

Warm Home Prescription® Insights and Impact Report

July 2024



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This report was authored by Anna Seaton-O’Connor, Rebecca Wilkes, Irene Garcia, Dr Rose Chard and Becky Sweeney in July 2024 as part of the Energy Systems Catapult’s Warm Home Prescription GB wide trial 2022-2024, funded by bp.

This work would not have been possible without the time and effort of residents that received Warm Home Prescription across England and Scotland and the energy installation partners who carried out the home energy improvements for the trial (Changeworks and AgilityEco).



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Executive summary

In winter 2022/23, Warm Home Prescription® (WHP) offered people with illnesses made worse by the cold a credit on their energy account which delivered the immediate impact of a warm home, raising the importance of achieving healthy temperatures and opening the door to a longer-term solution of warmth through energy efficiency and low carbon heating improvements. In summer 2023 a WHP of home energy improvements was offered to homeowners in Aberdeen and Teesside who had previously received energy account credit in 2022/23. 166 householders were initially interested in taking part and 92 of those ended up having home energy improvements.

Our evaluation found that WHP successfully started people on their retrofit journey with over half the sample of this group achieving healthy temperatures¹ this winter. Feedback on the service continues to be positive, and WHP provides householders with positive outcomes for health and well-being.

Our key findings from winter 2023/24 are:

- People understand that achieving healthy temperatures is important because of the impact of experiencing a warm home outcome with a WHP of credit last year. Home energy improvements gave people confidence they would achieve healthy temperatures this year and 81% thought they did at the end of the winter.
- Where people intentionally reduced their heat use to control costs, they reported reducing the number of heating hours rather than the temperature.
- From the available sample (n = 68), just over half of people that had home energy improvements achieved healthy temperatures above 18 degrees Celsius for most of the time.
- Most of that sample of people did not put their health at extreme risk, as temperatures above 16 degrees Celsius were achieved almost all the time.
- Of the same sample above (n=68), half of them achieved healthy temperatures across both winters (phase 1, 2022/23 and phase 2, 2023/24).
- Some people weren't clear up front on what measures they would receive and therefore what the benefits would be, which prevented some from taking up the offer.
- Controls that are easy to use and make it easy to understand temperatures in different rooms are important to people and could drive uptake of WHP and help them achieve healthy temperatures with confidence.

¹ Public Health England (2014) Minimum home temperature thresholds for health in winter

1. Introduction

Warm Home Prescription (WHP) finds people with health conditions made worse by the cold and prescribes them with a warm home by giving them immediate and effective support. This can be through energy credits or home energy improvements. The energy sector has the knowledge to make the changes needed to provide a warm home. However, it can be difficult to identify low income and vulnerable people as many do not recognise themselves as vulnerable. WHP partnered with different parts of the NHS such as social prescribers and public health teams who are best placed to identify and make a referral. Vulnerable people with health conditions are often in and out of hospital therefore their needs must be designed into the service.

In July 2023 WHP offered home energy improvements to 364 homeowners across two areas (Aberdeen in Scotland and Teesside in England). The home improvements offered were designed to reduce the energy consumption needed to achieve healthy temperatures. Those offered the service had previously received an energy credit from WHP in 2022/23 (details below). The experience and outcomes of those receiving home energy improvements were monitored over the winter of 2023/24. This evaluation seeks to answer several questions on the benefits of implementing home energy improvements to deliver a warm home, including the heating behaviour of recipients, and how the retrofit offer could be improved to increase consumer uptake. Where appropriate, it also compares participant experiences to the previous winter (2022/23).

Winter 2022/23: Energy Credits

In winter 2022/23, participants were offered energy credits to cover the cost of their heating bill and help them maintain healthier temperatures at home.

At the end of the winter, participants valued heat more and were more willing to consider home energy improvements in their home.

Residents that went on to have home energy improvements from the original WHP 2022/23 cohort. ²

Winter 2022/23	(Phase 1) Homeowner and private rental/social housing residents receive WHP as credit: 823 residents
July 2023	(Phase 2) Homeowner residents offered home energy improvements: 364 residents
	(Phase 2) Those that responded to the home energy improvements offer: 166 residents
Autumn 2023	Those that had improvements completed: 92 residents

² Not to scale

2. Background and methodology

Background

The winter 2023/24 trial offered homeowners who received a WHP of energy credits in winter 2022/23 a WHP focused on improving the energy efficiency of their house via a 'free warm home tune-up'. This was a full check and service of their heating system to make sure it was running as efficiently as possible. Where appropriate, the service also updated their heating controls.

The check of the heating system will have included some of the following things:

- A boiler service for gas central heating, including any parts needed.
- A clean-out of the heating system so it's working smoothly.
- New wireless heating controls to make it easier to set our recommended safe range of 18 - 21°C.
- Replacing radiator valves to enable more tailored temperature settings.
- Upgrading any old radiators to more efficient ones.

After an initial conversation with an installation manager, 166 interested householders across Aberdeen and Teesside were offered a check of their heating system and depending on their home and set up, insulation upgrades, solar panels and/or an air source heat pump. 92 took up the offer to have home energy improvements.

The range of home energy improvements were categorised into five groups with the majority being offered a 'heating tune-up' (a check of their heating system) including several of the improvements above. A smaller number of householders were offered insulation measures and an air source heat pump. The fitting of air source heat pumps was only deemed beneficial for homes that hadn't recently had new gas boilers fitted.

Further details of uptake of home energy improvements can be found in appendix 5.3.

Methodology overview

Research was carried out with participants (those who took up the offer of a WHP of home energy improvements) and non-participants (those who declined to take up the offer).

Surveys were sent to participants at the beginning and end of the trial. The number of surveys received back were:

n = 81 beginning of trial

n = 71 end of trial

Surveys were sent to non-participants at the beginning and end of the trial. The number of surveys received back were:

n = 55 beginning of trial

n = 196 end of trial

Temperature loggers were issued to participants and non-participants (a total of 155 sent). The number of loggers received back were:

n = 68 participants

n = 34 non-participants

Qualitative interviews were conducted at various points in the customer journey.

3 rounds of n = 8 x 30-minute phone calls with residents

3 rounds of n = 2 x 30-minute phone calls with IMTs (Installation Management Team)

Qualitative interviews were also conducted with non-participants:

n = 12

The sample varied across research activities depending on the project and participant needs. The exact number of responses per survey question varies as respondents were not forced to answer. For further in-depth detail on the methodology please see Appendix 5.2.

Participants: Those who registered interest in the offer and went on to have home energy improvements.

Non-Participants: A mix of those who replied back to the offer to decline and those who replied back to register interest but later declined.

