Report on the outcomes of

The C.H.E.E.S.E. Project

Covering Phase 3 (2017/18) and Phase 4 (2018/19)

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Contents

Executive Summary

The C.H.E.E.S.E (Cold Home Energy Efficiency Survey Experts) Project is a not-for-project community interest company (CIC) that aims to tackle both fuel poverty and climate change, by providing low-cost thermal-imaging surveys to make domestic heat losses visible.

This report examines customers feedback from surveys carried out in Phase 3 (2017-2018) and Phase 4 (2018-2019) of the project. The key findings by section are given below:

Remedial action

- 66% of households completed remedial action by one month after their survey.
- 87% of households completed remedial action by one year after their survey, showing that the vast majority of clients do take some form of action to improve the energy efficiency of their home.
- By one year after the survey, nearly ~50% of householders who paid for the survey reported having completed high cost remedial action (>£250) that will substantially improve the energy efficiency of their home.
- By one year after the survey, 85% of households said their home felt warmer after taking remedial action.

General feedback

- In general, the feedback was extremely positive. For the most recent season, 95%+ of householders agreed that the survey was good value for money and that they would recommend it to a friend or neighbour.
- The feedback scores for the most recent season (Phase 4) were higher than for the previous one (Phase 3), indicating clients had a more favourable view of the survey.
- By one month after the survey, around 50% of households reported changing their behaviour to maximise energy efficiency.

Energy consumption

Analysis of a small set of energy-consumption data, with data points before the survey, and one year after is included in an appendix. This analysis is intended to be illustrative of our data collection and methodology, but, because the sample size is too small given the variability of energy use in households, we do not draw any conclusions.

Introduction

The C.H.E.E.S.E Project was founded in 2015 with the aim to reduce domestic heat losses. Addressing inefficiencies in domestic heating is a key component in the UK's strategy to tackle climate change and to reduce fuel poverty. More than 1 in 10 UK homes are in fuel poverty[1] whilst the residential sector contributes 19% to UK total carbon emissions.[2]

A thermal imaging survey can show how energy moves around a home, and identifies areas where heat is being lost. This permits cost-effective, targeted remedial action that in turn can address both climate change and fuel poverty.

The unique low-cost C.H.E.E.S.E. survey protocol is as follows:

- A blower door consisting of a large fan fitted in a tarpaulin is sealed to an external doorway to reduce the internal air pressure by around 20 pascals. This setup mimics the effect of draughts caused by a steady breeze on the building.
- The specially trained Energy Tracer ™ (ET) thermally surveys all rooms of the interior with a bespoke combination of iPhone, FLIR thermal camera and Heatview™ software while the householder watches on a tablet computer linked by portable Wi-Fi.
- The entire survey is videoed and recorded, with audio of the surveyor's comments and householder's questions, onto the iPhone.
- The assistant ET completes a written and tick-box summary of the findings, which is given to the householder, photographed, and later uploaded by the ET to the C.H.E.E.S.E. database.
- Thermal photographs are also taken of significant faults.
- A memory-stick of the survey is given to the householder for them to review as they wish.
- The memory-stick is pre-loaded with digital data-sheets from the Centre for Sustainable Energy on methods for remedial action to save energy loss.

The C.H.E.E.S.E. Project successfully carried out 91 surveys in Phase 3 (2017-2018) and 115 in Phase 4 (2018-2019) across Bristol and nearby, mainly of domestic properties, but also of some community buildings. One month after the survey of the property, a representative from the project (usually the lead ET who conducted the survey) followed up with the householders to record the following information:

- Completed remedial action
- Planned remedial action
- Wellbeing changes
- Behavioural changes
- General feedback on the survey

[1] Annual Fuel Poverty Statistics in England, 2019 (2017 data).

[2] BEIS 2018 UK Greenhouse Gas emissions provisional figures (March 2019).

The project then followed up with households again after a year, to record further information on the following:

- Completed remedial action.
- Wellbeing changes.
- Behavioural changes.
- Changes in energy consumption (gas & electricity).

