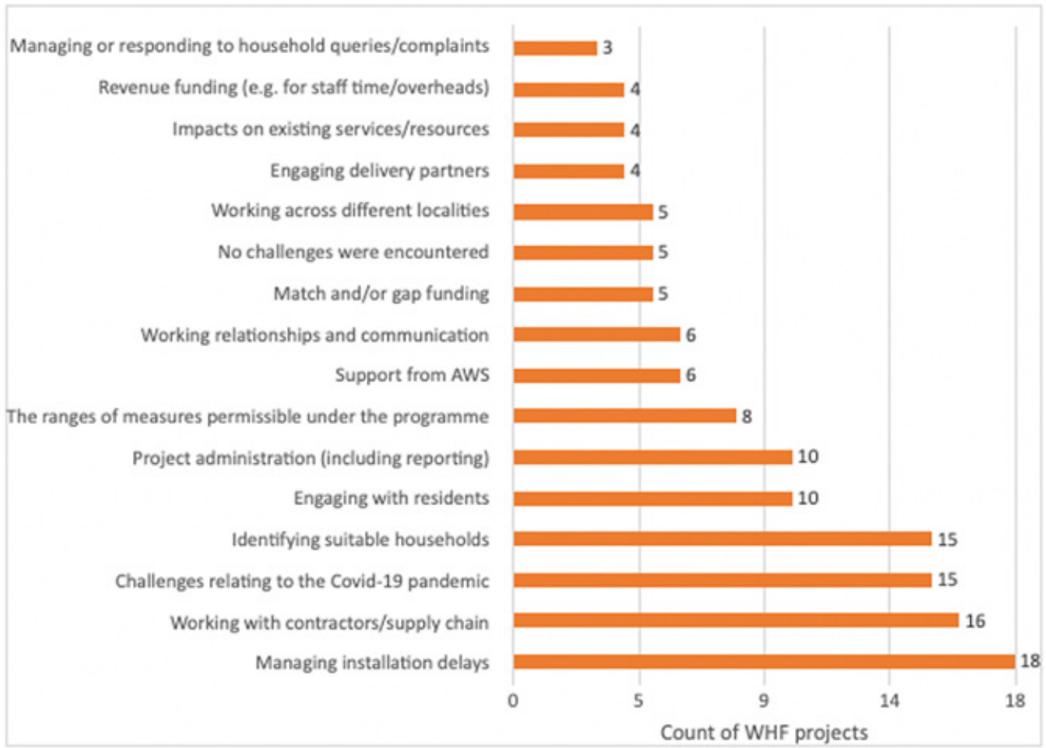

Figure 1: The main challenges reported by WHF projects in project surveys (n=54).

In addition, **Figure 2 below shows that a significant number of projects had experienced household withdrawals. The most common time for withdrawals to take place was at assessment for measures or advice, followed by the application stage. A slightly smaller number of withdrawals occurred just before the delivery of advice or installation.**

In interviews, projects discussed some of the ways that they had tried to reverse or prevent households' decisions to withdraw. This can be broken down into three themes: firstly, attempts by projects to use trustworthy middle actors to mediate engagement, thus increasing levels of trust; secondly, attempts by projects to address and mitigate the perceived extent of disruption that households would face during the installation process; and thirdly, issues relating to landlord engagement in the private rented sector.

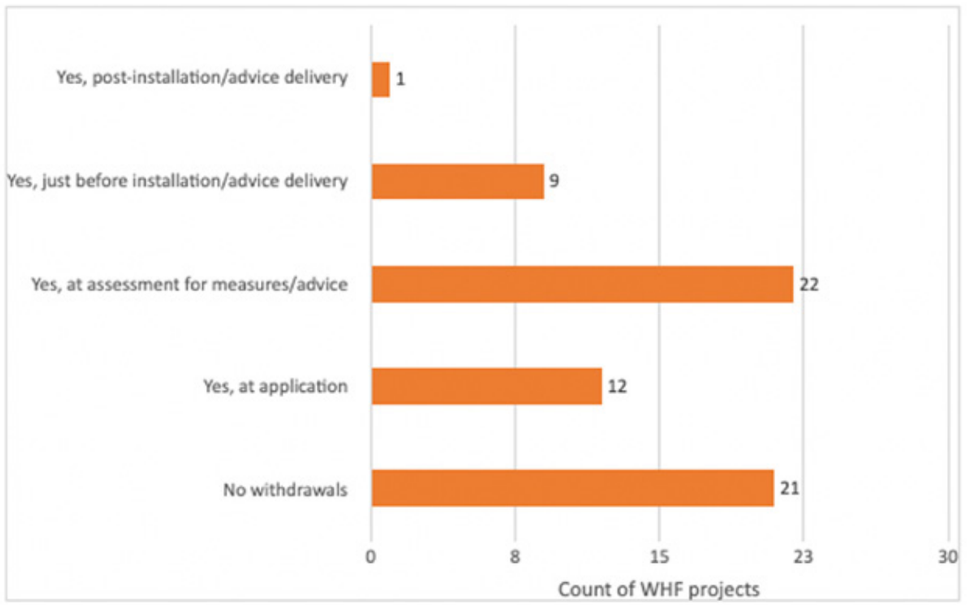

Figure 2: Withdrawals experienced by WHF projects, disaggregated into when withdrawals were experienced, as reported in project surveys (n=54). Note that because some projects had experienced withdrawals at multiple stages, the total count is higher than 54.

Firstly, projects discussed how having trusted intermediaries to manage the engagement process was a successful way of preventing household withdrawals. Interviewees suggested that trusted intermediaries are often best placed if they are from charities and third-sector organisations, because they are perceived as neutral and not interested in profiting from an installation or advice delivery process. Importantly, however, interviewees also emphasised that what constitutes a 'trusted intermediary' will be different for different client groups. For example, the presence of a charity supporting older people was imperative for engaging with that client group, but was sometimes detrimental for engaging with younger vulnerable groups. For housing associations, Tenant Liaison Officers were often perceived as the perfect trusted intermediary to prevent withdrawals. Overall, this evidence shows that positive engagement from trusted intermediaries prevents withdrawals, but also that **what constitutes a 'trusted intermediary' needs to be carefully considered**, to maximise the possibility of building trust and good relations with different vulnerable groups.

"I think the fact that you have got a charity that generally looks out for the elderly, I think that adds a little bit of weight to, you know, some of the clients that are a little bit, maybe, sceptical. So you have got a charity that can back up the, you know, 'We are there for your best interests. This is not a scam. This is not people trying to hoodwink you into something that you do not want.'"

Secondly, some projects had focused on the possibilities of upheaval and disruption, and took steps to try and minimise the real or perceived disruption households would experience during the installation process. Housing associations and social landlords were the projects that discussed this most positively. These projects had, for example, liaised with tenants to arrange for them to stay in hotels while installations were taking place, to minimise their experiences of disruption; or they had delivered installations in empty social housing 'show home' properties, to demonstrate the ease of the process and the benefits for thermal comfort, affordability, and health that would follow for the tenant. Being able to tap into additional gap funding and resources to facilitate these kinds of engagement was crucial,

as one project explained, with reference to resolving a client's hoarding problem that would have otherwise resulted in a withdrawal. **This shows the importance of ensuring that additional resources are built into projects, to focus on and engage with households that might withdraw due to issues beyond their control. Moreover, issues of upheaval and disruption should not necessarily be seen as related to perceptions of disruption, but as stemming from broader vulnerabilities which can be engaged with and addressed.**

"We've even gone an extra mile, where we've gone there to do the survey for the installation and the whole house is full completely – you can't hardly move in any room – and what we've done is we've actually helped with the resident and a removal company to put items in storage to finish the installation, and then the removal company then redelivers all their items back to them. Because you go into some lounges and they've got so much shelves full of books, you can't move at all in there. And some of them in the bedroom, you could hardly even move. So, we've gone an extra mile, liaising with the RLO, the resident and the removal company in assisting, so that the contractor can have a clear run for the installation."

Thirdly and finally, projects delivering installations in the private rented sector experienced withdrawals from landlords they were trying to engage with. Generally, projects noted that engaging with private landlords was a serious challenge. Others said the problem with private landlords was not necessarily initial engagement, and that the point of withdrawal often came when landlords were informed that a capital contribution would be required for the installation to proceed. However, some projects experienced success with landlord engagement, and explained some of the reasons why they felt this had occurred. Often, the key to landlord engagement was what one project referred to as a 'carrot and stick' approach, whereby the project would work closely with private sector licensing enforcement teams in local authorities, to pressurise landlords to meet Minimum Energy Efficiency Standard (MEES) regulations, while at the same time engaging constructively with landlords themselves regarding the project offer. **These experiences suggest that in order to successfully deliver projects in the private rented sector, it is necessary to balance enforcement and positive engagement, to persuade landlords to part-fund their part of the installation.** Local authority projects looking to engage in the private rented sector should evidently engage with wider internal actors in private sector teams, to boost referrals and successfully convert landlord interest into completed installations.

2.5. The outcomes and impacts of delivering the WHF for delivery partners

Finally, projects described how receiving funding from the WHF and delivering their projects had generated important outcomes for themselves and their partners, in addition to their beneficiaries.

The first outcome for projects was how delivering the WHF had enabled them to establish and expand internal resources, processes, delivery mechanisms, and partnerships. The most prominent way this was discussed was in terms of the recruitment and retention of new staff members, who had been employed initially to deliver a WHF project but were kept on after the project ended. In some cases, this was because projects had learned that delivering schemes like the WHF was much more efficient and effective with additional resources, and they therefore took steps to ensure these resources were maintained beyond the end of their WHF project. Projects also discussed positive outcomes of delivering their projects for pre-existing staff members (e.g. through professional development or training opportunities). Finally, projects discussed broader outcomes in relation to resources, capacity, and ability to deliver. Some projects emphasised that this approach had enabled them to build relationships, referral networks and trust with partner organisations that would continue into the future.