3. Evaluation outcomes

Mental health and wellbeing were maintained throughout this winter and further analysis suggests that the intervention positively impacted mental health.

The survey asked some general questions around health and results suggest that mental health and wellbeing were maintained throughout this winter with approximately half the sample having excellent, good or very good mental health, including their mood and their ability to think.

Further analysis suggests that peace of mind was the most reported benefit of receiving a WHP of home energy improvements and some people perceived that the service reduced the risk that their boiler might break down, that dangerous faults would go undetected, and that damp and mould (which affects respiratory health) would be reduced. Achieving a warmer home and saving people money were the next most important benefits. This suggests that **WHP continues to provide value which has a positive impact on people's mental wellbeing and that some people perceived that it had made their home warmer.**



35%

Peace of mind



14%

Warmer home



10%

Saving money

Winter 2023/24 Survey 2_Q3. What benefits do you think there have been from having a Warm Home Prescription boiler service or home energy improvements?

Base: n=77 participants receiving WHP interventions in 2023/24

People also felt hopeful going into winter that home energy improvements would improve the efficiency of their heating system resulting in a warmer home environment which would improve their health and wellbeing.

Those that had a home visit from an installation manager but then declined the offer of home energy improvements, talked positively about the reassurance they felt because an expert had assessed their house by giving it a 'WHP Health Check'.

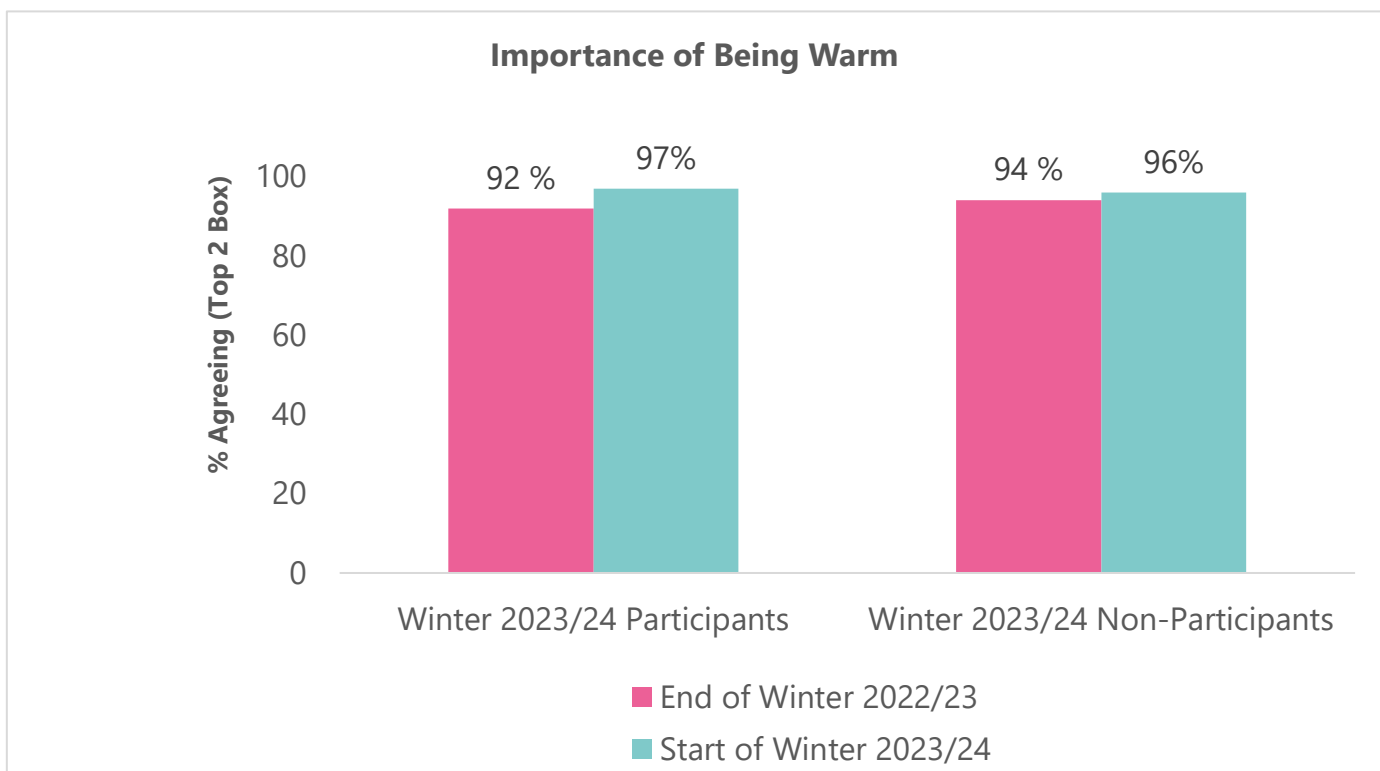
Qualitative interviews with both those that accepted home energy improvements and those that didn't, suggested that being empowered to control and monitor heating was

important. People who have smart home technology highly value it because it makes them feel more in control of their costs and reassures them that their heating system is working. People told us that it helped them to focus on the outcome of achieving healthy temperatures but also being able to manage cost.

People understand that achieving healthy temperatures is important because of the impact of experiencing a warm home outcome with a WHP of credit last year. Home energy improvements gave people confidence they would achieve healthy temperatures this year and the majority thought they did at the end of winter.

Our evaluation suggests that WHP can raise awareness of the importance of the value of achieving healthy temperatures for people with illnesses made worse by the cold.

Most people in the sample that had home energy improvements this winter 2023/24 told us that they valued a warm home more at the end of winter 2022/23 after their WHP of energy credit. This group then told us that they continue to value a warm home at the beginning of winter this year 2023/24.