Geographic distribution of surveys

Phase 3

Phase 4

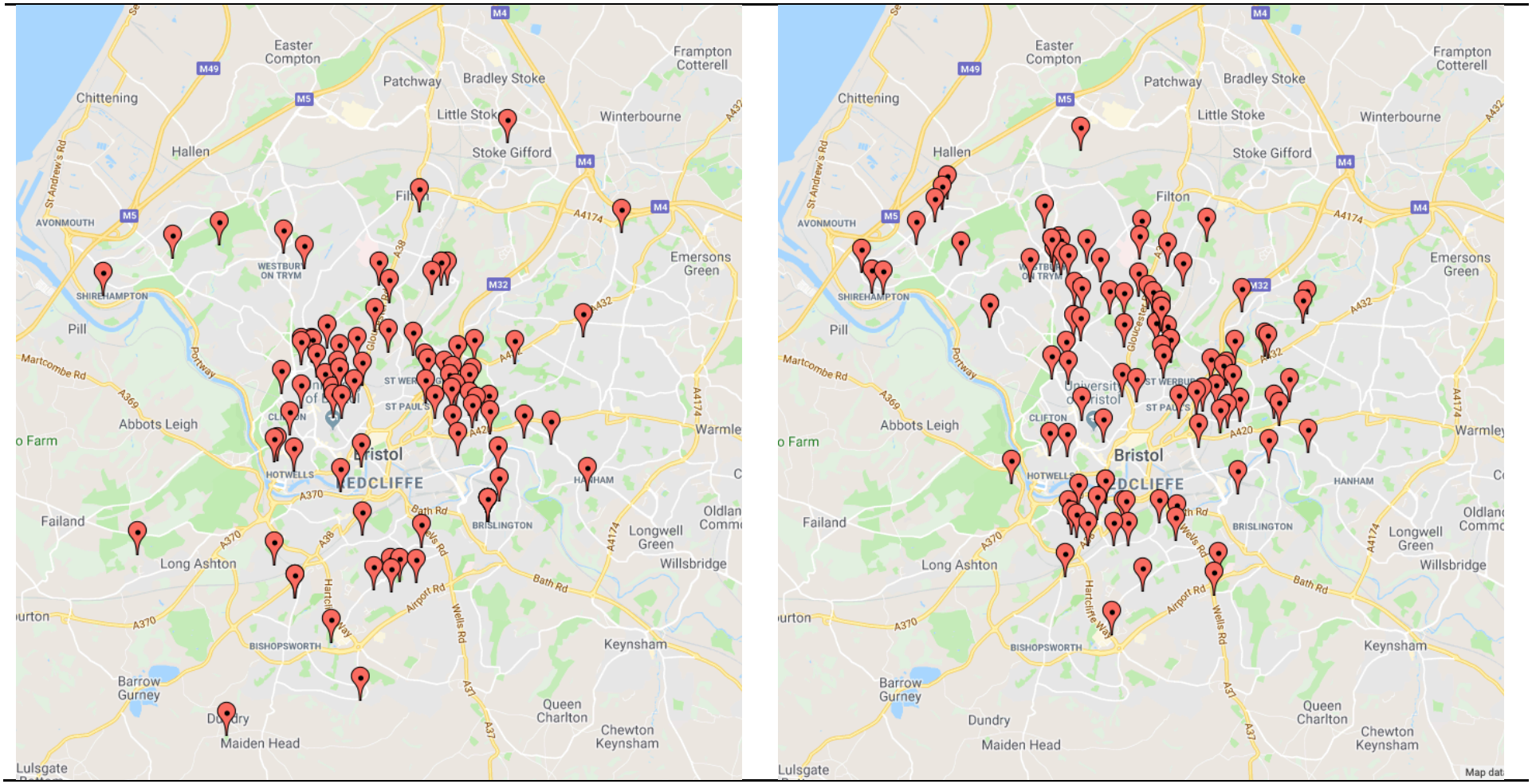

Figure 1: The survey locations for both Phase 3 & 4, fifteen surveys are excluded from the Phase 4 map (these were either on the outskirts of Bristol or in Bath/Swindon).