"I put a business case together a couple months ago, probably six months ago, around trying to get a funding officer in my team. And one of the streams was putting in the Warm Homes Fund to try and build that case up, to say, 'This is how much funding we've received. This is potentially what the future looks like.' So we got that signed off and I've now got a new person on my team who manages funding. So in that sense, [the WHF has] definitely helped get us extra resources."

A second key outcome for WHF projects was how delivery had contributed to, and in many cases refined, broader organisational priorities and strategies. Perhaps most notably, projects had channelled the experience of delivering the WHF to help senior decision-makers at their organisations develop fuel poverty strategies and objectives. Different projects explained how the WHF had intersected with several local authority objectives, such as reducing the proportion of social housing tenants with storage heaters, reducing fuel poverty, improving the energy efficiency of their housing stock, and (in projects where private rental properties were included) the enforcement of MEES regulations. Housing associations that took part in interviews also discussed a similar but far broader set of outcomes for their organisations, linked to strategies and targets regarding housing stock sustainability, energy efficiency, and safety, as well as more general priorities for housing stock maintenance and improvement.

The third key outcome for WHF delivery organisations was that learnings obtained through the delivery of their projects has enhanced their ability to undertake large-scale energy efficiency and fuel poverty projects in the future. These are summarised in Table 2 below.

"It's helped us all to build our confidence, working with each other, apart from anything else. But also, because we've got the established processes in place, and that established partnership, then because of the short-term nature of funding, and the quick turnaround on funding applications, we've got that structure already there. Which, if we hadn't done the Warm Homes Fund, and set up our collaboration agreement, we wouldn't have that established process already. So, it's definitely put us in a strong position."

Finally, projects highlighted that the fourth outcome of delivering their WHF project was that it helped them apply for and/or secure further funding for fuel poverty and energy efficiency schemes. In project surveys,

- 19 respondents – exactly one-third of all survey respondents – had applied for and/or been successful in securing additional funding; 15 of these had secured additional funding, three had applied, and one had both secured funding and applied for further funding as well.

Survey responses show that projects had secured a mixture of capital and revenue funding from alternative sources. In addition:

- Of the 19 respondents who had applied for and/or succeeded in further funding applications, 15 said that delivering their WHF project had significantly helped them to do so.
- More specifically, nine said delivering their WHF was an important part of applying for and/or securing funding, while seven said they would not have applied for and/or secured further funding if they had not delivered their WHF project.

Similarly to the match and gap funding that had been tethered to their WHF projects, **interviewees described an eclectic range of sources from which they had secured additional funding after the completion of their projects**. These included national and devolved government schemes, such as the Local Authority Delivery element of the Green Homes Grant, the Social Housing Decarbonisation Fund, and the Home Upgrade Grant. Wider sources of grant income were also being tapped to deliver (or prospectively deliver) fuel poverty and energy efficiency schemes, such as through Innovate UK, the UK Government's City Deals framework, or funding available through local hospital trusts or CCGs.

Key learning theme	Explanation
Bid development	Projects gained experience in costing large-scale energy efficiency projects and writing grant applications in-house without relying on external consultants; this improved prospects of
Business case preparation	Projects learned how to construct business cases for unlocking internal funding from their own organisations, especially through using their WHF project as a source of necessary match funding, and by highlighting how the impacts of their WHF project would be
Communications and marketing	Projects gained experience in reaching vulnerable households and using different methods of promotion to increase scheme uptake, especially relating to low-carbon technologies (e.g.
Data analysis and eligibility checks	Projects learned how to holistically analyse internal data (e.g. housing stock data) and public datasets (e.g. IMD, fuel poverty statistics) to target marketing and interventions more
Fuel poverty	Projects gained new knowledge on the links between fuel poverty and (e.g.) heating type, payment method, mould/damp, vulnerability, and wider climate and social objectives, thus
Geographical aspects of delivery	Projects deepened their knowledge of fuel poverty and vulnerability within their specific geographical remit (e.g. local authority boundaries), and enhanced their understanding of
Household engagement	Projects gained experience and knowledge of different ways to engage with households. This included developing better ways of supporting households throughout their journey (e.g. advice, heating system use and operation, communicating regularly), and liaising with other
Monitoring and evaluation	Projects learned the importance of assessing the outcomes of their scheme delivery for households, especially with regard to wider impacts on the health system. Projects also learned how to set up effective monitoring arrangements with delivery partners that could
Procurement	Projects had developed or enhanced their procurement frameworks through delivering their WHF project, or had learned of new ways to approach procurement, to ensure future schemes were delivered more effectively (e.g. by procuring different types of contractor with
Quality assurance	Projects learned the importance of conducting thorough quality assurance of works independent of their main contractor or delivery partner, and the importance of having internal expertise on technical installation matters (e.g. a Clerk of Works) and retrofit
Roles and responsibilities	Projects gained experience and knowledge of the roles and responsibilities of different partner organisations throughout the project, especially regarding project set-up, and how
Scaling project delivery	Several projects had not previously delivered at the scale of their WHF project, and gained experience, sometimes through errors they had made, of how to do so more effectively in the future. Other projects had delivered small-scale WHF projects, which they felt had laid
Technologies and measures for	Projects gained experience and knowledge of the advantages and weaknesses of different technologies for addressing fuel poverty, including less commonly utilised technologies such

Table 2: Main learnings reported by WHF projects in project surveys and project interviews.

3. What was the difference to beneficiaries?

This section turns to an analysis of the impacts of the WHF on its beneficiaries. It discusses the impacts of the programme across six key indicator groups:

- Fuel poverty and thermal comfort
- Running costs and energy affordability
- Health and wellbeing
- Energy rationing practices and 'spatial shrink'
- Control
- Energy advice

As in the previous section, findings from survey fieldwork with households are integrated throughout, to support and illustrate the points made. Illustrative quotations from household interviewees are also used.

Before this, however, this section begins by examining the question of who exactly the WHF reached, based on an analysis of several different quantitative datasets assembled by the evaluation team.

3.1. Who did the programme reach?

This subsection examines the question of who and which locations received support from the WHF. It does so by analysing several factors linked to vulnerability and from the energy modelling dataset. Specifically, the section covers:

- Age
- Household size
- Tenure
- Household income
- EPC bands (pre- and post-intervention)
- Geography

These factors are treated in turn. Note that although it is a key vulnerability, health is treated separately in Section 3.4 below.

3. BEIS (2022) Annual Fuel Poverty Statistics in England, 2022 (2020 data).

4. BEIS (2022) Annual Fuel Poverty Statistics in England, 2022 (2020 data).

Age

The relationship between occupant age and fuel poverty can be analysed in two different ways, using data from the evaluation. Namely, with respect to the:

- Age of the oldest member of the household
- Age of the youngest member of the household

The findings from the household survey show that households where the age of the youngest member was 16–24 reported the highest levels of subjective fuel poverty pre-intervention. Regarding the oldest member, households where this person was aged 25–34 had the highest subjective fuel poverty before intervention.

Household size

Households with three or more occupants are more likely to be living in fuel poverty than those with one or two occupants. Fuel poverty statistics published for England by BEIS show that 12.6% of single-occupancy households were living in fuel poverty in 2020, and that 10.1% of households with two occupants were also living in fuel poverty, according to the LILEE metric.[3] As the household size increases to three, the proportion in fuel poverty begins to rise: 14.8% of households with three occupants, 16% of households with four occupants, and 26.9% of households with five or more occupants were living in fuel poverty in 2020, according to the BEIS statistics.[4] Larger households require more energy to be able to meet the needs and requirements of all household occupants, which explains this trend.

In survey of WHF households data, there were very few responses from households with four or more occupants. We can therefore consider any differences in pre-intervention subjective fuel poverty status and outcome by comparing findings for single-occupancy households, dual-occupancy house-holds, and households with three or more occupants. However, there were no observable or statistically significant differences in pre-intervention subjective fuel poverty status between these groups, as shown in Figure 3 below.

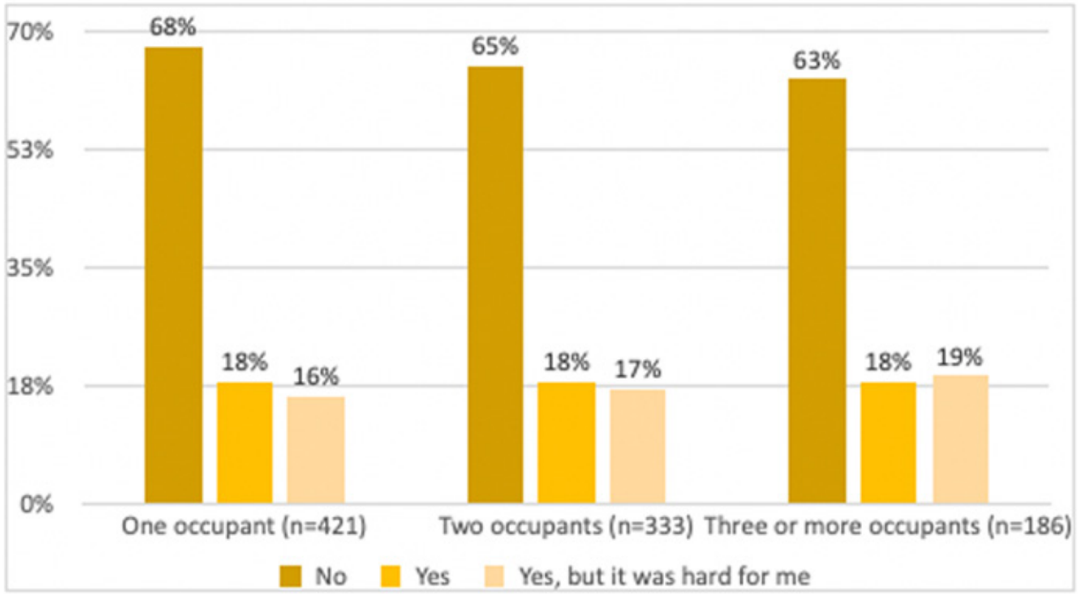

Figure 3: Pre-intervention subjective fuel poverty status by occupancy.

