Progress of The CHEESE Project

April 2016 - April 2017

Mike Andrews, General Manager, 4 June 2017.

Contents

Summary

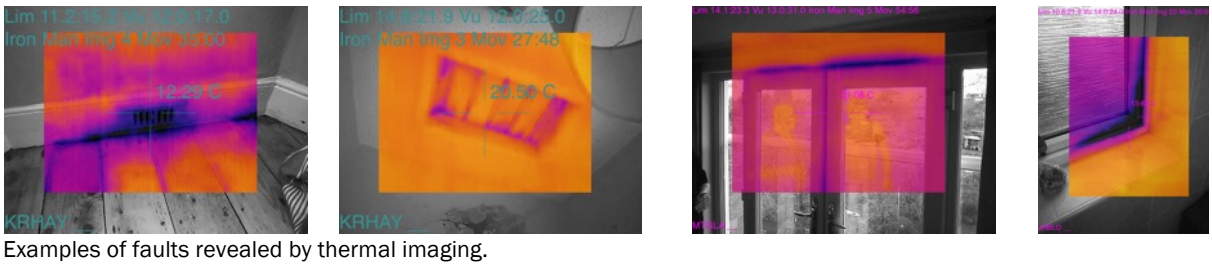
During winter 2016-17 the non-profit, community based, CHEESE Project (TCP) successfully completed 56 internal surveys of homes and three community buildings. Twenty of these surveys were conducted for free for low-income homes, subsidised by the fees we charged more affluent householders. In contrast to the previous winter, when Brian Harper surveyed 47 households for us, all surveys were carried out by our own teams trained by Brian. To get to this point, where we could achieve 25 surveys in one month (March 2017) we had to develop our own low-cost digital kit, develop our unique CHEESE app software, train 13 new 'Energy Tracers™' by developing a new course and high-quality videos, and overcome a series of significant set-backs (detailed below). Our outcomes have been extremely positive and encouraging, and we can claim to have successfully demonstrated TCP's efficacy:

1. As an exemplar project for tackling the serious problem of excessive domestic energy consumption
2. As a model for aiding those in fuel poverty to have more comfortable and healthy homes.

The typical reaction to an internal survey is that it is 'revelatory' of energy loss. (See testimonials included at the end of this document.) Follow-up surveys of 49 surveyed households, after 1-3 months, confirmed that 73% had *already* carried out low-cost improvements; while 94% of these plan to carry out further retrofitting, often claiming that our surveys encouraged them to do more. We are also compiling a valuable database of faults in particular Bristol housing types, together with data on construction and retrofitting errors by contractors.

Given that this was only the second pilot season for TCP, achieved very largely on volunteer effort, we are confident that we now have a technique and equipment fit for the challenging job of reducing Bristol's domestic energy use. Indeed, we are the only group in the country who are using these low-cost methods to achieve these kinds of results. To improve our technique further we are using money generated from surveys to develop our own bespoke thermal camera and a sophisticated monitor to log the changing conditions inside homes. There is very little data currently available, in any country, on this subject.

Survey outcomes


Examples of faults revealed by thermal imaging.

Please see the analysis presented in the pie-charts and tables included on pages 10-11 of this document. Beyond the figures already included in the summary above, it is noticeable that a large number of separate remedial actions have been taken by different households, with a relatively small overlap of actions between households. This demonstrates the value of surveys *specific* to homes. Few homes are alike when it

comes to tackling wasted energy. Data on behavioural change is included separately on page 15.

We continue to collect data, and now that a year has elapsed since our first surveys, we are beginning to assess total energy consumption from bills. This year-on-year data-collection will be augmented next winter.

Households on low incomes are less likely to reduce their energy consumption as their homes are made more energy-efficient. Instead they will gain in comfort and also health for the same expenditure. This benefits both them and society rather than the environment.

Partners

In order to be truly community based, TCP began with informal partnerships with the BCR Energy Group in Redland, Easton Energy Group and Ambition Lawrence Weston. These original 'CHEESE Segments' have been expanded to six wards this season, to include Cotham and Bishopston, and joined by Re:work in Filwood. Another partnership is in development with Sustainable Westbury on Trym. Surveys have also been carried out in other wards as 'outliers'.

The segments, where possible, coordinate and carry out surveys in their areas, have their own trained Energy Tracers and use equipment supplied by the central office. To obtain referrals for surveys we have contacts with numerous other socially active local groups (see separate list on page 12). Separately-funded partners such as Ambition Lawrence Weston and Re:work can follow up the findings of our surveys by carrying out remedial work for low-income households.

We are also in touch with groups in Oxford, Lewisham, London, and Vancouver, British Columbia, who are interested in adopting/licensing our CHEESE protocol because of its novelty and success in addressing a common problem.

Thermal imaging hardware development

A CHEESE internal thermal-imaging kit, including iPhone, FLIR sensor, battery pack, tablet, WiFi hub, charging block, hand-held mount, wires and USB memory sticks for transferring the video to householders.