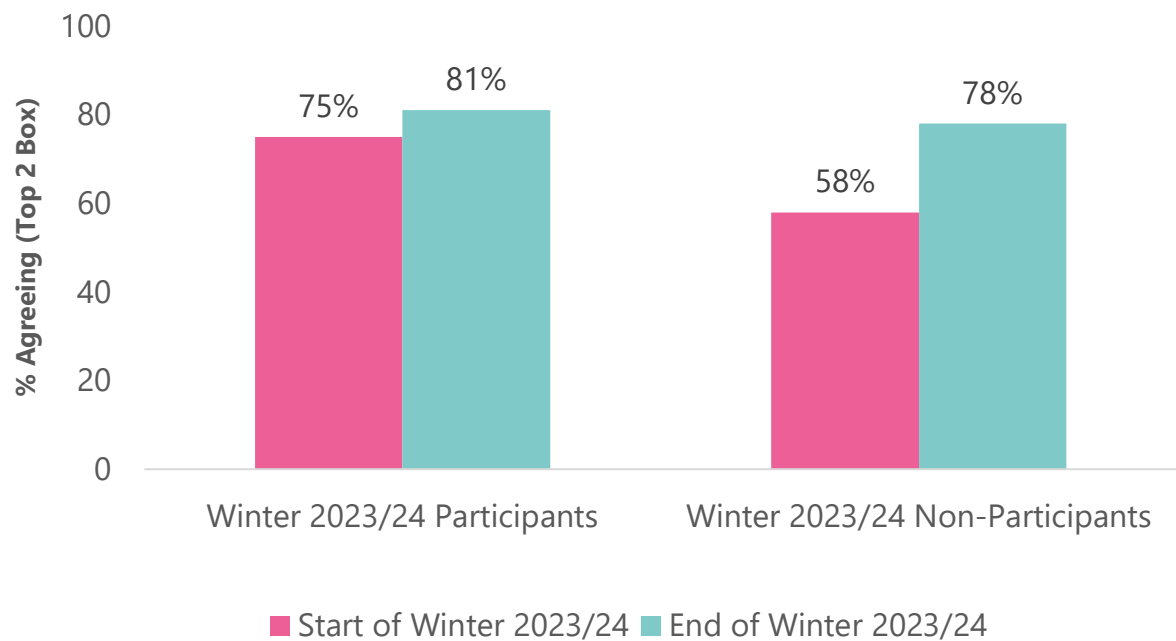
Winter 2022/23 Survey 2_Q55: To what extent do you agree or disagree with the following statements: Being warm is more important to me than before? (5-point agreement scale)

Winter 2023/24 Survey 2_Q3: To what extent do you agree or disagree with the following statements: Being warm in my home is important to me? (5-point agreement scale)

Base: Participants replying to both surveys: n=71. Non-participant replying to both surveys: n=49.

Both groups who either did or didn't have a WHP of home energy improvements this year told us that they were confident they would achieve healthy temperatures going into winter. Confidence that healthy temperatures had been achieved throughout winter was even higher.

Confidence in achieving healthy temperatures



When people are less likely to be confident about heating to healthy temperatures and/or for as many hours as they wanted both before and after winter, the key reason is that they are worried about the cost of energy. Many people that didn't have home energy improvements were also worried about how to use and understand their heating controls.

At the end of winter, most people thought they had achieved healthy temperatures. This is an interesting finding because it suggests that the message being presented by the WHP service about the importance of achieving healthy temperatures is getting through to and resonating with both groups. However, the real insight will come when the temperature logger data is used to understand whether people did achieve healthy temperatures during the winter 2023/24, as discussed in page 10.

Where people intentionally reduced their heat use to control costs, they reported reducing the number of heating hours rather than the temperature.

Whether someone thinks they achieved healthy temperatures doesn't necessarily tell us whether they actually felt warm. Whilst over three quarters of people who had home energy improvements told us they achieved healthy temperatures, only two thirds of people said they had felt comfortably warm this winter and about half told us they heated as many hours as they wanted. This suggests that **feeling comfortably warm could depend on heating as many hours as people want**, not just achieving healthy temperatures, and that there are barriers preventing people from achieving this, with 63% of people citing cost as the main reason. Further qualitative research also suggests that people are concerned about not being able to control and monitor their heating suggesting that when they are worried about cost, they reduce the hours they heat rather than the temperature they are heating to.



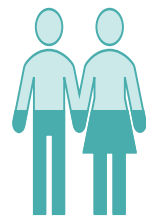
81%

Report achieving
healthy temperatures



64%

Comfortably warm
this winter



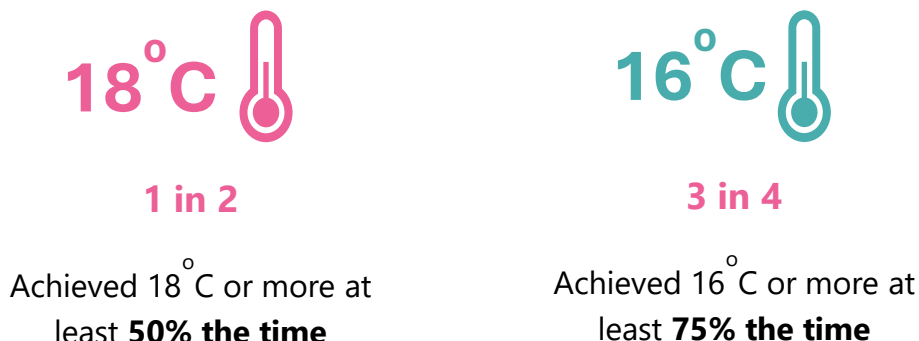
49%

Heated as many
hours as they wanted

Winter 2023/24 survey 2_Q1 & Q2: To what extent do you agree or disagree with the following statements: I heated my home to healthy temperatures (18-21 degrees) this winter / I was normally able to keep warm in my living room this winter / I was able to heat my home for as many hours as I wanted this winter (5-point agreement scale)

Base: n=77 participants receiving WHP interventions in 2023/24

From the available sample of people who had home energy improvements (n = 68), over half of them achieved healthy temperatures above 18 degrees Celsius for most of the time.



Source: Temperature logger data from participants receiving WHP interventions in 2023/24

Base: n=68 participants

The available temperature logger data for this group of participants showed that 53% of them achieved healthy temperatures above 18 degrees Celsius most of the time. This is lower than people's intentions going into winter and their perceptions at the end of winter. It is, however, closer to their perception of whether they felt comfortably warm and whether they heated as many hours as they wanted.

While the analysis of the temperature logger data is key to understand whether participants achieved the healthy temperatures they aimed for, there are some caveats to consider. Firstly, the size of the sample used is relatively small, hence significance is compromised. In addition, the actual location of the temperature loggers, both in terms of room of the house and position within the rooms, was unknown, so data of the two loggers had to be combined. This analysis also assumed that loggers were located in the bedroom and main living space and that they were not relocated over the winter.

Most people did not put their health at extreme risk over winter 2023/24.

While around half of that sample achieved temperatures above 18 degrees Celsius most of the time, three quarters kept the rooms at temperatures above 16 degrees Celsius almost all the time. Achieving temperatures between 16 degrees Celsius and 18 degrees Celsius can lead to discomfort and smaller health risks, however it is reassuring that most people did not put their health at extreme risk during this trial.

Of the same sample above (n=68), half of them achieved healthy temperatures across both winters (phase 1, 2022/23 and phase 2, 2023/24).

The analysis traced the same group of people who received energy credit in 2022/23 that went on to have home energy improvements in 2023/24 to see whether they achieved healthy temperatures across both winters with two different interventions.