Housing tenure

WHF operational data (n=48,474) shows that, once aggregated into the broad categories of social housing, owner-occupier, and private rental, social housing properties were the most common form of housing tenure to receive support from the WHF. Social housing properties made up 48% of WHF beneficiaries, with owner-occupiers comprising 37%. Beneficiaries living in private rental accommodation were fewer in number, making up 15% of the total. National statistics show that, within England, 25% of those living in privately rented homes are in fuel poverty, as are 18.7% of those in social housing. Private rented homes account for 35.4% of all fuel-poor households, and social housing accounts for 23.8%. Correspondingly, 40.8% of fuel-poor homes are owner-occupied.[5] Viewed in comparison to the tenure of households supported by the WHF, **this shows that private rental properties make up a smaller proportion of WHF beneficiaries than national statistics would suggest need support**. The underrepresentation of private rental sector tenants among WHF beneficiaries as a whole, when compared to national statistics, suggests that while interventions in the private rented sector have been largely successful, more may be required in future programmes, to target interventions at this group in a way that is proportionate to need in the sector.

Household income

Low household income is a core driver of fuel poverty, as it shapes occupants' ability to afford the energy they need to adequately heat and power their homes. The findings show that the majority of survey respondents were living on a household income of £16,010 or less, with 42% reporting less than £12,000, and a further 22% with an annual household income of between £12,001 and £16,010. Findings further show that Category 3 respondents were more likely to be living with a household income of less than £12,000, whereas Park Homes respondents were more likely to receive between £12,001 and £16,010. Overall, responses show that low annual household income, especially below £16,010, was prevalent among the sample.

EPC Bands

WHF operational data (n=22,986) shows that the majority of Category 1, Category 2, and Park Homes beneficiaries had pre-intervention EPC bands of D or E, together accounting for two-thirds of all beneficiaries. EPC band F homes comprised 18% of beneficiaries, with the worst-performing homes, those in EPC band G, making up 7% of WHF beneficiaries. Moreover, 8% of beneficiaries were living in an EPC band C home prior to their intervention, and would therefore not be considered fuel poor under the LILEE indicator. A very small number of beneficiary homes, 66 in total, were EPC band A or B.

Figure 4 below shows that there were small but statistically insignificant differences in subjective fuel poverty depending on pre-intervention EPC band. Notably, 79% of respondents with a pre-intervention EPC band C reported being unable to keep their home comfortably warm, thus representing the highest of all EPC bands.

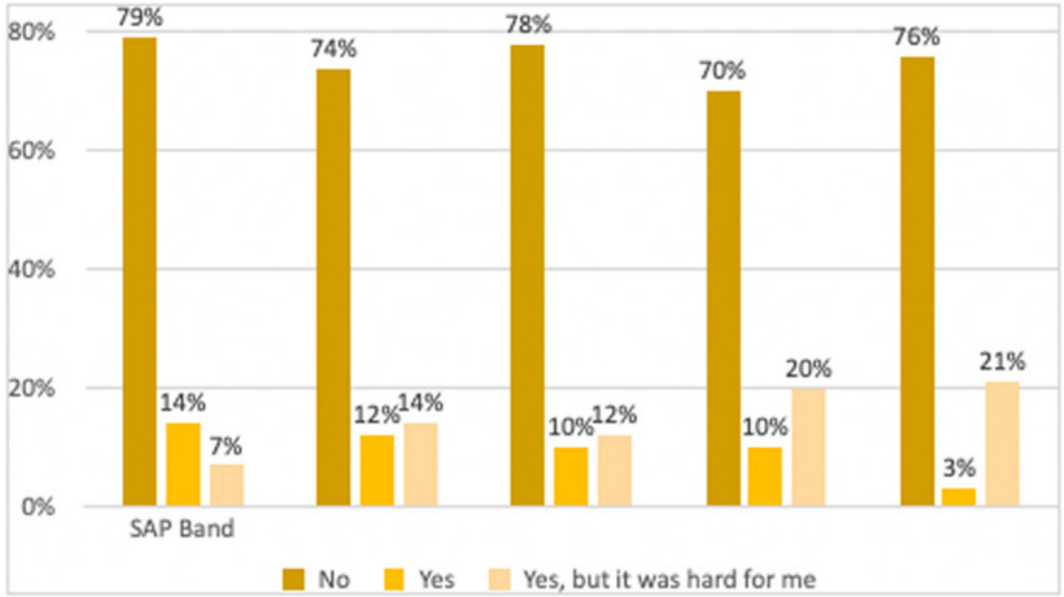

Figure 4: Pre-intervention subjective fuel poverty status by SAP/EPC band.

Geography

Of the full 15,690 homes in the energy modelling analysis, 15,677 were included in the socio-spatial mapping analysis. Based on counts of properties, improvements are spatially concentrated in several Local Authority Districts. The districts with the highest number of properties receiving improvements as part of the scheme are Leeds (970), Cornwall (621), Liverpool (455), Wakefield (407), Argyll and Bute (395), Flintshire (277), Dorset (260), East Riding of Yorkshire (244), Perth and Kinross (244), Hambleton (236), and Leicester (229). These areas have a wide range of geographic characteristics, from large urban conurbations such as Leeds and Liverpool, to relatively rural areas such as Argyll and Bute, and Dorset.

The WHF programme design reflects how fuel poverty can manifest in a range of settings in Great Britain, especially urban areas and rural areas where there are a higher proportion of older homes with solid walls. This makes them less efficient than those in suburban and residential areas, where properties tend to be newer. This is in keeping with wider evidence of the diverse geographical distribution of fuel poverty across the devolved nations, which spans urban–rural divides.

5. BEIS (2022) Annual Fuel Poverty Statistics in England, 2022 (2020 data).

6. Morrison, C. and Shortt, N. (2008) Fuel poverty in Scotland: Refining spatial resolution in the Scottish Fuel Poverty Indicator using a GIS-based multiple risk index, Health & Place, 14(4), 702–717; Gordon, D. and Fahmy, E. (2008). A Small Area Fuel Poverty Indicator for Wales. Bristol: University of Bristol; Robinson, C., Bouzarovski, S. and Lindley, S. (2018) 'Getting the measure of fuel poverty': the geography of fuel poverty indicators in England, Energy Research & Social Science, 36, 79–93.

3.2. Fuel poverty and thermal comfort

This subsection analyses the impacts of WHF interventions on fuel poverty. It does so by presenting the results of the energy modelling analysis alongside a subjective fuel poverty indicator, collected through the household survey. The energy modelling analysis uses the recently introduced Low Income Low Energy Efficiency (LILEE) fuel poverty indicator, whereby a household is considered fuel poor if:

- It is living in a property with a Fuel Poor Energy Efficiency Rating (FPEER) of band D, E, F or G; and
- Its disposable income after housing costs and energy needs is below the poverty line (60% of the national median income).[7]

In addition, the energy modelling analysis includes an assessment of the change in the fuel poverty gap for households defined as fuel poor before and after their interventions. The fuel poverty gap is defined as *"the reduction in fuel costs needed for a household to not be in fuel poverty"*, and is a measure of the depth and severity of fuel poverty experienced by a given household.[8]

On the other hand, the household survey attempts to capture a broader subjective indicator of fuel poverty that reflects the definition set out in the Warm Homes and Energy Conservation Act of 2000, which states: *"A person is to be regarded as living 'in fuel poverty' if [they are] a member of a household living on a lower income in a home which cannot be kept warm at a reasonable cost."*[9] Consequently, the questionnaire asks whether respondents could/can keep their whole homes warm in winter or when it was/is cold outside, before and after they received their intervention from their WHF project.

The energy modelling analysis shows that the number of homes in fuel poverty (measured using LILEE) and the fuel poverty gap have both reduced after improvements were made. Figure 5 and Table 3 show that, because of the corresponding drop in running costs (demonstrated in Section 3.3 below), **households primarily move from the low energy efficiency categories to the high energy efficiency categories**. In addition, a small number of homes move from low-income categories to high income categories, which is caused by running-cost reductions pushing their disposable incomes after energy needs (as defined by the LILEE), above the poverty line. Figure 5 below shows the changes between fuel poverty categories before and after the interventions took place.

Figure 5: Fuel poverty classification of properties using LILEE pre- and post-improvement. The abbreviations in the diagram refer to: LILEE (Low Income Low Energy Efficiency), HILEE (High Income, High Energy Efficiency), LIHEE (Low Income, High Energy Efficiency), and HIHEE (High Income, High Energy Efficiency).

	Before Improvements		After Improvements	
Fuel Poverty Status	**Number Of Homes**	**Average Fuel Poverty Gap (£/yr)**	**Number Of Homes**	**Average Fuel Poverty Gap (£/yr)**
Low Income High Energy Efficiency	969 (6.2%)	NA	3,785 (24.1%)	NA
Low Income Low Energy Efficiency	**9,907 (63.1%)**	**699**	**5,668 (36.1%)**	**121**
High Income High Energy Efficiency	876 (5.6%)	NA	3,784 (24.1%)	NA
High Income Low Energy Efficiency	3,938 (25.1%)	NA	2,453 (15.7%)	NA

Table 3: Fuel poverty status and fuel poverty gap of beneficiary homes before and after improvements were made. Note that 'high income' does not necessarily designate an income (e.g.) at or above the national median. It is more likely that households classified as 'high income' under LILEE are slightly above 60% of the median income but still below the median itself. This is an unfortunate result of how LILEE defines fuel poverty quadrants.

Interestingly, **the household survey suggests that a much larger proportion of respondents were able to keep their homes warm after interventions than the energy modelling suggests**. Figure 6 below shows whether surveyed households could keep their whole homes warm in cold temperatures both before and after they received their interventions, both in total and disaggregated by WHF funding category. It also shows the percentage point change between before and after they received their interventions. **Category 1 interventions have resulted in the most substantial improvements,** with an increase of 73 percentage points, from 11% before intervention to 84% after intervention. **Category 2 interventions have also resulted in significant improvements,** with an increase of 66 percentage points, from 16% before intervention to 82% after intervention. There were lesser, but nonetheless significant improvements reported by Category 3 and Category 3 (Park Homes) beneficiaries, with increases of 19 percentage points and 25 percentage points respectively. Approximately half of Category 3 respondents could keep their whole homes warm after their interventions (just under 30% could do so pre-intervention), whereas 88% of Category 3 (Park Homes) beneficiaries reported being able to do so, albeit from a higher baseline of 63%.