For the CHEESE Project, we do not use standard, stand-alone equipment. We have developed our own low-cost surveying kit with sophisticated, unique software, for a fraction of the price of contemporary industry thermal cameras. FLIR unexpectedly

discontinued sale of their original 'One' model last year, replacing it with a new version. Unfortunately for us, this meant considerable changes to our software during 2016/17, and re-engineering connections that we use between the camera, phone, and tablet computer. We currently reserve our old-model FLIR cameras for external surveys.

To reduce our exposure to product changes in the future, and to allow more sophisticated use with a longer battery life, we are also developing our own thermal-imaging camera attachment for a smartphone, designed specifically for our surveys.

The prototype of our own thermal imaging camera attachment for a smart phone, including a Rasberry Pi and custom 3D printed case. On the right is a circuit board layout for our household data recorder, also under development.

We have also developed our own design of 'blower-door' to reduce pressure inside a house, prior to survey. Again, at a cost of £170, it is a fraction of the price of commercial ones which can cost in the region of £2,000.

A CHEESE blower door in action.

CHEESE energy-saving boxes

For the 2016-17 season, we assembled our own energy saving boxes (rather than using Brian Harper's). These are lent to each householder for about four weeks. They contain:[1]

- A whole-home energy monitor to clip to the mains feed.
- An individual meter for sockets (to show appliance consumption and electricity cost).
- Two thermometers for inside and outside.

[1] The contents of the box and their uses is explained in detail on our website: https://cheeseproject.co.uk/cheese-box

- A Haynes Eco-House Manual.
- instructions and energy-use logging sheets.

This provides the householder with the means to investigate and measure their energy use, with the principal aim to encourage them to make energy-use reductions through behaviour change. (We have twenty boxes of our own, and access to another twenty, which also include a logging monitor, bought by BEN and Ambition Lawrence Weston.)

A CHEESE box packed with its contents, and unpacked to display each item. (Logging monitor in the left-hand picture)

Software development

The most significant software developed by TCP is a bespoke iPhone app to perform thermal surveying. This shows the thermal images within a frame of a visible light image so that the viewer knows what they are looking at. There are numerous sophisticated features, such as different temperature ranges and colour palettes to show up different thermal problems. The app is still being refined by Jeremy Birch with input from Brian Harper and our surveyors. The app was necessary to address various problems in the FLIR-provided software and has enabled us to continue to improve our surveying techniques in a way that would not be possible with off-the-shelf software.

Software has also been written to link the imaging output to a tablet computer so that the householder can clearly see the live thermal images as the home is surveyed. The tablet then stores the data for subsequent use.

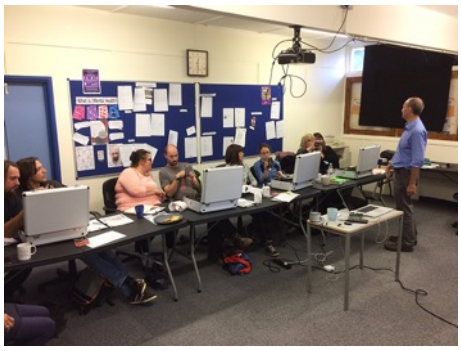
We have developed secure databases for collecting and analysing household data, including remedial action taken, and changes in fuel consumption, with a view to later scientific analysis. A web-based interface to the database is accessible by surveyors to add and amend information. There are also publicly-accessible forms on the website for gathering data from householders.

Our Technical Manager, Jeremy Birch, has also developed energy mapping by ward in Bristol which allows us easily to select fuel-poor target areas. An interactive map can be accessed via our Heatview website.[2]

[2] http://www.heatview.co.uk/fusion_lsoa.html

Training Energy Tracers™

In autumn 2016 we carried out two, two-day intensive hands-on courses with Brian Harper as survey protocol trainer, and Jeremy Birch as equipment trainer. Thirteen individuals completed the course together with a health and safety course for entering homes, run by CSE. We have enrolled the courses to qualify for a Continuing Professional Development (CPD) certificate. The experience is gained first by shadowing Brian Harper or one of our experienced thermal surveyors, then performing surveys while being shadowed by a trainer assessing their expertise. At present, videos of the surveys led by the new Energy Tracers are being analysed by Brain Harper to check each surveyor's competence, prior to their being signed off for the CPD certificate.



(Left) Jeremy Birch giving the new Energy Tracers an introduction to the internal TI kit. (Right) The attendees of the CHEESE health and safety workshop at the Centre for Sustainable Energy.

Videos for training

We made a second high-quality 20-minute training video of Brian's illustrated lecture on the development of thermal imaging and its application to buildings – suitable for showing elsewhere[3]. We have also made a large portfolio of short training videos to demonstrate different aspects of the use of our survey equipment[4].

Survey technique

The process is described on our website.[5]

Data collection

Data on the home, for example past fuel bills, can be entered on-line into our confidential data-base by the Energy Tracer at the end of a survey. In the event of a lack of WiFi, we have printed forms for householders, who are also warned in advance what data we shall collect (with an option to opt-out).

The surveys are followed up after about one month with a phone-call to find out what the householder has done or plans to do, and then after a year by a visit to check what has been done in the way of remedial measures and to collect new energy-consumption data.

[3] The video is available privately at https://vimeo.com/182068748.