Analysis of the temperature logger data was carried out to measure both the percentage change in the time spent above 18 degrees Celsius and the shift in the temperature profiles between winter 2022/23 and winter 2023/24 for this sample of participants.

Whilst there has been a significant shift towards colder temperatures from one winter to the next for two thirds of this group (i.e., for 44 participants), still half of them achieved healthy temperatures most of the time in both winters.

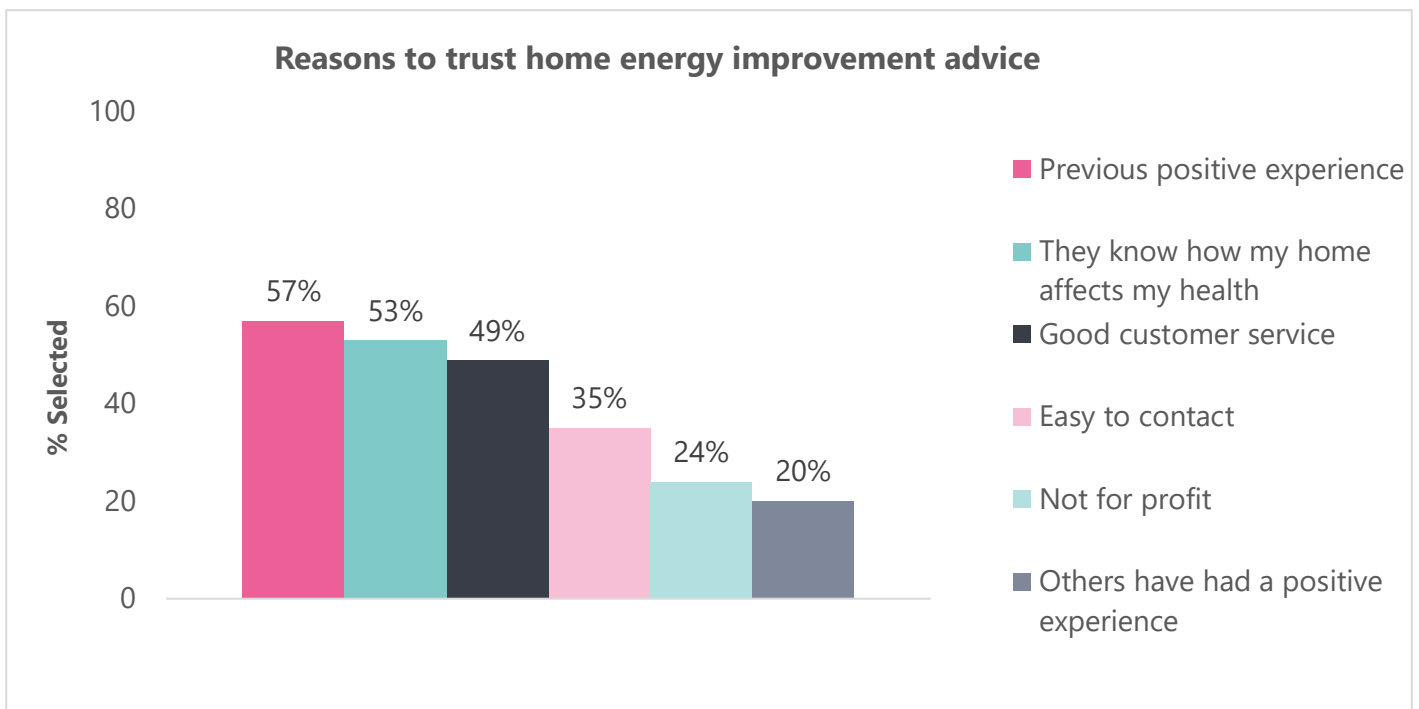
As for the remaining third of the group, almost all of them (18 participants) showed a significant shift towards warmer temperatures between winter 2022/23 and winter 2023/24, with most of them achieving healthy temperatures this winter.

Therefore, even though the interventions implemented in the two WHP trials were different, the analysis of this data suggests that half the sample achieved a warm home outcome both winters. Caveats and limitations associated to this data still stand and are the same as those explained earlier and in appendix 5.2.

Some people weren't clear up front on what measures they would receive and therefore what the benefits would be, which prevented some from taking up the offer.

Recall of WHP was high and people spoke positively about the service based on their experiences receiving credit last year. People talked about trust in the service because of a) the referral from the NHS and b) that WHP had delivered them a warm home outcome and saved them money last year. Those that had a home visit before they opted out also appreciated the reassurance of what they called a 'WHP Health Check' on their heating system.

In the group that decided not to have home energy improvements, the top 3 reasons for them to trust organisations to give them energy advice are: having had a positive experience of them myself (selected by 57% of the respondents), they know how it affects my health (53%) and customer service (49%).



Winter 2023/24 Survey 1_Q3. What are the 3 most important reasons for you to trust organizations to give advice about home energy improvements?

Base: n=55 non-participants (opting out of WHP interventions) in 2023/24

Qualitative interviews with those that did have home energy improvements confirm that the installer/organisation understanding how their home affects their health is very important which some participants believed they had benefited from during the service. Good customer service and communication are also key reasons for trust and much of this was based on people's experience of WHP last year. **This suggests that WHP aligns with what is important to people from a service that delivers home energy improvements and that when people declined the offer it was not because of a lack of trust in the service but because of other barriers.**

Some people weren't motivated to take up the offer this year because the benefits weren't clear up front and some of those benefits didn't resonate with this group. This was partly because some people thought they had done all necessary home energy improvements either themselves or via local retrofit grants. Many of those we interviewed that decided not to have home energy improvements did so because they already had a boiler service contract in place through an energy supplier or local contractor who had been providing the service for many years. At this point after receiving an initial offer letter, a householder would not have known there was potential to have more than a check of their heating system and they were therefore more inclined to stay with their existing provider.

Many people would have liked more information on what could have been available to them at the start of the customer journey. This includes information about smart technology (thermostats, meters, radiator valves) and low-carbon technology (solar panels, batteries and air source heat pumps).

Many people who accepted the offer this year told us in the survey at the beginning of winter that they hoped the home energy improvements would benefit them for a long time but for some people they struggled to visualise the long-term cost benefits as there is no immediate impact compared to last year's energy credits. Many of the householders interviewed were elderly and didn't see the point in what was perceived as 'a costly and disruptive process' for little immediate return despite many experiencing little disruption with previous home energy improvements.

Controls that are easy to use and make it easy to understand temperatures in different rooms are important to people and could drive uptake of WHP and help people achieve healthy temperatures with confidence.

The surveys suggested that after cost, the main concerns among people who did not take up the offer of home energy improvements were struggling to understand and use heating controls. This aligns with the qualitative research suggesting that feeling empowered to control and monitor usage and temperatures is important to people.