Phase 3		**Phase 4**	
Area	Frequency	Area	Frequency
Easton	18	Westbury-on-Trym and Henleaze	12
Filwood (Knowle West)	12	Easton	10
Cotham	9	Horfield	7
Clifton	7	Bedminster	6
Redland	7	Bishopston & Ashley Down	6
Bishopston & Ashley Down	4	Ashley	5
Central	3	Avonmouth & Lawrence Weston	5
Lockleaze	3	Windmill Hill	5
Ashley	2	Clifton	4
Avonmouth & Lawrence Weston	2	Eastville	4
Bishopsworth	3	Shirehampton	4
Brislington East	2	St George	4
Eastville	2	Redland	3
Westbury-on-Trym & Henleaze	2	Southville	3
Other	14	Bath*	2
		Bishopsworth	2
		Brislington West	2
		Filwood (Knowle West)	2
		Fishponds	2
		Knowle	2
		Long Ashton	2
		South Gloucestershire	2
		Stoke Bishop	2
		Stoke Gifford	2
		Swindon*	2
		Westbury Park	2
		Other	14

Table 1: The ward of each survey location in Phase 3 & 4, the 'Other' area combines all wards that had a frequency of 1. *Cities outside of Bristol are in bold.

Outline of the data used in this report

This report analyses outcomes over two years of the CHEESE Project:

- Phase 3 (2017/18), approximately one-month and one-year after a survey.
- Phase 4 (2018/19), approximately one month after a survey.

Free surveys were offered during both phases 3 and 4 to those on low incomes. In practise this usually meant those claiming benefits.