7. BEIS (2022) Annual Fuel Poverty Statistics in England, 2022 (2020 data).
8. BEIS (2022) Annual Fuel Poverty Statistics in England, 2022 (2020 data)
9. Warm Homes and Energy Conservation Act (2000).

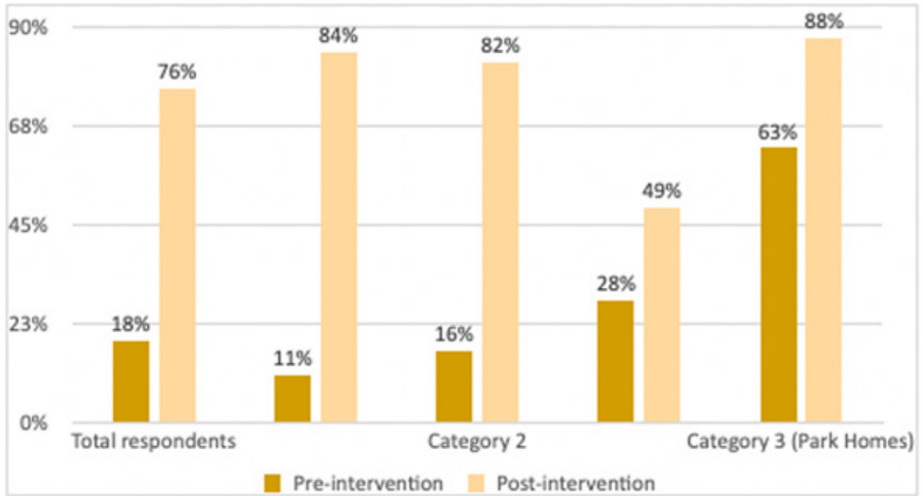

Figure 6: The proportion of respondents who reported being able to keep their whole homes warm in winter or when it was cold outside, pre- and post-intervention.

Figure 7: Running cost profiles before and after making improvements to beneficiary homes.

In addition, the evidence shows that cost and energy efficiency were the key barriers preventing a small proportion of WHF beneficiary households from being able to keep their homes warm post-intervention. **In these cases, more needed to be done to help households access energy efficiency upgrades, increase their incomes, and/or reduce their running costs.**

Furthermore, **these findings point to a potentially interesting question of how well a technical fuel poverty indicator (LILEE) reflects the subjective lived experiences of fuel poverty before and after an energy efficiency intervention is made, and they suggest divergent answers to the question of how accurately interventions have been targeted at households most in need**. This may also suggest the need to develop multi-indicator approaches to measuring fuel poverty and assessing the delivery performance of energy efficiency programmes.

3.3. Running costs and energy affordability

This subsection analyses the impacts of WHF interventions on the running costs of beneficiary homes, as calculated in the energy modelling analysis, and the parallel ability of beneficiary households to afford sufficient energy. It follows a similar approach to the previous section, considering the energy modelling and household survey data in tandem, and exploring their similarities and differences.

The energy modelling analysis shows that the improvements made to beneficiary homes have had a substantial effect on the required running costs. Figure 7 below displays the running costs profile both before and after improvements were made. Before making improvements, 6,428 homes had annual running costs above £2,000, and after making improvements the number of homes left in this band was 460. In terms of averages, the mean annual running costs fell from £2,011 to £1,089; or in other words, on average the installation of a new heating system saved households £922 per year.

Changes in running costs were driven by energy efficiency improvements, which transformed the energy performance of beneficiary homes. As Figure 8 below shows, the average SAP rating of the dwellings before any improvements were made was approximately 51, corresponding to SAP band E. After making improvements the average rose to 68, one point below band C. Figure 8 also shows how the EPC band profile of homes in the modelled dataset changed as a result of making improvements. The main effect was a movement from the E, F and G bands into the C and D bands.

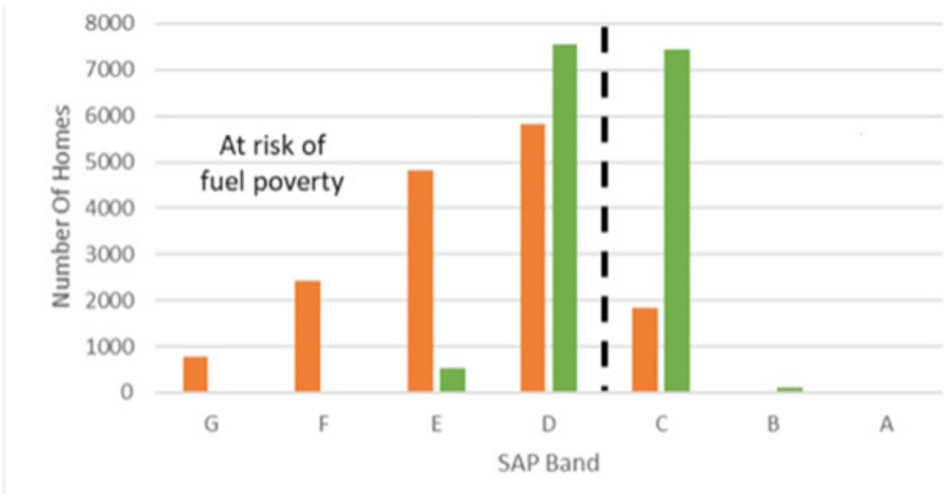

Figure 8: Change in SAP/EPC band status for beneficiary homes before and after improvements were made.

It is interesting to disaggregate the median running-cost savings by Degree Day Region, as this allows a finer analysis of the spatial distribution of the impacts than disaggregating simply by England, Scotland, and Wales. Figure 9 below shows that Wales has the widest range of cost savings, and the highest median net cost savings per year. Median values are also comparatively high for Orkney and North East Scotland. This potentially reflects the older (and thus relatively energy inefficient) housing stock and low household incomes in rural areas targeted by the WHF, especially by projects such as Argyll Community Housing Association and Ceredigion County Council, which substantially improved a large number of very poorly performing remote dwellings through their Category 2 funding.

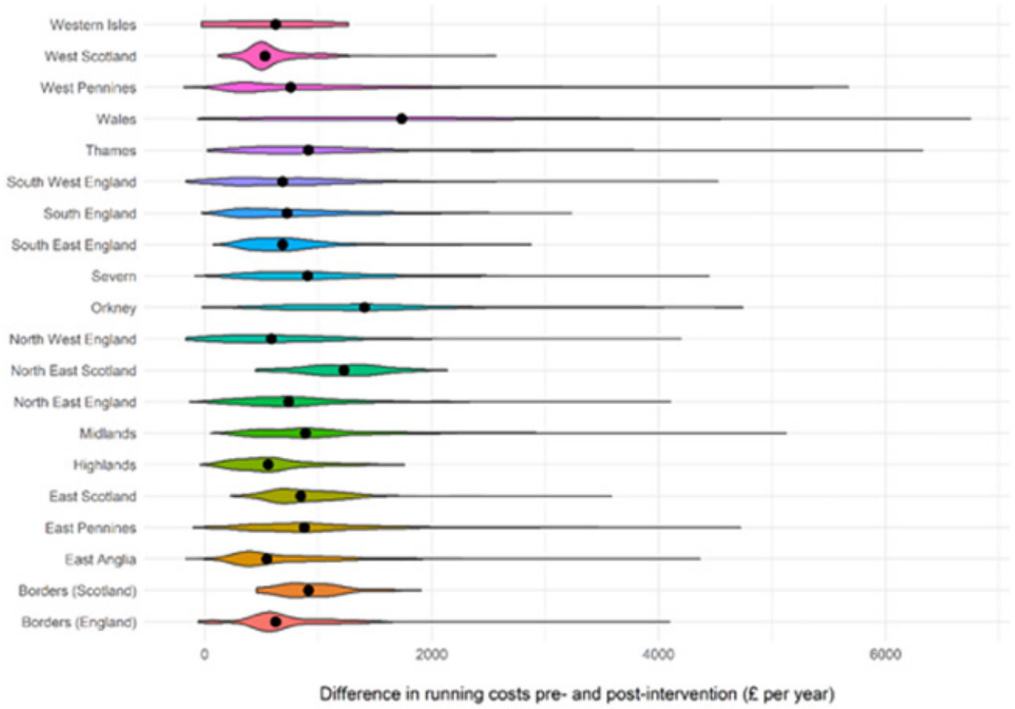

Figure 9: Distribution of properties for each Degree Days Region according to the difference in running costs (£ per year) pre-improvement and post-improvement. The violin plots show the distribution of the data and should be read in a similar way to a box plot. The median value is indicated using a black point.

Findings from the household survey, illustrated in Figure 10 below, allow changes in running costs to be considered from the perspective of the beneficiary. Figure 10 shows that changes in running costs have translated into self-reported improvements in energy affordability, especially for beneficiaries of Category 1 interventions. Thus, 53% of Category 1 respondents reported that they find their energy bills a lot easier or a little easier to afford post-intervention, compared to before their intervention. Furthermore, 44% of Category 2 respondents replied the same, as did a marginally lower 40% of Park Homes respondents and 31% of Category 3 respondents.