84%

Worried about
energy bills



18%

Struggle to understand
heating controls



18%

Struggle to use
heating controls

Winter 2023/24 Survey 1_Q2. Which of the following statements apply to you: I am very worried about the cost of my energy bills / I struggle to understand my heating controls / I struggle to use my heating controls.

Base: n=55 non-participants (opting out of WHP interventions) in 2023/24

People who do have smart home technology highly value it because it makes them feel more in control of their costs and reassures them that they are achieving healthy temperatures. Those people that have smart meters liked being able to monitor how much energy they had used. Some people mentioned how useful they found the temperatures loggers given to them and said they liked being able to monitor the temperatures because it reassured them that they were achieving healthy temperatures. **This is because many people said they wanted to reduce costs but not to the extent that they compromise achieving healthy temperatures.** This aligns with the finding that where cost was an issue, people were more likely not to heat as many hours as they wanted, in preference for achieving healthy temperatures.

Some people would have liked more information about smart home technology at the beginning of the customer journey. However, people who don't have smart home technology are scared it will be too complicated. There is therefore an opportunity to focus more on this part of the retrofit process early in the customer journey. If the intervention can overcome people's fears and show them how easily they can control and monitor temperatures using smart technology, this could improve uptake of the service and ensure that people achieve healthy temperatures.

4. Conclusion

Phase 2 of WHP delivered home energy improvements during winter 2023/24 to homeowners who had received an energy credit last year in winter 2022/23.

Take up of the service saw just over half of people who registered interest receiving a range of improvements. The majority received a boiler service and check of their heating system with a smaller number receiving insulation and/or low carbon technology. The fitting of air source heat pumps was only deemed beneficial for homes that hadn't recently had new gas boilers fitted. Consequently, the full impact of the potential for retrofit to improve the energy efficiency of homes and deliver a warm home outcome has yet to be felt by most at this stage.

This could be a key reason why a smaller percentage of the group that received energy credit in winter 2022/23 achieved healthy temperatures in winter 2023/24 with home energy improvements, although there are also some caveats when interpreting the temperature logger data. However, over half of people this year achieved healthy temperatures for most of the time, and most of them did not put their health at risk during winter 2023/24. Many have also reported a positive impact on mental health because they felt less anxious due to the boiler service and check of their heating system.

The service is trusted and viewed positively by both those that took up the service this year and those that didn't. The delivery of a warm home outcome in phase 1 winter 2022/23, combined with good customer service and the credibility of the NHS as a partner has been a key influencer in take up this year.

For those that didn't take up the offer this year, barriers included age, possible disruption and the perception that they have had all home energy improvements completed. Not having the information on what they might be offered and the benefits up front also played a part. Whilst cost remains a barrier to achieving healthy temperatures and heating as much as people want, other key concerns are struggling to use and understand heating controls and many people are seeking the ability to monitor their heating, so they feel in control of their surroundings.

It can be argued that for many people, this is just the first step on their retrofit journey and the outcome has been positive with many people citing that their boiler service and heating system check has provided them with reassurance and peace of mind.

There is an opportunity early in the customer journey to address people's fears of low carbon technology by introducing them slowly to smart technology, for example, to help them monitor the temperature in different rooms so they are certain they achieve the temperatures they want. Combining this with more information up front on the long-term potential benefits of low carbon technology could help drive future uptake.

5. Appendix

5.1 Objectives

Energy Systems Catapult conducted research during the winter trial of WHP in 2023/24, to understand:

1. Whether WHP has a lasting effect on the value and perception of warmth and achieving healthy temperatures at home.
2. If home energy improvements allowed recipients to achieve a warm home outcome and the impact on recipients reported health and wellbeing.
3. Why people rejected the offer of retrofit to inform where uptake could be increased.
4. Whether and how WHP this year is valued as a service to better enable people to achieve a warmer and more carbon neutral home and what constitutes a 'trusted organisation'.

The research questions to support the trial objectives were organised as follows:

Has the ability to heat to healthy temperatures changed since receiving a WHP? (either in winter 2022/23 or 2023/24)

Understand if people heated as much as they want

Understand if people achieved healthy temperatures

Understand if people felt warm or not

Understand why people were not normally able to keep warm in their living room this winter after home energy improvements were installed

Understand why people who rejected the offer of home energy improvements did not achieve healthy temperatures or for as many hours as they wanted

How could the offer of retrofit measures be improved to increase consumer uptake?

Understand what people expected from the home energy improvements

Understand why people did not take up home energy improvements

Understand why people who rejected the offer of home energy

improvements trust certain organisations to offer them home improvements

How has WHP support impacted people's health and wellbeing in winter 2023/24?

Understand whether physical and mental health were positively affected

5.2 Methodology

Qualitative

Qualitative telephone interviews were carried out to understand people's experiences of WHP. Three rounds were conducted and each round took place after a key step in the WHP service. This included both people who accepted the offer and people who opted out at different points in the process.

Round 1 evaluated the initial offer communications. It included:

- n = 8 x 30 minute phone calls with residents who had expressed an interest in the service to understand their experience and the home energy improvements they are expecting
- n = 2 x 30 minute phone calls with IMTs (Installation Management Team responsible for sourcing and managing the installers who were making the home energy improvement changes. Including quality assurance assessment)

Round 2 followed the technical survey home visit. It included:

- n = 8 x 30 minutes phone calls with residents who had expressed an interest in the service to understand their experience and drivers for final home energy improvements selected
- n = 2 x 30 minutes phone calls with IMTs per area

Round 3 followed the installation of any home energy improvements and/or boiler servicing. It included:

- n = 8 x 30 minutes phone calls with residents
- n = 2 x 30 minutes phone calls with IMTs per area

To understand barriers to uptake of the service an additional n = 12 qualitative interviews were carried out in the middle of winter (January 2024) with householders who had declined a WHP of home energy improvements. 3 of these were householders who turned down the offer at the initial letter stage and 9 turned down the offer after a home visit/phone call from an energy advisor.