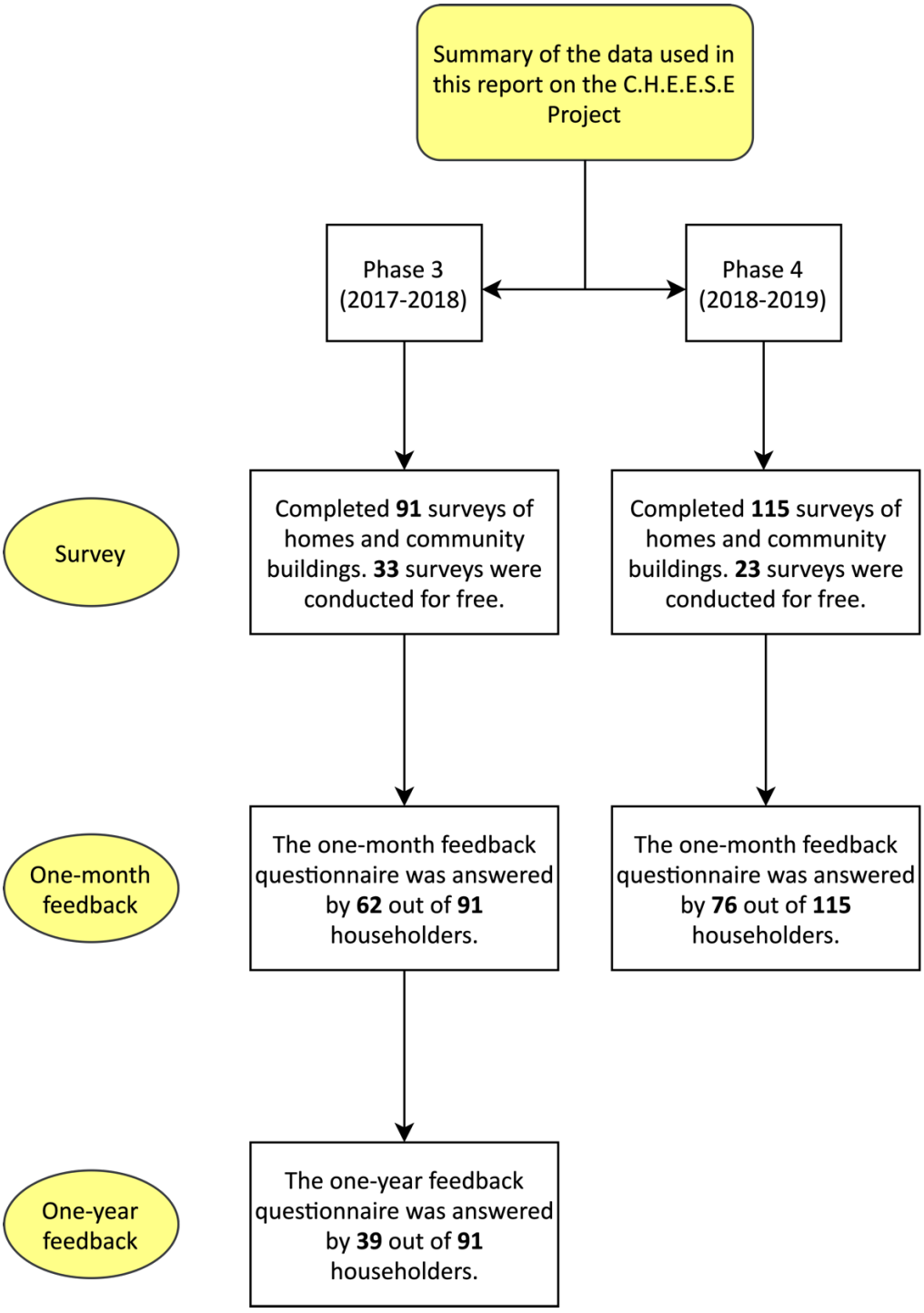

Figure 2: Flow chart detailing the structure of the data used in this report.

Remedial work analysis

Remedial actions are suggested to the householder during a survey conducted by the ETs. The table below outlines the overall figures from those who responded to the questionnaire for the number of households that *did* take remedial action within one-month and after one year from the date of the original survey.

Table 2 details the total number of householders completing any remedial action at each stage, with the key highlights being:

- The number of Phase 3 and Phase 4 householders who had completed remedial action at one-month was 66% (91/138).
- The figures for Phase 3 householders at one year demonstrated a strong outcome from the survey, with 87% (34/39) completing remedial action by this stage. This result suggests that the vast majority of C.H.E.E.S.E. clients do take action after the survey. In addition, two of the non-completing householders still had remedial action planned, but it had not been completed at this feedback stage.
- Householders who paid for the survey were more likely to complete remedial action but the difference between groups was relatively small, as a majority of householders who had the survey completed for free still took remedial action.
- Phase 4 showed a higher rate of remedial action completion rate at one-month than Phase 3 (71% compared to 60%).
- It is important to note that almost all (95%+) householders plan to take remedial action at the one-month feedback stage if they have not done so already.

<table>
<tr><th colspan="4">Phase 3</th><th colspan="2">Phase 4</th></tr>
<tr><td colspan="4">Households at 1 month
62 respondents (41 paid, 21 free)</td><td colspan="2">Households at 1 month
76 respondents (65 paid, 10 free)</td></tr>
<tr><td colspan="2">Paid
24/41
(59%)</td><td colspan="2">Free
13/21
(62%)</td><td>Paid
48/66
(73%)</td><td>Free
6/10
(60%)</td></tr>
<tr><td colspan="4">Additional households at 1 year</td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="2">Old respondents* (22 paid, 8 free)</td><td colspan="2">New respondents* (8 paid, 2 free)</td></tr>
<tr><td>Paid
19/21
(90%)</td><td>Free
8/8
(100%)</td><td>Paid
7/8
(88%)</td><td>Free
0/2
(0%)</td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="4">Total households after 1 year
72 respondents (49 paid, 23 free)</td></tr>
<tr><td colspan="2">Paid
37/49
(76%)</td><td colspan="2">Free
15/23
(65%)</td><td colspan="2"></td></tr>
</table>

Table 2: Details of the total number of households taking remedial action at each feedback stage. *'Old respondents' refers to households who responded to both the one-month and one-year feedback, while 'New respondents' refers to households who did not respond to the one-month survey.

The remedial work was also divided into two categories of cost and complexity:

- **Low cost**: costs around £250 or less and can be implemented by a competent DIY person.
- **High cost**: costs more than £250 and likely to require a specialist installer.

Table 3 gives a more detailed breakdown of completed remedial action in terms of these categories of cost. It is important to note that householders can take low **and/or** high cost action. The key information from this table is given below:

- Low-cost remedial action was significantly more likely to be undertaken than high-cost remedial action (68% vs 21% overall at each stage), particularly by householders who had the survey completed for free.
- However, after one-year, nearly half (48%) of householders who paid for the survey reported having completed high cost remedial action, suggesting the survey had a large impact on their decision to invest a significant amount of money to improve the energy efficiency of their household.