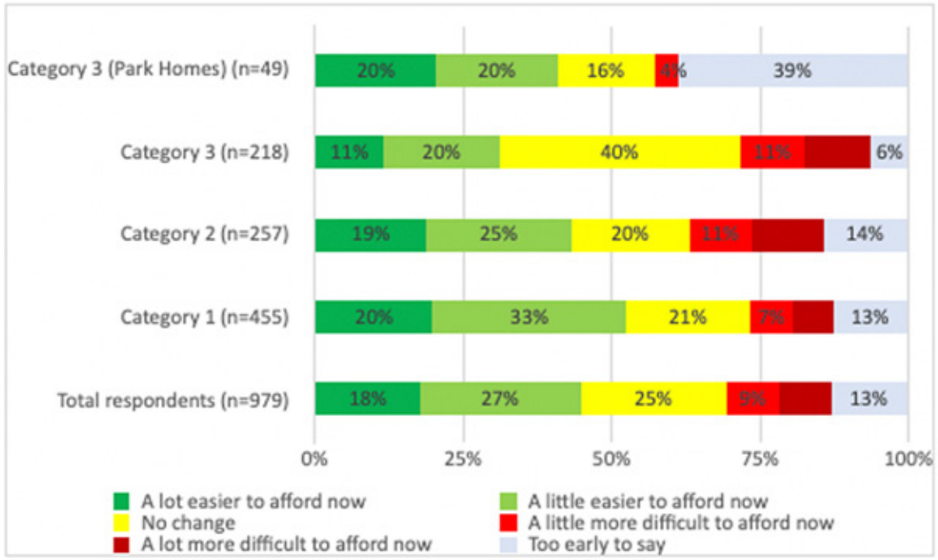

Figure 10: Responses to the questionnaire item 'How easy or difficult do you find it to afford your energy bills (gas, electricity, oil etc.) now, compared to before you received your health and energy-related support?', disaggregated by WHF funding category.

Interviewees with beneficiaries confirmed the range and extent of affordability improvements enabled by WHF interventions. In interviews, beneficiaries were asked if they had experienced changes to the cost of their energy bills, and if they had, to quantify them to the best of their understanding. Interviewees explained this in different ways: some accounted for their energy bills by commenting on how much their direct debit was per month, while others discussed weekly costs or the amount they topped up prepayment meters in a given timeframe. Table 4 below consolidates these findings into an estimated pre- and post-intervention annual bill for a sample of Category 1 and Category 2 beneficiaries.

Household Category and Wave	Estimated pre-intervention annual bill	Estimated post-intervention annual bill	Annual bill decrease (%)	Pre-intervention modelled running costs	Post-intervention modelled running costs	Modelled running cost decrease (%)
Category 2, Wave 2	£2,340	£1,560	33%	£1,904	£1,638	14%
Category 1, Wave 2	£1,920	£920	52%	£2,405	£835	65%
Category 1, Wave 2	£2,160	£1,164	46%	£2,078	£1,002	52%
Category 2, Wave 2	£1,650	£1,080	35%	£2,693	£1,712	36%
Category 2, Wave 2	£1,200	£792	34%	£1,596	£1,277	20%
Category 1, Wave 2	£1,800	£840	53%	£3,831	£1,714	55%
Category 2, Wave 2	£1,920	£1,440	25%	£2,035	£1,449	29%

Table 4: Estimated pre- and post-intervention annual bill for a sample of Category 1 and Category 2 beneficiaries.

In interviews, **beneficiaries mentioned not only that their energy bills were lower, but also that they were also easier to afford than prior to their intervention**. There were several different ways that interviewees discussed this. Most notably, they explained how their **energy bills had reduced at the same time as their thermal comfort and control over their heating systems had increased**. Other interviewees preferred to describe the affordability of their energy in terms of unit usage, and had calculated how much this had decreased following the installation of their new heating system, which resulted in a corresponding drop in energy costs. Beneficiaries' experiences of positive changes to energy affordability also varied depending on their payment method. Several interviewees who paid by direct debit commented that although they had received new heating systems, their direct debits to their energy supplier had not immediately changed. As a consequence of the efficiency of their new systems, they quickly built-up higher credit balances. In parallel, **interviewees with prepayment meters noted visible and welcome differences in the rate at which their credit declined after their heating system installations. Finally, Category 3 beneficiaries in particular discussed the knock-on impacts that being unable to afford their energy bills had on debt accumulation, and how their interventions had helped them to reduce their levels of arrears with energy suppliers and other utilities.**

"I think the boiler has made a big difference because of course your immersion heater was – you've got that on, and your electricity meter was going round, whizzing round. So it's saved a lot of money in that respect."

"However, the bills, they've come down a lot. I'm amazed actually, because we were never heating it. It's set now at 21, the temperature. We're getting that. We'd never heat it to 21 before. It's quite incredible. We were like, 'Oh my God, what's the bill going to be like?', but the bill has gone right down."

Although Figure 10 shows that a significant number of survey respondents reported no change to the affordability of their energy bills, **interview data shows that these respondents often did not consider this an issue, but instead perceived it as paying the same amount of money they previously had, for a much higher standard of warmth**. Furthermore, beyond changes to affordability, interviewees also reported that their new heating systems had delivered an enhanced ability to control, monitor and forecast their energy usage and associated costs.

"But had we not had [the system installed], [our bills] would have been in excess of £200, so it's been a real reassurance really. We're really enjoying having a house that we can wear a t-shirt in. It's mad."

"It's just timing really; the price increase has come at the worst time. We'd just had it all fitted and starting to enjoy it, and the prices are shooting up."

Lastly and importantly, for **interviewees whose energy bills had become less affordable, evidence suggests that the main reasons were the financial impacts of global crises, specifically the Covid-19 pandemic, which began in March 2020, and increases to the price of domestic gas and electricity, which began in October 2021 – the first of several increases to the energy price cap in Great Britain from 2021 to 2022**. This evidence shows that even in cases where energy affordability had not been improved by new heating system installations, interviewees recognised that they would now be paying even more if those installations had not taken place. Furthermore, as emphasised elsewhere in this section, this would also have meant inadequate thermal comfort, heating system control, and a restricted use of domestic spaces in addition to higher energy costs. In other words, for Wave 3 beneficiaries, energy affordability was typically the only negative outcome of their intervention, and it was not attributable to the intervention itself, but to externally driven increases in energy prices.

3.4. Health and wellbeing

Living in a cold home is connected to range of respiratory, cardiovascular, and musculoskeletal conditions, as well as mental ill-health, and it is well established that cold indoor temperatures exacerbate pre-existing illnesses. Previous research has demonstrated the links between cold homes and these conditions,[10] and a recent systematic review of evidence from across the globe concluded that fuel poverty is associated with *"poorer general health, poorer mental health, poorer respiratory health, more and worse controlled chronic conditions, higher mortality, higher use of health services and higher exposure to health risks, with worse results for vulnerable groups across dimensions of inequality."*[11] The National Institute for Health and Care Excellence (NICE) has also repeatedly stressed the importance of addressing the health risks that are associated with cold, energy-inefficient homes.[12]

Four in five survey respondents were living in a home where at least one occupant had a cold-related health condition, and over half were living in a home where at least one occupant had multiple cold-related health conditions. On average, WHF beneficiaries had two cold-related health conditions per household, and households with the lowest household incomes were more likely to contain an occupant with at least one condition. There is significant evidence that the poor, cold housing of WHF beneficiaries contributed to their ill-health, **with 58% of respondents agreeing that not being able to keep warm at home affected their physical health, and 44% agreeing that it affected their mental health**. However, Park Homes residents far less commonly reported cold-related illness, and Category 3 respondents were slightly more likely to report struggling with their mental health.

"I suppose the cold and the damp just made you, sort of, ache. If it got really bad, I would have steroid injections, which eased the pain, but yes, just the general cold just makes your bones ache. So, yes. It made you miserable, really, if the house was cold."

Together, this evidence shows that for a majority of WHF beneficiaries with pre-existing cold-related health conditions, their conditions worsened or were exacerbated by not being able to keep their homes warm. **Even among respondents who disclosed no health conditions, a not insignificant proportion said that their health had been impacted by living in a cold home prior to their intervention.** Interviewees expanded on precisely why this was the case, such as discussing the significantly negative impacts of worrying about the health of more vulnerable family members, feeling shame and embarrassment about their situations, and the constant stress and burden of trying to juggle inadequate household budgets.

10.. NEA (2018) Under One Roof; and NEA (2017) Connecting Homes for Health: Phase 1 Review.

11. Ballesteros-Arjona, V. et al. (2022) What are the effects of energy poverty and interventions to ameliorate it on people's health and well-being?: A scoping review with an equity lens, Energy Research and Social Science 87: 102456, p.1

12. NICE (2015) NICE Guideline NG6: Excess winter deaths and illness and the health risks associated with cold homes.

Post-intervention, **48% of respondents reported that their physical health was better now than it was before, and 39% of respondents reported that their mental health was better than before**. Approximately three in five respondents across Categories 1, 2 and 3 thought it was probable or very probable that their physical and/or mental health improvements were attributable to their WHF intervention. Interviewees with respiratory conditions described several positive impacts of their WHF intervention, including better and more comfortable breathing, less frequent inhaler usage, and fewer flare-ups of pre-existing conditions such as asthma and COPD. Moreover, there is evidence from household interviews that WHF interventions have made it easier for beneficiaries to manage long-standing musculoskeletal conditions and mobility issues, with interviewees reporting that they now find it easier to move around their homes, use their heating systems, and that they feel less pain on a daily basis.

Evidence also shows that there have been **improvements in mental wellbeing** for WHF beneficiaries after their interventions took place, especially for highly financially vulnerable Category 3 beneficiaries, who were supported with debt and similar issues. Interviewees reported variegated positive impacts on their mental health and wellbeing; they described how receiving support from the WHF had enabled them to feel more in control of their costs and household expenditures, improved their feelings of safety and security at home, and allowed them to worry less about the impacts that living in a cold home were having on them and their family.

"I have diabetes, asthma. I have had pneumonia. I have a lot of underlying health problems. I think being cold all the time didn't help. The black mould, that didn't help because that didn't help the asthma, but it seems like, in the bathroom especially, it seems to be clearing up, or it seems like it's drying up, it's weird. I haven't had nowhere near as many problems with my asthma since having [the central heating] fitted. The whole house is a lot warmer, happier, and healthier, due to having the central heating fitted."

Four further impacts were highlighted in interviews with **WHF beneficiaries. Firstly, evidence shows that WHF interventions are preventing the development or exacerbation of health conditions for young children** by enabling them to grow up and live in a warm home. Secondly, there is evidence that the **WHF has enabled improvements in diet and nutrition** that have had a positive impact on the physical health of beneficiaries, particularly by enabling them to spend a larger proportion of their household income on healthy food. Thirdly, there is evidence that **WHF interventions have facilitated safer home environments for beneficiaries with dementia**. Fourthly and finally, WHF interventions, particularly Category 1 and Category 2 interventions, have partially or entirely led to the **elimination of damp and mould from beneficiary homes**, thus reducing the risk of the development or exacerbation of respiratory and mental ill-health.