Quantitative

To understand the impact of WHP on the ability of householders to achieve healthy temperatures, health and wellbeing, and trust in organisations to deliver home energy improvements; two quantitative postal surveys were sent to householders taking part in the service. One survey was sent at the beginning of the service and one at the end. Both achieved a high response rate of 85%, with 81 people completing the first survey and 77 completing the second. The same closing quantitative postal survey was also sent to

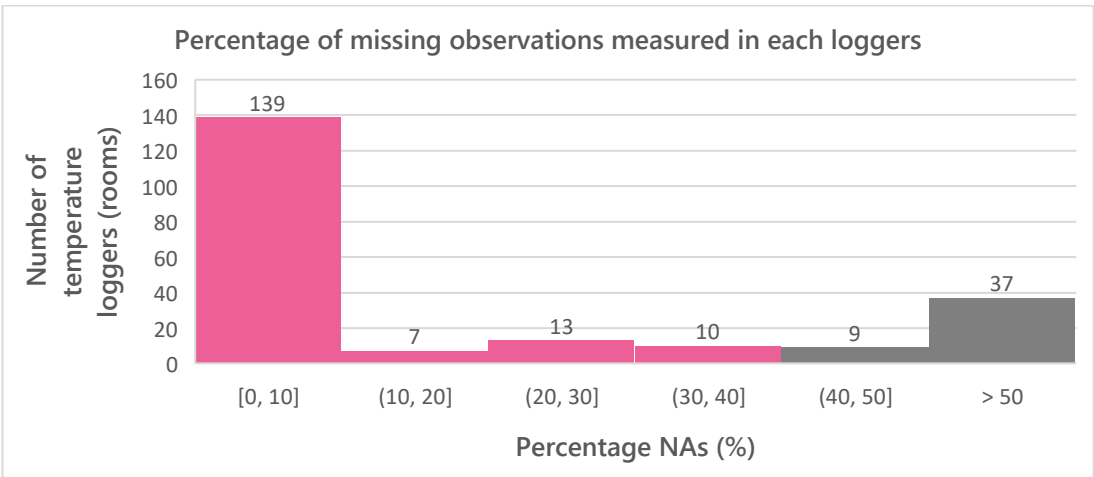
householders who had not either taken part this year or been offered the service (those participants from Phase 1 winter 2022/23 that live in rented accommodation were not included in the phase 2 offer this year 2023/24). 196 people responded, 43% of those invited to take part.

Both participants and those who did not take up the WHP offer this winter were also sent temperature loggers to understand the ‘real world’ impact of WHP this winter. Recipients were asked to put a logger in their main living space and in their bedroom to record the temperatures in those rooms. 68 people who took up the service this winter returned their temperature loggers, along with 34 people who had chosen not to take part.

Temperature Logger Analysis:

The data from all the temperature loggers received was first mined to determine its quality. While last year the loggers’ data recorded temperature values every 30 min, this year some of the loggers had a large percentage of missing values, i.e., entries with no temperature recorded. After a preliminary cleaning process, the whole data from loggers with more than 40% of missing observations was discarded.

Therefore, from the total number of 215 loggers received, corresponding to 114 individual households, 46 were discarded due to quality issues. The data from the 169 loggers kept (89% of the loggers received this winter) came from 102 different households. This constitutes 66% of the homes that received at least one temperature logger this year.



Distribution of percentage of missing observations (NA entries) measured in each of the 215-temperature loggers received in winter 2023/24.

This year the location of the loggers within a house could not be determined as labelling of the loggers was not done. This means that it was unknown whether the data from a logger came from the household’s bedroom or main living space. For this reason, the temperature data from the two loggers, when both were available, were combined and general statistics derived for each home calculated. To consistently compare the results

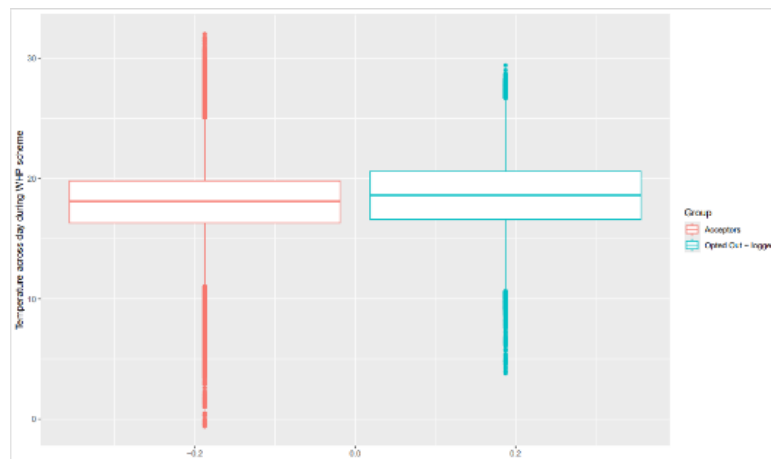
across the two winters, a similar approach was applied to the data from last winter 2022/23, even if the specific room where each logger was placed was known.

The final step of the data cleaning was to filter out any temperature values recorded before January 1 2024 and after March 31 2024. This timeframe ensures enough time for the loggers to arrive at people's houses and considers the same ending date as last winter's trial. It is important to indicate that over the two winters, the number of data points recorded for each household, i.e., number of days for which temperature data is available, is likely to differ as last winter the WHP service started on different days and months for each patient.

The table below summarises some of the descriptive statistics derived for each home across this and last winter WHP service, combining the data of both loggers when available:

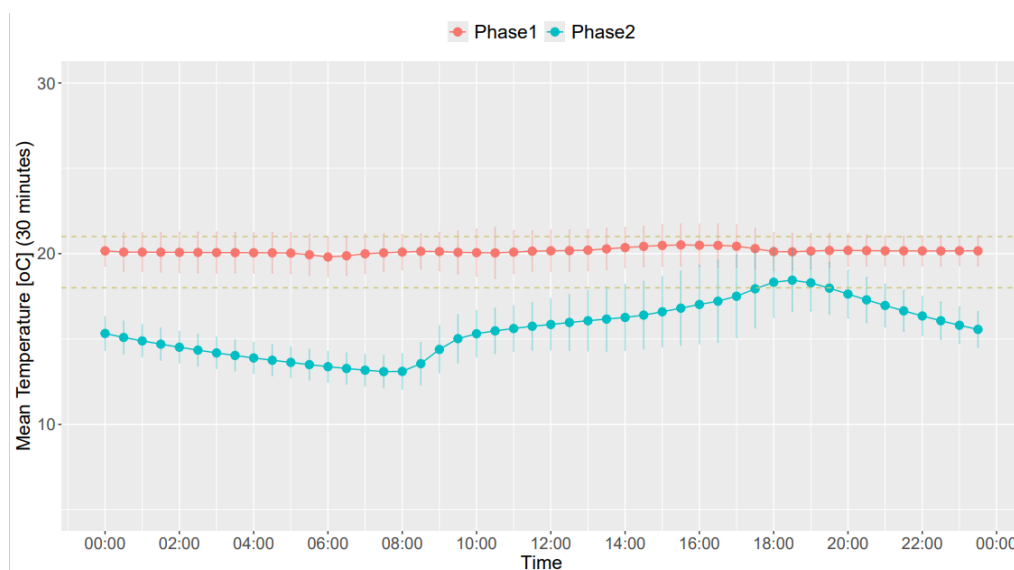
Metric	Definition
median	Median temperature recorded in the room across the WHP scheme (i.e., including only dates when it is likely for the loggers to reach the homes).
mean	Average temperature recorded in the room across the WHP scheme (i.e., including only dates when it is likely for the loggers to reach the homes).
standard deviation	Standard deviation of the temperature recorded in the room across the WHP scheme (i.e., including only dates when it is likely for the loggers to reach the homes).
minimum	Minimum temperature value recorded during the WHP scheme.
maximum	Maximum temperature value recorded during the WHP scheme.
quantile 25	First quantile value for the temperature recorded during the WHP scheme.
quantile 75	Same as above but for the third quantile
period (days)	Number of days covered by the WHP scheme
%age NaNs	Percentage of missing/NaN (Not a Number) observations
Number entries	Total number of non-NaN observations, i.e., recorded temperature values.
%age < 18 degrees Celsius	Percentage of time the room(s) were at temperatures below 18 degrees Celsius. This metric is based on total number of observations available, i.e., discarding faulty or NaN entries.
%age < 16 degrees Celsius	Percentage of time the room(s) were at temperatures below 16 degrees Celsius. This metric is based on total number of observations available, i.e., discarding faulty or NaN entries.
%age [17-22] degrees Celsius	Percentage of time room(s) were at temperatures between 17 and 22 degrees Celsius (both included). This metric is based on total number of observations available, i.e., discarding faulty or NaN entries.