Phase 3				**Phase 4**			
Households at 1 month 62 respondents (41 paid, 21 free)				Households at 1 month 76 respondents (65 paid, 10 free)			
Low cost		High cost		Low cost		High cost	
Paid	Free	Paid	Free	Paid	Free	Paid	Free
27/40 (68%)	14/22 (64%)	8/40 (20%)	0/22 (0%)	46/66 (70%)	5/10 (50%)	12/66 (18%)	2/10 (20%)
Households at 1 year 39 respondents (29 paid, 10 free)							
Low cost		High cost					
Paid	Free	Paid	Free				
20/29 (69%)	8/10 (80%)	14/29 (48%)	2/10 (20%)				

Table 3: Details of the total number of households taking either 'low' and/or 'high' cost remedial action at each feedback stage.

Table 4 shows the average and total amounts of money that householders at one-year spent on both DIY solutions and high cost professional work. A substantial amount of money was spent at the local level, benefiting the regional economy.

Calculation Type	Total Spent (£)	Total Spent on DIY (£)	Total Spent Locally (£)
Mean	5015	101	4957
Median	1070	40	2000
Sum	110,335	2524	44,616

Table 4: Details of the average and total amount that households (who answered this question) had spent on remedial action at the one-year feedback stage (Phase 3).

Table 5 shows the most common types of high cost remedial action undertaken by householders. Upgrading insulation, installing double glazing and refitting doors/windows formed 62% of the types of action undertaken.

High-Cost Action	Frequency
Insulation	9
Double glazing	7
Refitting doors/windows	7
New door	5
New blinds/curtains	3
Other	6

Table 5: Details of the most frequent types of 'high' cost remedial action taken, with the data being taken from one-year Phase 3 feedback and one-month Phase 4 feedback.

Table 6 shows the most common types of low-cost remedial action undertaken by householders. The C.H.E.E.S.E. survey process highlights spaces in households that are losing heat to draughts, so the high frequency of this type of action shows that householders readily implement advice from ETs about how they can minimise heat loss from this source.

Low-Cost Action	Frequency
Draught proofing*	56
Chimney sealing**	12
Insulation	11
Radiator heat reflectors	8
Replacing light bulbs	2
New blinds/curtains	2
Other	4

Table 6: Details of the most frequent types of 'low' cost remedial action taken, with the data being taken from one-year Phase 3 feedback and one-month Phase 4 feedback. *'Draught proofing' refers to any action that reduces draughts entering the house, such as sealing cracks. **'Chimney sealing' refers to any action such as completely sealing a chimney off or placing a chimney balloon inside the shaft.

Feedback score analysis

At one-month, householders are asked to give a score between 1-5 for the following questions:

1. How satisfied they were with the survey overall (1: least, to 5: most)
2. How useful did you find the CHEESE box[3] (1: not at all, to 5: very)
3. How useful they found the survey video (1: not at all, to 5: very)
4. How they found the conduct of the surveyor (1: poor, to 5: excellent)
5. Whether the survey was good value for money (1: disagree, to 5 agree)
6. How likely they were to recommend the survey to a friend or neighbour (1: unlikely, to 5: definitely)