3.5. Energy rationing practices and 'spatial shrink'

It is now well established that fuel poverty and energy vulnerability are closely connected to practices of limiting household spending on heat, food, and other essentials (e.g. childcare items). This is sometimes referred to as the 'heat or eat' trade-off, but is better defined as a more complex arrangement of rationing practices that stem from household budgets existing in a continual state of precarity and uncertainty.[13] **The 'heat or eat' trade-off is therefore less a binary choice between one essential or another, but a recognition that energy and food consumption have an inherent elasticity and flexibility that can be controlled and limited by households.** Furthermore, previous research has highlighted the ideal values that are positively associated with home, or what could be described as the things that make homes homely. These include home as a place that offers privacy, security, comfort, independence, safety, control, relaxation, and belonging.[14] However, f**or fuel-poor and vulnerable households, home can too often be place of exclusion and entrapment, failing to meet their needs and requirements, and creating feelings of alienation and resentment towards the home itself.**

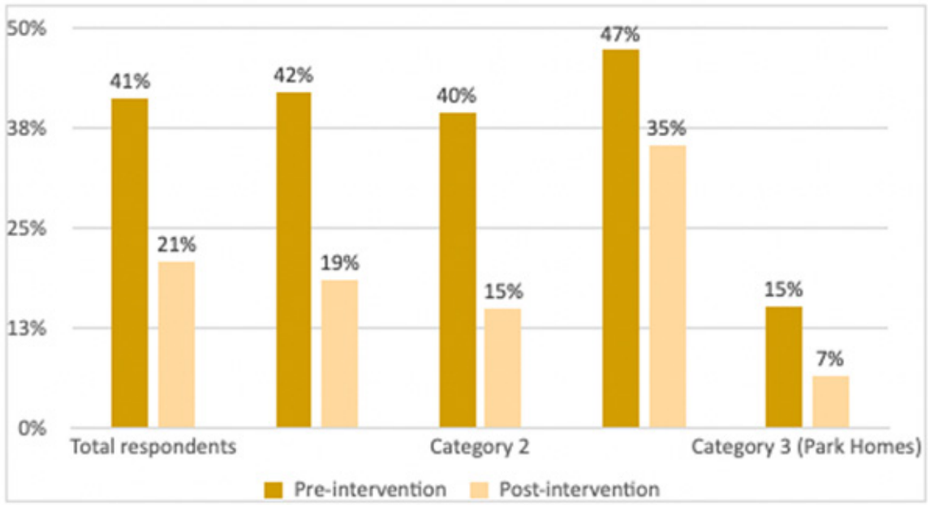

Figure 11: Proportion of respondents who reported cutting back on heating all or most of the time to save money pre- and post-intervention, disaggregated by WHF funding category.

The findings show that WHF interventions have had a substantially positive impact on the prevalence and severity of rationing practices, as well as facilitating home environments for beneficiaries that felt homely, rather than alienating. Figures 11 above and 12 below show that the proportion of respondents rationing their use of heat and purchase of essentials 'all or most of the time' decreased across all four intervention categories, especially Category 1 and Category 2. Evidence from household interviews shows that, pre-intervention, beneficiaries were cutting back on a wide range of household essentials in order to save money. Many were severely restricting food and other essentials, to be able to afford to heat and power their homes at a level appropriate for their health and medical needs. Post-intervention, many of these situations were reversed, although some survey respondents and interviewees, especially recipients of Category 3 interventions, were still struggling due to the precarity and vulnerability of their wider financial situations.

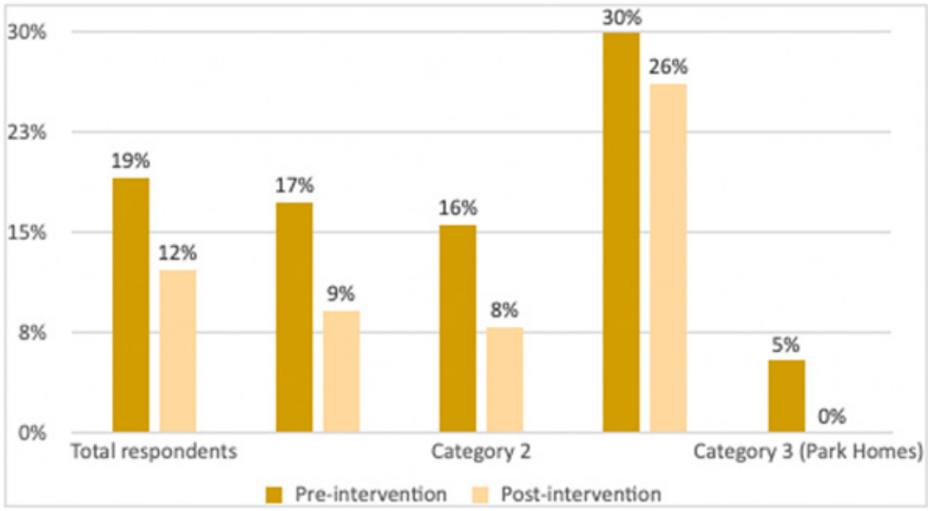

Figure 12: Proportion of respondents who reported cutting back on other essentials (e.g. food, hygiene products) all or most of the time to save money pre- and post-intervention, disaggregated by WHF funding category.

13. Snell, C.J., Lambie-Mumford, H. and Thomson, H. (2018) Is there evidence of households making a heat or eat trade off in the UK? Journal of Poverty and Social Justice 26 (2). ISSN 1759-8281

14. Ellsworth-Krebs, K., Reid, L. and Hunter, C.J. (2015) Home -ing in on domestic energy research: "House," "home," and the importance of ontology, Energy Research & Social Science 6: 100–108.

Regarding domestic space use, WHF beneficiaries' rationing practices were manifested most clearly in the extent to which they did not use or did not fully use the majority of rooms in their home because they were too cold. Instead, they would spend much of the day occupying only one or two rooms and focused their efforts on trying to make these rooms as warm, comfortable and bearable as possible – a practice sometimes referred to as 'spatial shrink'. However, the necessity of using different rooms of the home to perform different practices (e.g. cooking, going to the toilet) meant that interviewees would periodically have to leave warm rooms and enter cold ones. Others would prepare for using different rooms of the home by trying to pre-emptively heat them to when they were likely to be used, for example by moving plug-in radiators around the home. For the majority of interviewees who discussed these practices, they were experienced as mentally exhausting, demeaning, and, to a certain degree, dehumanising.

"It's cut down on condensation in the rooms that we weren't using that we didn't put the heating on, obviously because of the bills. And we'd go in there and there was a lot of condensation on the windows. Now, because we have the bungalow, it's only a small bungalow, but because we have it all the same temperature all the way through so we can freely go from one room to the other, it's cut down a lot on the condensation."

Post-intervention, Category 1 and Category 2 interviewees experienced partial or complete reversals in these situations following the installation of their new heating systems. Because previously unheated and unused rooms were now heated to a comfortable temperature, beneficiary homes as a whole were described as more pleasant and amenable places to spend time in. They became places where privacy, security, comfort, independence, safety, control, relaxation, and belonging could be achieved. This sense of new heating system installations 'making the house really liveable' is an appropriate way of summarising this impact. For several interviewees, the links between comfort, contentedness, happiness, personal expression, and home have been re-established through their WHF interventions, allowing them to live in places that fulfil the social norms of what a home should be like in an ideal society.

3.6. Taking control over heating and energy

Numerous beneficiaries discussed how problematic their heating systems were to control prior to their WHF intervention.

In particular, **interviewees with storage heaters in their properties frequently described them as difficult (if not impossible) to control effectively**. These storage heaters were heterogenous in terms of their age, efficiency and settings, and interviewees explained how their attempts to make them release heat in certain ways and at certain times were constantly thwarted. These issues, combined with the expense of the electricity needed to charge them to a sufficient level, meant that the most common response from interviewees was to simply not use their storage heaters at all, or to concentrate on trying to work a storage heater in one room and then spending as much time as they could there.

Solid fuel fires and LPG heating systems were also discussed as near-impossible for beneficiaries to control, although for different reasons. Most notably, older interviewees who had solid fuel systems prior to their intervention mentioned the physical and mental labour associated with controlling and using their heating, especially at colder times of the day or year, such as in evenings or in winter. Summarily, **issues related to control and controlling storage heaters, LPG heating systems, and solid fuel heating systems were common, and often negatively impacted on the thermal comfort, wellbeing, and domestic space use** of WHF beneficiary households prior to their interventions.

"They were okay but you just couldn't control them, could you? That's the biggest downfall with them is you can't control it. If it suddenly turns cold you can't turn them on and if it turns hot you can't turn them off. So that's the problem with them [...] If it suddenly turns cold, you can't turn them on. So they were very uncontrollable."

Evidence from the household survey shows that there were significant improvements in beneficiaries' ability to use and control their heating systems following their WHF intervention. Figure 13 below shows that 77% of respondents agreed with the statement 'You feel more able and confident about using and controlling your heating system'. Category 1 and Category 2 respondents experienced the most significant improvements, with 88% of Category 1 and 76% of Category 2 respondents agreeing with the statement. Furthermore, 58% of Category 3 respondents and 57% of Park Homes respondents agreed.