Boxplots with the temperature distribution as a function of different metrics, such as group, period of the day or year in which data was collected, were generated for checking and testing reasons.



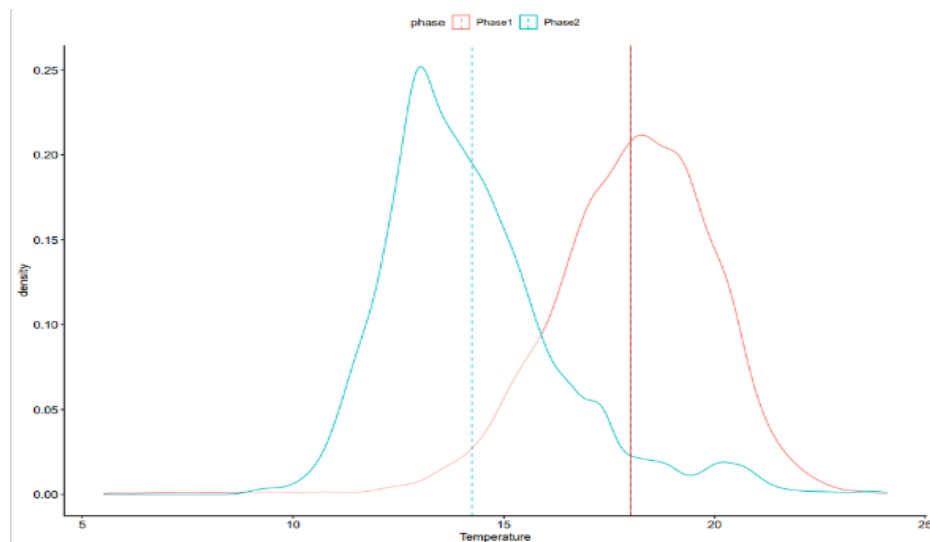
Boxplot showing the distribution of the temperature recorded across winter 2023/24 for two groups: homes that had energy home improvements (red) and for those who did not (blue).

In addition, for each home, a graph was produced plotting the average temperature for each 30 min block across a 24-hour day. The purpose was to create a daily average profile for each home and room, with error bars indicating the variability of the temperature recorded in each 30-min block. The purpose of the daily average temperature profile was to have a visual representation of the temperatures achieved across the day for each person and in each room across the WHP service. The comparison of these profiles could be used to visually inspect differences in average temperature achieved across the day.



Average temperature profile derived for each 30-min block across the day for a specific household and covering the whole WHP service. The error bars are the standard deviation of each data point (measure of variability across the service) and the dotted yellow lines the healthy temperature ranges (i.e., 18- and 21-degree marks). When values recorded for the two phases/winters are compared, then the average combines the data from all the two loggers when available, i.e., from both rooms. In red the daily temperature profile for a household over winter 2022/23 ('Phase 1') and in blue the daily average profile for the same house recorded over winter 2023/24 ('Phase 2').

Density temperature profile plots were also generated at a home level and broken down by relevant metrics, i.e., whether they had, or they didn't have home energy improvements and whether the data was collected this year or last year. These plots are smoother versions of histograms showing the distribution of temperature recorded, but they have been normalised so the distribution of values could be compared even if the number of data points are different. The x-axis of these plots shows the range of temperature values recorded across the WHP service. The y-axis represents the number of data points registered in each temperature value, divided by the total number of points used (number of entries as per table above). The normalisation allows comparison of the temperature profiles within the same scale and therefore enables a visual inspection and check of whether there has been a shift towards warmer or cooler temperatures, for example from one winter to another. These graphs are used in combination with the non-parametric significance tests that explore whether the change in temperature recorded in a household is significantly different from across the two WHP interventions and if so, their direction (i.e., towards cooler or warmer temperatures).



Density temperature profile for a specific household across the WHP service. The x-axis indicates the value of the temperature recorded and the y-axis the number of observations reporting that temperature, normalised by the total number of non-NaN observations in each dataset. The density profiles combine the data from the two loggers when available, i.e., from both rooms. In red the daily temperature profile for a household over winter 2022/23 ('Phase1') and in blue the daily average profile for the same house recorded over winter 2023/24 ('Phase2').

Analysis Methodology

Survey and temperature logger Analysis:

Analysis of temperature logger data and surveys were carried out to answer several research questions.

1. Did people who had home energy improvements and people who didn't achieve healthy temperatures?

To determine whether people maintained healthy temperatures in their bedroom and living room, the data recorded by the temperature loggers between the start of January 2024 and end of March 2024 was analysed. After cleaning and exploring this data (see previous section), we considered that the percentage of time the loggers recorded temperatures below 18 degrees Celsius across the indicated period (metric '%age < 18 degrees Celsius' in table above) was a more appropriate proxy to determine whether households maintained healthy temperatures in those rooms than the average temperature. This is because the temperature data does not follow a normal distribution, which means that the average fails to represent the central values and tendency of the data. Once the percentage of time below 18 degrees Celsius was derived for each household combining the data from both rooms, when available, homes were classified into four main categories:

- 'Almost all the time reaching healthy temperatures' when percentage was less than 25% of the time;
- 'Most of the time reaching healthy temperatures' when percentage was between 25% (included) and 50% of the time;
- 'Rarely achieving healthy temperatures' when percentage was between 50% (included) and 75% of the time;
- 'Almost never' when percentage was equal or more than 75%.