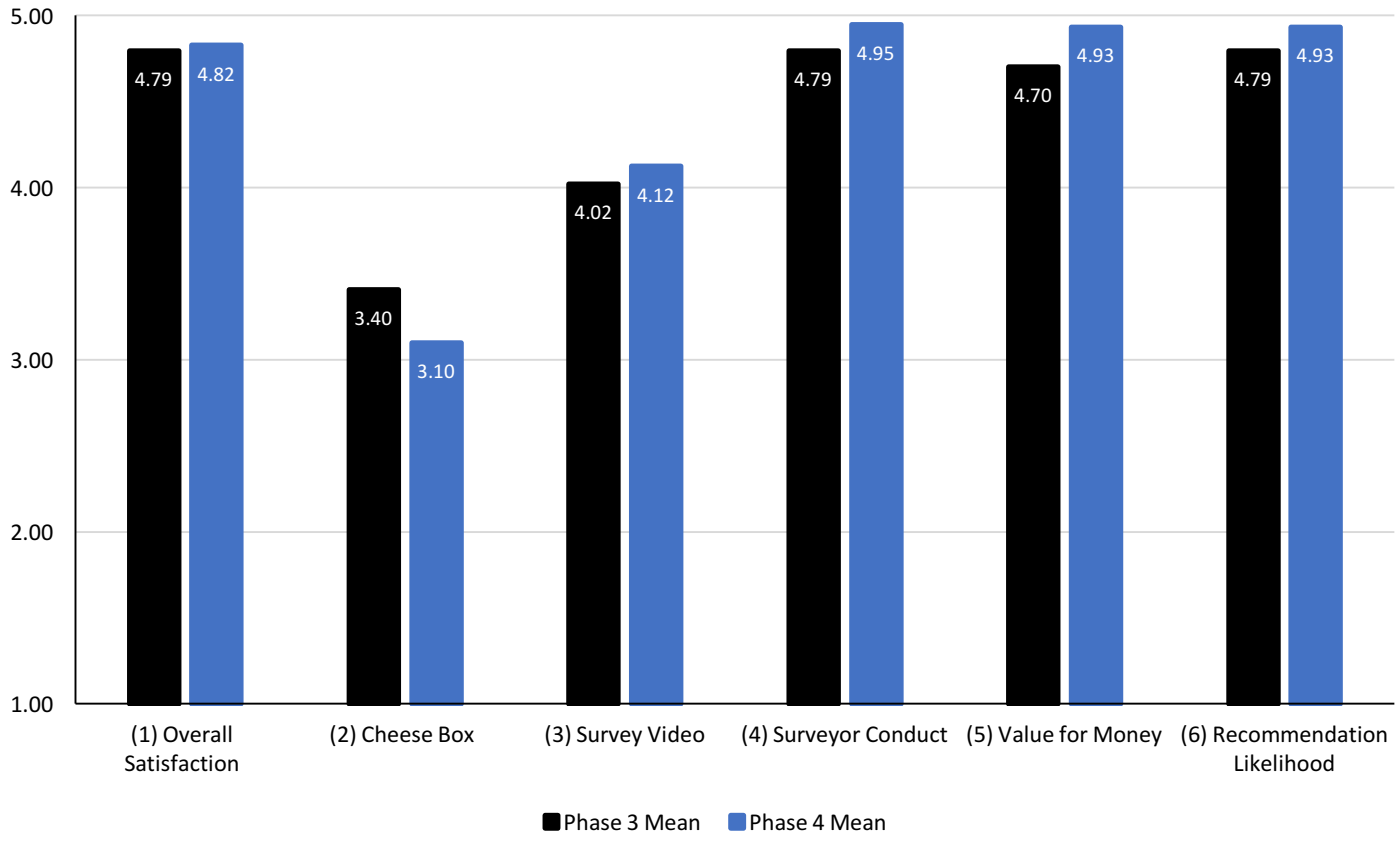

Figure 3: Graph showing the change in average score between Phase 3 to Phase 4 for each question on the one-month feedback

Figure 3 shows that in general, the overall satisfaction with C.H.E.E.S.E. surveys is very high. Additionally, the scores for five out of the six questions showed an increase from Phase 3 to

[3] A 'CHEESE Box' was offered on loan for at least a month, but not all those surveyed accepted it or used it. It contained: instructions, two thermometers to measure inside and outside temperature, a meter to clip onto the mains (similar in function to a smart meter) to indicate total electricity use, a socket meter to measure the electricity consumption of individual appliances, and a Haines Eco-House Manual.

Phase 4, suggesting that surveys during the 2018-19 season were slightly more successful from the clients' perspective.

The only score to decrease was for how useful clients found the C.H.E.E.S.E. box, which was largely due to clients giving a score of one when they had not received it or had chosen not to use it.

Testimonial analysis from feedback

A word cloud was constructed from client feedback at every stage, with larger words being used more frequently (Figure 4).

Figure 4: Word cloud constructed from feedback at all stages, with the size of words corresponding to how frequently they were used in the feedback comments (larger size denoting higher usage).

Analysis of changes to wellbeing

Householders were asked, “Have the actions you've taken made your house feel warmer?”. The results for households that took remedial action, and thus theoretically making their house feel warmer, are given below. Table 7 shows that at one-year the vast majority of households answered yes (85%), suggesting that remedial action following a C.H.E.E.S.E. survey has a significant tangible effect on the temperature of a household.

Phase 3	Phase 4
Households at 1 year (taken action) 28/33 (85%)	Households at 1 month (taken action) 25/54 (46%)

Table 7: Details of the total numbers of householders that said their house felt warmer after taking remedial action.

Analysis of changes in behaviour

Householders were also asked whether they had modified their behaviour in relation to improving the energy efficiency of their home[4] Table 8 shows the results for clients who answered this question, with the overall average that answered yes being ~50%.