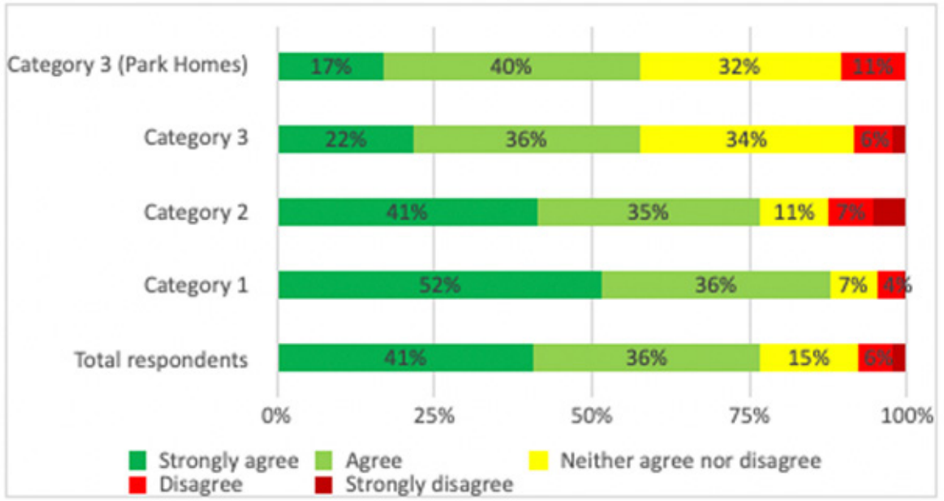

Figure 13: Proportion of respondents agreeing or disagreeing with the statement 'You feel more able and confident about using and controlling your heating system', disaggregated by WHF funding category.

In interviews, the recipients of first-time central heating installations discussed how replacing their storage heaters and solid fuel heating had dramatically improved the control they felt they had over their homes. The installation of improved heating controls, especially thermostats and timers, was credited by interviewees with granting them control over their home environment. A common theme across all household interviews was the adaptability and flexibility that new heating controls conferred. In contrast to storage heaters and solid fuel systems, the installation of timers and thermostats enabled beneficiary households to explore different configurations of warmth in different places in their homes, and at different times of day. Other interviewees described how they relied on the programmability and autonomy of their heating controls to set the level and timing of heating in their homes. For many, it was the possibility and potential of controlling the heating system in different flexible ways that underpinned their feelings of control. In other words, **the constant ability to adjust and experiment with their new heating controls enabled and empowered interviewees to feel that they determined and could shape their own levels of thermal comfort.**

"With the storage heaters, it used to be timed to come during the night. Now, my central heating is timed to come on during the day. Obviously, when I've been out, it's lovely and warm when I come home. Even though I still don't have it on the bedrooms, in all the other rooms it's definitely on."

Lastly, however, some challenges were noted by interviewees. Some did not have the skills, capacities or confidence to successfully experiment with using their new heating systems in a way that worked for them, and would have appreciated more detailed advice and support to do so by their respective WHF project. Furthermore, some interviewees felt that their heating systems had been set up by installers in a way that was not optimal for their own needs and requirements, and that they had not been adequately consulted as to their preferred temperatures and timings. Overall, therefore, **the evidence shows that while heating control was greatly enhanced for the majority of interviewees, some did not receive adequate advice and support with understanding their heating controls**. This was particularly the case for vulnerable households that required more help in being able to confidently operate and control their systems.

3.7. The centrality of energy advice to fixing fuel poverty

Finally, the findings of the evaluation highlight the centrality of energy advice to addressing fuel poverty. Previous research has suggested that delivering energy advice and capital measures together as part of one streamlined customer

journey tends to result in more optimal outcomes for households than delivering one or the other in isolation.[15] This is because this approach can address multiple drivers of fuel poverty in one intervention (e.g. low income, through income maximisation and energy (in)efficiency through replacing inefficient boilers).

Better outcomes were achieved for beneficiaries when they received energy advice and capital measures together. This occurred in two ways. Firstly, Category 1 and Category 2 beneficiaries who also received a form of energy advice were statistically more likely to experience greater impacts on thermal comfort and energy affordability than beneficiaries who did not receive parallel energy advice. Secondly, Category 3 beneficiaries who also received a match-funded hard measure (e.g. boiler replacement, insulation, new heating system) were statistically more likely to experience greater impacts on thermal comfort and energy affordability than beneficiaries who received only advice.

Overall, these findings show the importance of delivering energy advice and capital measures interventions together, as part of a journey that the recipient experiences as being streamlined. Ways in which this can be enabled in future energy efficiency and fuel poverty programmes will be considered in the accompanying blueprint.

15. NEA (2018) Health and Innovation Programme: Social Evaluation Report.

4. What were the costs and benefits of the programme?

Intentionally or unintentionally, investments made in fuel poverty and energy efficiency programmes create ripple effects across the wider economy and society. On some level, they change the economy, primarily by reducing household running costs and freeing up household income to be spent on other services. Warmer homes also have health implications, and it is estimated that excess cold alone costs the NHS approximately £857mn per year more than if the hazard were effectively mitigated.[16] In a time when reducing societal carbon emissions is an ever greater priority, fuel poverty and energy efficiency programmes can also have environmental impacts, by reducing energy demand through the installation of energy-efficient heating systems and insulation.

Investing in fuel poverty and energy efficiency programmes therefore comes with undoubted economic, health, and environmental benefits; however, another important consideration is how proportionate these impacts are to the initial investment that is made, especially if that money could be spent elsewhere. This section therefore sets out the rationale and outputs of a series of modelling exercises undertaken by the evaluation. These exercises, which are all underpinned by the findings of the energy modelling analysis presented in the previous section, rigorously quantify the economic, health, and environmental impacts of the WHF.

4.1. Impacts of the WHF on the wider economy

There are two main ways in which the impacts of the WHF on the wider economy have been modelled. The first is modelling how the WHF investments have supported and grown different sectors of the economy, using a Social Accounting Matrix produced by researchers at the University of Strathclyde.[17] The second is modelling changes in the economy driven by changes in household spending; or, put differently, the effect of households spending less on energy and more in other parts of the economy because of their interventions. These two economic 'effects' are analysed in turn in this section.

4.1.1. Investments in the construction, retrofit, installer and support services industries

The starting point for this analysis is the National Grid's £150mn investment in the WHF. This was split between £132mn in the building, housing services and energy installation industry, and £18mn in support services. This led to an additional £200mn of indirectly stimulated demand in the economy, giving a total demand stimulus of £350mn. This means that for every £1 invested, a further £1.34 was stimulated in the economy, amounting to £2.34 of total economic impact for every £1 invested, as shown in Table 5 below.

16.. BRE (2021) The cost of poor housing in England.

17. Katris, A., Figus, G. and Greig, A. (2019) The 2013 Social Accounting Matrix for Scotland disaggregated by household income quintiles. The detailed methodology underpinning the economic modelling can be found in the full evaluation report.

Value of the Initial Investment	**£150,000,000**
Construction Sector Portion	**£132,000,000**
Round 1: Re-spending by Construction and Installers	£104,685,455
Round 2: Further re-spending in the economy	£78,359,374
R1+R2	£183,044,830
Total Economic Boost crated by the grant funding	£315,044,830
Direct to indirect boost ratio	1.39
Support Services Portion	**£18,000,000**
Round 1: Re-spending by Construction and Installers	£10,495,158
Round 2: Further re-spending in the economy	£6,820,245
R1+R2	£17,315,404
Total Economic Boost crated by the grant funding	£35,315,404
Direct to indirect boost ratio	0.96
Total Indirect Economic Boost created by funded work	£200,360,234
Total Economic Boost of funded work	**£350,360,234**

Table 5: Economic impact analysis of capital expenditure using Office for National Statistic (ONS) multiplier coefficients.[18]

4.1.2. Economic impacts of changes in household spending

As demonstrated in Section 3 above, required running costs have decreased on average for WHF Category 1 and Category 2 households. Academic literature shows that in such instances a 'rebound effect' occurs, where financial savings driven by the installation of energy efficiency measures are re-spent by households in different ways. A review of this literature suggests a rebound coefficient of 0.75, whereby 25% of achieved savings are spent on energy to keep the home warmer, meaning the real reduction in spending on energy bills is 75%.[19] In other words, the assumption is made that 75% of the modelled reduction in running costs for any given household is spent elsewhere in the economy, and the wider economic impacts of this re-spending can be modelled.

After the rebound effect was accounted for, the total energy bill savings generated by the WHF, which can be stated as an increase in household disposable income, was £10.8mn.

Table 6 below shows that this figure is reached by applying the 75% rebound coefficient to the total potential increase in annual disposable income, which was £14.4mn. Of the £10.8mn increase in disposable income, the analysis shows that £8.6mn was re-spent in the economy in the first round of re-spending. This re-spent disposable income then had multiplier effects throughout the economy, in a second round of economic impacts of £9.6mn. These are estimated by using the ONS demand multipliers for each sector of the economy, to create marginal multiplier coefficients, as described in the methodology. Taken together, **these two rounds of positive economic impacts total £14.4mn and represent the positive** economic impact of the bill reductions on the wider economy. This happens because even though some of the bill savings are not spent in the UK economy (they are used to pay off debt, saved, taxed, or spent abroad), the proportion that is spent in the UK goes on to circulate in the economy. A multiplier effect is created which produces demand in the economy greater than the amount initially re-spent by households.

Potential increase in annual disposable income	**£14,444,019**
Actual increase in annual disposable income after rebound effects	**£10,833,014**
1st Round of annual re-spending	**£8,579,604**
2nd Round of annual re-spending	**£9,584,580**
Total Economic Impact	**£14,420,653**

Table 6: Economic impacts arising from increases in WHF beneficiary households' disposable income.

A further comparison can be made between the modelled economic impacts of the WHF measures and their likely impacts if they had not been so specifically targeted at low-income households. Households in different income quintiles have observably different spending patterns, rates of saving, and taxation liabilities. As a result, boosting the incomes of households with different incomes leads to different economic impacts, which can be modelled.

Table 7 below compares three different scenarios, to illustrate the difference between 1) the actual modelled impacts of the WHF throughout the economy, 2) a scenario in which the average household expenditure was used, and 3) one in which measures were provided exclusively to higher-income households. This is relevant to this exercise because it indicates the likely impact of the interventions had they been distributed across all households and income bands, which is how one might imagine a non-targeted WHF operating. Including a third scenario where measures are directed to higher-income households helps to illustrate what could be termed a 'sliding scale' in economic impacts in relation to the household income of recipients, whereby the lower the recipient income, the greater the economic impacts, and vice versa. In summary, **by targeting low-income households, the WHF grants produced a £2.2mn greater boost in the economy than if measures had not been targeted**.