The table below shows the total number of households in each of these categories for the whole sample and for the two groups separately, those that had home energy improvements and those who did not, together with the percentage they represented.

	Had energy improvements		DIDN'T have energy improvements		Total	
%age < 18 degrees Celsius	Number of homes	Column %age	Number of homes	Column %age	Number of homes	Column %age
1. Most of the time or almost all the time	36	52.9%	21	61.8%	57	55.9%
3. Rarely or almost never	32	47.1%	13	38.2%	45	44.1%
Grand Total	68	100.0%	34	100.0%	102	100.0%

2. Were people who had home energy improvements more likely to achieve healthy temperatures than those who didn't?

To answer this question, the metric described above was used, calculating the percentage of homes that fell within each of the four categories for each of the two groups compared, i.e., those who had home energy improvements and those who didn't. Then, a significance test for independent percentages was used to establish whether the percentages for each group were significantly different. No significant difference was found, mostly because the number of homes within each category were too small for the power of this test, even when the four categories were combined (example: '*Almost all the time reaching healthy temperatures*' and '*Most of the time reaching healthy temperatures*' were added up).

The non-parametric Wilcoxon rank test was also applied to determine whether the temperature profile of these two groups, those that had home energy improvements and those who did not, were significantly different (see example of a density temperature profile in previous section). For this, the data of all homes within each group was considered and combined in the test. The 'one-sided' and 'two-sided' hypothesis of the test determined whether the temperature profile of one of the groups shifted towards lower/higher temperatures, i.e., cooler/warmer temperature, compared to the temperature distribution of the other group. Even if the test suggests that the combined temperature profiles for the group that didn't have any home energy improvements significantly shifted toward warmer temperatures compared to that of the participant's group, it does not account for differences in the likelihood of achieving healthy temperatures, just the direction of change in temperature profile. Therefore, this result needs to be considered together with the outcomes from the analysis of the metric before, i.e., '%age < 18 degrees Celsius. Change of the temperature profile is significant, but the likelihood of achieving healthy temperatures cannot be significantly quantified.

3. Did those that didn't heat to healthy temperatures tell us they did/didn't heat to healthy temperatures?

A comparison of the results from Q1 with the coded values from this survey question "I heated my home to healthy temperatures (18-21 degrees Celsius) this winter" for both groups: those that had home energy improvements and those that didn't. This sample is made up of 61 households who had home energy improvements and only 16 who didn't.

4. For those that didn't heat to healthy temperatures what were the main barriers?

Analysis of the open-ended questions as follows by using a code framework to create a summary table of the percentages of the group that cited each answer.

- For those that had home energy improvements that disagreed with the statement “I was normally able to keep comfortably warm in my living room
- For those that didn’t have home energy improvements that disagreed with the statement “I heated my home to healthy temperatures”.

5. Are there some homes that only consistently reach a temperature of 16 degrees Celsius or less?

A similar metric used to that of Q1 was derived for all the homes over the same time period, but for the 16 degrees Celsius threshold (see table in previous section, metric: ‘%age < 16 degrees Celsius). Then, homes were classified into four categories depending on the value of the percentage of time the rooms recorded temperatures were below 16 degrees Celsius. These categories fall within the same range values as for metric in Q1. The total number of homes within each category, and the proportion they represented, was derived and presented in the table below. Both metrics, the one derived in this research question and that of Q1, were compared to people’s answers from survey 2 on perception of heating at healthy temperatures to provide a more comprehensive picture: people’s perceptions vs. actuals.

	Had energy improvements		DIDN'T have energy improvements		Total	
%age < 16 degrees Celsius	Number of homes	Column %age	Number of homes	Column %age	Number of homes	Column %age
1. Most of the time or almost all the time	58	85.3%*	28	82.4%	86	84.3%
3. Rarely or almost never	10	14.7%	6	17.6%	16	15.7%
Grand Total	68	100.0%	34	100.0%	102	100.0%

**Where 75% of the households that had home energy improvements reached temperatures above 16 degrees Celsius almost all the time.*

6. Did more people value a warm home at the beginning of winter phase 2 than the end of winter phase 1?

A comparison of the percentage of people who said they valued a warm home at the end of winter 2022/23 with the percentage of people who said they valued a warm home at the beginning of winter 2023/24 by identifying the same sample at a patient level from this year to compare to last year. This sample is made up of 120 homes who replied to both surveys: 71 households who had home energy improvements and 49 who didn’t.

7. Were most people who received home energy improvements able to keep comfortably warm?

The total percentage of participants who agreed or strongly agreed with the statement “I was normally able to keep comfortably warm in my living room” in the end survey of winter 2023/24 was 64%. This percentage is based on 77 responses.

8. Were people who received home improvements more likely to be confident to heat to healthy temperatures than as many hours as they wanted?

Comparison of total percentages of people who agreed and strongly agreed with the statement, “I am confident I will heat to healthy temperatures this winter” compared to total percentages of people who agreed and strongly agreed with the statement “I am confident I will heat as many hours as I want this winter” was made for the sample of 77 respondents who had home energy improvements this winter. These percentages are 81% and 49%, respectively, and they are significantly different.

9. Health questions were designed to be asked as a group of four to assess general health and were not attributed to the WHP intervention this year. Reported physical health scores declined throughout winter and there are many possible reasons for this. Mental health was however maintained as discussed in the main report and further analysis suggests that people attributed the positive impact of WHP to this.

Caveats and assumptions

There are some caveats to consider when interpreting the results using temperature logger data and assumptions that had to be made.

- *Caveats:* It is unknown where each of the two temperature loggers were placed, in terms of room of the house and position within the rooms, and how those locations compare to last winter.
- *Assumption:* The position of the loggers in winter 2023/24 is the same as that for winter 2022/23 and loggers were not relocated over the winters.

Therefore, due to these caveats and assumptions, confidence in the results is compromised and should not be used in isolation to determine final conclusions.

5.3 Offer take up by home energy improvement measure

6% of participants received low carbon technology and the majority had a boiler service and check of their heating system³.

L1	Heating tune-up	66
L2	Insulation upgrades	23
L3	Air Source Heat Pump (ASHP)	0
L4	ASHP and insulation	0
L5	ASHP, insulation, solar panels and battery	2

³ Figures correct as of 1st May

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Energy Systems Catapult

7th Floor, Cannon House
18 Priory Queensway
Birmingham
B4 6BS

es.catapult.org.uk

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