Phase 3		Phase 4	
Households at 1 year		Households at 1 month	
Paid	Free	Paid	Free
16/28	5/8	29/66	6/9
(57%)	(63%)	(44%)	(67%)

Table 8: Details of the total number of householders that reported they had changed their behaviour after the survey.

A variety of behavioural changes were recorded from the free-text responses, with the most common being:

- Having central heating on for less time.
- Turning appliances off when not in use.
- More aware of heat loss from open windows and doors.

[4] The specific questions asked were: Has your behaviour changed as a result of your survey? (yes/no), How has the period and temperature you use the heating for changed? (free text); How do you use space in your home differently? (free text); In what other ways has your behaviour changed after the survey? (free text).

Appendix: Energy consumption figures

In this appendix, we present analysis of household energy data relating to the periods of the year before the survey and the year after. Householders were asked to submit their total energy use for electricity and gas in these periods in kilowatt hours.

We received only six full responses (both periods dated and for non-estimated readings). Because there are many factors affecting energy use in a home, such as occupancy, work patterns, changes to the heating system etc., we include this analysis as illustrative of our methodology, in particular using degree days to account for variations in weather, but we do not draw any conclusions from it.

Table 9 shows the results for gas use in Phase 3 households. The weather conditions over which the gas consumption occurred were accounted for by a degree-day analysis. This meant calculating the number of 'heating degree days' within a given time period. Heating degree days represents the number of days the local temperature fell below the baseline temperature of 15.5°C whereby the home would require heating.[5] The consumption figure was then simply divided by the total heating degree days.

Low-Cost Action	High-Cost Action	CGC* (kWh/day)	CGC* (kWh/day as a %)	CGC* (kWh/DD**)	CGC* (kWh/DD** as a %)
✓	✓	-20.7	-54.2	-3.2	-43.1
✓	✓	-31.7	-56.4	-0.7	-12.8
✓	✖	-1.9	-8.2	-0.5	-9.2
✖	✓	-6.6	-14.9	-0.8	-8.8
✖	✓	-1.7	-7.3	+0.1	+2.8
✓	✓	-4.0	-3.8	+1.1	+5.1
		Average: **-11.1**	Average: **-24.1**	Average: **-0.7**	Average: **-11.0**

Table 9: Table detailing the change in gas consumption between the years before and after the C.H.E.E.S.E survey was conducted, for each household that both answered the question and completed some form of remedial action. *CGC refers to Change in Gas Consumption. **DD refers to Degree Days.

Table 10 shows the figures for electricity consumption of Phase 3 households. The degree-day methodology remained the same, on the assumption that the majority of electricity was expended for heating, with a similar average result for the change in consumption per degree day (CGC of -0.7 kWh/DD compared to CEC of 0.6 kWh/DD).

[5] The degree day figures were obtained from a Bristol-based weather station (EGGD: Bristol / Lulsgate (2.72W,51.38N) more information on degree days: https://www.degreedays.net/.

Low-Cost Action	High-Cost Action	CEC* (kWh/day)	CEC* (kWh/day as a %)	CEC* (kWh/DD**)	CEC* (kWh/DD** as a %)
✖	✓	-23.2	-44.7	-3.7	-33.6
✓	✓	-3.0	-41.6	-0.4	-27.5
✖	✓	-1.9	-16.8	-0.2	-10.8
✓	✖	-0.2	-3.0	-0.0	-4.1
✖	✓	-0.8	-11.4	-0.0	-1.7
✓	✓	-1.4	-31.6	+0.2	+36.9
✓	✓	+3.2	+32.4	+0.9	+44.6
		Average: -**3.9**	Average: -**16.7**	Average: **-0.6**	Average: +**0.5**

Table 10: Table detailing the change in electricity consumption between the years before and after the C.H.E.E.S.E survey was conducted, for each household that both answered the question and completed some form of remedial action. *CGC refers to Change in Electricity Consumption. **DD refers to Degree Days.

Further energy consumption information

It is clear from this analysis of energy data that useful quantitative insights into the effectiveness of C.H.E.E.S.E. surveys could be drawn. We plan to increase the size of this dataset by adjusting the way we collect the measurements and the quality by collecting readings more frequently. Additionally, we will include more questions to gather information about changes in the last year which may impact household consumption, and to prompt a quantitative response to support the analysis.