18. ONS (2021) UK input-output analytical tables.

19. See Barker, T., Ekins, P. and Foxon, T. (2007) The macro-economic rebound effect and the UK economy, Energy Policy 35 (10): 4935–4946; Sorrell, S., Dimitropoulos, J. and Sommerville, M. (2009) Empirical estimates of the direct rebound effect: A review, Energy Policy 37 (4): 1356–1371; Gillingham, K., Kotchen, M.J., Rapson, D.S. and Wagner, G. (2013) The rebound effect is overplayed, Nature 493 (7433): 475–476.

	Scenario 1: Low-income targeting	Scenario 2: Measures go to middle-income households	Scenario 3: Measures go to high-income households
Round 1 re-spending	£8,579,604.13	£7,345,493.08	£6,384,373.14
Round 2 re-spending	£5,841,048.94	£4,847,808.94	£4,007,291.27
Total re-spending	£14,420,653.07	£12,193,302.03	£10,391,664.41

Table 7: Comparison of economic impacts of the WHF in different targeting scenarios.

4.2. Impacts of the WHF on health service costs and wider society

To estimate the health and wider societal impacts of the WHF, including avoided NHS costs and wider societal benefits of the Category 1 and Category 2 measures installed, the best tool available is the Building Research Establishment's (BRE) Housing Health Cost Calculator (HHCC), which takes a risk-based approach to health, and assigns different costs to different risks associated with housing.[20]

The key risk of relevance here is excess cold, which is known to be present in homes where there is no adequate heating system, or which have a very low SAP rating. The risk-based approach used by the BRE's calculator is premised on the likelihood of excess cold leading to ill-health, and how that likelihood changes when measures such as those funded by the WHF are undertaken. Put simply, this means that the movement of a home from one SAP band pre-intervention to another SAP band post-intervention can be converted into a transition from one excess cold risk likelihood pre-intervention to a different, most often lower, excess cold risk likelihood post-intervention. The HHCC produces the likely NHS costs before and after the measures, and thus enables a comparison of these, and reveals the resulting NHS savings.

Based on the approach described above, **the total NHS cost savings generated by the WHF are estimated to be £2,491,381 per annum, while the wider societal benefits are estimated to be £41,854,679 per annum.**

The NHS and wider societal impacts of the measures funded under Category 1 and Category 2 of the WHF are detailed in Table 8 below. Some of the greatest savings have been created in improving many extremely poorly performing homes; and even though some of these households may still technically be in fuel poverty under the LILEE metric, the likely costs arising from excess cold have been significantly reduced. Table 9 overleaf provides the full breakdown of these findings, including the wider societal benefits.

Pre-intervention SAP Band	Post-intervention SAP Band	Total NHS savings per annum
B	A	£96
C	B	£3,239
D	A	£276
	B	£2,052
	C	£279,809
E	B	£2,490
	C	£254,592
	D	£478,035
F	C	£260,325
	D	£82,002
	E	£552,420
G	C	£39,146
	D	£437,236
	E	£91,949
	F	£7,714
	Total NHS savings	**£2,491,381**

Table 8: NHS savings attained through the movement of beneficiary homes from pre-intervention SAP bands to post-intervention SAP bands.

20. BRE (no date) Housing Health Cost Calculator.

SAP Band			Risk Scale Point		NHS Costs of Excess Cold			Wider Societal Costs of Excess Cold			Risk Ratings			
PRE	POST	n	ONE IN ...	ONE IN ...	PRE	POST	IMPACT	PRE	POST	IMPACT	PRE	POST	Total NHS Savings per annum	Total Societal Savings per annum
B	A	4	560	1,000	£54	£30	£24	£967	£541	£426	D	E	**£96**	**£1,704**
C	B	79	320	560	£95	£54	£41	£1,692	£967	£725	C	D	**£3,239**	**£57,275**
D	A	2	180	1,000	£168	£30	£138	£3,008	£541	£2,467	C	E	**£276**	**£4,934**
D	B	18	180	560	£168	£54	£114	£3,008	£967	£2,041	C	D	**£2,052**	**£36,738**
D	C	3,833	180	320	£168	£95	£73	£3,008	£1,692	£1,316	C	C	**£279,809**	**£5,044,228**
E	B	10	100	560	£303	£54	£249	£5,414	£967	£4,447	B	D	**£2,490**	**£44,470**
E	C	1,224	100	320	£303	£95	£208	£5,414	£1,692	£3,722	B	C	**£254,592**	**£4,555,728**
E	D	3,541	100	180	£303	£168	£135	£5,414	£3,008	£2,406	B	C	**£478,035**	**£8,519,646**
F	C	585	56	320	£540	£95	£445	£9,668	£1,692	£7,976	A	C	**£260,325**	**£4,665,960**
F	D	346	56	180	£540	£303	£237	£9,668	£3,005	£6,663	A	B	**£82,002**	**£2,305,398**
F	E	1,485	56	100	£540	£168	£372	£9,668	£5,414	£4,254	A	C	**£552,420**	**£6,317,190**
G	C	46	32	320	£946	£95	£851	£16,919	£1,692	£15,227	A	C	**£39,146**	**£700,442**
G	D	562	32	180	£946	£168	£778	£16,919	£3,008	£13,911	A	C	**£437,236**	**£7,817,982**
G	E	143	32	100	£946	£303	£643	£16,919	£5,414	£11,505	A	B	**£91,949**	**£1,645,215**
G	F	19	32	56	£946	£540	£406	£16,919	£9,668	£7,251	A	A	**£7,714**	**£137,769**
												Total	**£2,491,381**	**£41,854,679**

Table 9: Total NHS and wider societal savings.

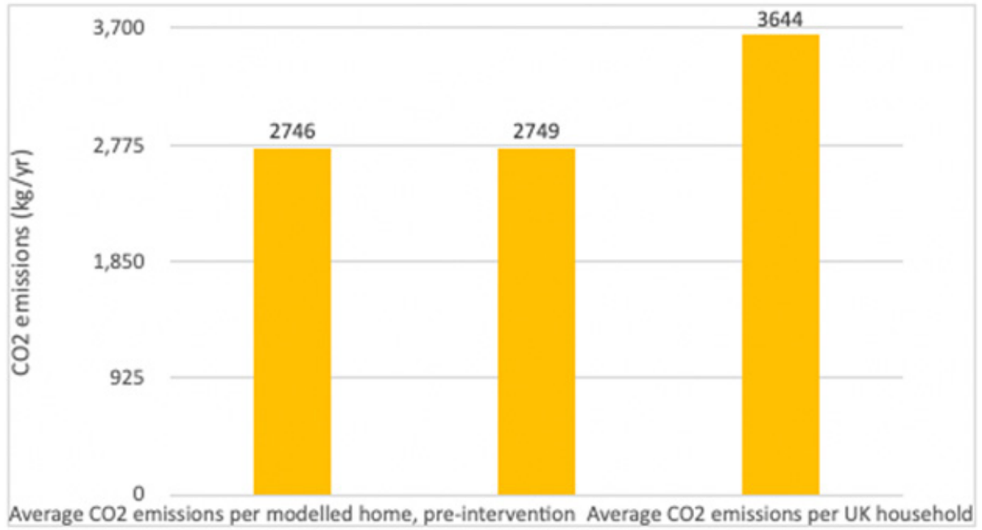

Figure 14: Comparison of the emissions produced by modelled homes and the average UK home.

4.3. Impacts of the WHF on carbon emissions and the environment

Lastly, the energy modelling analysis shows almost no change in carbon emissions from the WHF programmes' modelled interventions. **Average CO2 emissions per home across all modelled homes increased by a negligible sum of 3 kg/yr, from 2,746 kg/yr to 2,749 kg/yr.** This can be explained by the balance of measures installed through the WHF. The majority of heating systems installed through the WHF replaced electrically powered systems, predominantly room heaters and storage heaters. The new heating systems themselves were predominantly gas boilers. In recent years the electricity grid has rapidly decarbonised, and electrical systems therefore emit less carbon than gas systems. Indeed, it is only due to the match-funded installation of extra insulation measures in WHF beneficiary homes, and a sizable number of heat pump installations (3,012 in total in the modelled dataset), that modelled average CO2 emissions per home have not risen more substantially. **It should however be noted that 2,749 kg/yr of carbon emissions is still substantially lower than the emissions produced by the average UK household, which are estimated to be 3,644 kg/yr (see Figure 14 below).**[14]

Geographical disaggregation of these findings show that some Local Authority Districts have experienced significant total emissions reductions; especially districts in receipt of Category 2 funding for improvements to rural homes, and where significant energy efficiency improvements have also been made (e.g. East Riding of Yorkshire, Northumberland, and Argyll and Bute). In parallel, major urban conurbations in receipt of Category 1 funding witnessed the greatest increases in CO2 emissions, again due to the predominance of gas central heating installations in urban homes and communities (e.g. in Leeds, Liverpool and Leicester). However, median differences in in CO2 emissions per year were more geographically varied, only reducing post-improvement in 57 districts.

Changes in CO2 emissions post-improvement illustrate some tension between reducing fuel poverty and decarbonising the building stock. Whilst efforts to decarbonise housing and energy supply can be conducive to reducing fuel poverty, this is not always the case. However, fuel poverty is driven primarily by running costs and not carbon, and it should be remembered that in the findings presented in Section 3, Category 1 (i.e. first-time gas central heating installations) had a consistently larger impact than other WHF interventions. Accordingly, the expenditure and investment in first-time gas central heating systems as a means of tackling fuel poverty is not without merit or impact, and the evaluation notes that a follow-on phase of the WHF focuses exclusively on low-carbon heating solutions, thus reflecting a desire to reduce CO2 emissions and fuel poverty simultaneously.

21. This figure is calculated from UK Government (2022) UK local authority and regional greenhouse gas emissions national statistics, 2005–2020. According to this data, 90,739 kt CO2e was the combined total of emissions produced by UK homes in 2020. Assuming there are 24.9mn homes across the country, this results in a figure of 3,644 kg/yr of CO2 on average.

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