[4] These are available at http://www.heatview.co.uk/training.

[5] See https://cheeseproject.co.uk/home-surveys.

Research

Despite domestic energy consumption contributing significantly to national greenhouse emissions, there is remarkably little research in this area. One significant study conducted by Plymouth University demonstrated that householders who have seen a thermal image of the inside of their homes are 4.8 times more likely to carry out remedial work than those who have only received written and verbal encouragement.[6] This reinforces the methods taken by TCP.

Finance

Funding

In the summer of 2016, BEN received £10,000 grant funding for TCP from DECC via the Bristol City Council/Quartet - Community Energy Fund (CEF). In September BEN also received a £9,950 grant on behalf of TCP from The Big Lottery: Awards for All. The CEF funding allowed us to employ an organiser for 40 days at two days a week. This was extended to the end of April.

Sales of surveys

TCP earned a total of £4,322.00 from the sale of surveys to more affluent households up to end April 2017. This was 17.8% of our total income and an important additional source of funds – allowing us to pay for activities during the summer and autumn of 2017 and to carry a small surplus forward to the next survey season.

Value of voluntary contributions

The project has benefited from highly-skilled hardware development work and a large amount of equally skilled software development *gratis* from Jeremy Birch, his son Peter, and James Hanlon. David Tudgey has contributed his extensive knowledge of working with local community groups and energy activities. Sue Nicholls has provided valuable analysis of our results as well as coordinating and promoting surveys in Redland. Mike Andrews has employed his skills, learned at the BBC, of managing complex filming and logistics, as well as in communicating with the public. Surveyors also work for free until they are qualified. Costed at commercial rates, these contributions have been worth considerably in excess of a hundred thousand pounds.

Impact of adverse events and late funding

The progress of the project has been impacted by adverse events and late funding:

- TCP requires a temperature difference of at least 8 degrees Celsius to carry out effective internal surveys. Last winter, a warm October and November delayed our start.
- The late arrival of grant funding was made worse by the fact that BEN's accountant had just moved to Australia. It took a further month before funds were received (at the end of November) to allow us to purchase equipment. This, again, delayed the start of our recruiting of homes and surveying.

[6] Matthew Fox, David Coley, Steve Goodhew, Pieter de Wilde, Thermography methodologies for detecting energy related building defects, Renewable and Sustainable Energy Reviews, Volume 40, December 2014, Pages 296-310, ISSN 1364-0321, http://dx.doi.org/10.1016/j.rser.2014.07.188.

- The late arrival of the CEF funding meant we could employ an organiser only from December 2016.
- The decision by CEF not to fund our 3 CHEESE Segments (BCR, Easton Energy Group and Re:work) in 2016, resulted in significant delays in recruiting homes to be surveyed.
- One of our management committee and a key Energy Tracer suffered serious illness during the winter and were unable to work for a long period.

These adverse factors led to a reduced number of surveys achieved over the winter season. However, our survey total of 25 surveys in March 2017 gives a more accurate picture of the potential capacity and achievement of TCP when these significant problems had been successfully overcome and our training and development work completed.

Press comment

BBC Futures are about to run a feature on the scheme. We have been in the Bristol Cable newspaper[7] (see right), and filmed for a documentary for Hong Kong TV.[8]

Next survey season, October 2017 – April 2018

We will continue to expand the number of our internal surveys, and, given the necessary grant funding, will develop our training course with new videos, train more surveyors and buy/develop more surveying equipment, to this end. We have also bid to participate in Bristol City Council's REPLICATE project[9], exploring new technology for smarter homes.

We have found that the most effective way to recruit homes is through word-of-mouth from satisfied customers; as well as giving talks at local venues with local, trusted, community groups. For next season, we are planning for CHEESE Segments to host events and give CHEESE parties to gain clients. We are also using the contacts of other community organisations to seek out the fuel-poor.

Legal status of The CHEESE Project

When TCP gains further grant funding this autumn, or is successful in its bid to participate in the REPLICATE project of BCC, TCP will be incorporated as a CIC. At present, it is a not-for-profit unincorporated association, including charitable purposes, governed by our own Constitution and expert Management Committee.

Conclusion

The second season of The CHEESE Project's pilot has been extremely successful in proving the efficacy of our methods in both encouraging and stimulating householders to consider their energy use more carefully and to take a range of measures to save energy, while also improving the comfort of the fuel-poor. The significant numbers surveyed in the final month of the season were achieved despite adverse funding circumstances,

[7] See https://thebristolcable.org/2017/01/energy-gaps
[8] See http://podcast.rthk.hk/podcast/item_epi.php?pid=1045&lang=en-US
[9] See http://www.connectingbristol.org/replicate/

and other significant difficulties which were successfully overcome. It is important to see these numbers and the outcomes in the context of the very large amount of development work carried out by an entirely voluntary team. This includes the development of new survey hardware kits, software, training courses, videos, on-the-job training, data collection, website development, and analysis. TCP now has a proven system that can be replicated widely, not only within Bristol, but in other UK cities and abroad. The outcomes, in terms of people retrofitting their homes and improving comfort, are exceptional.

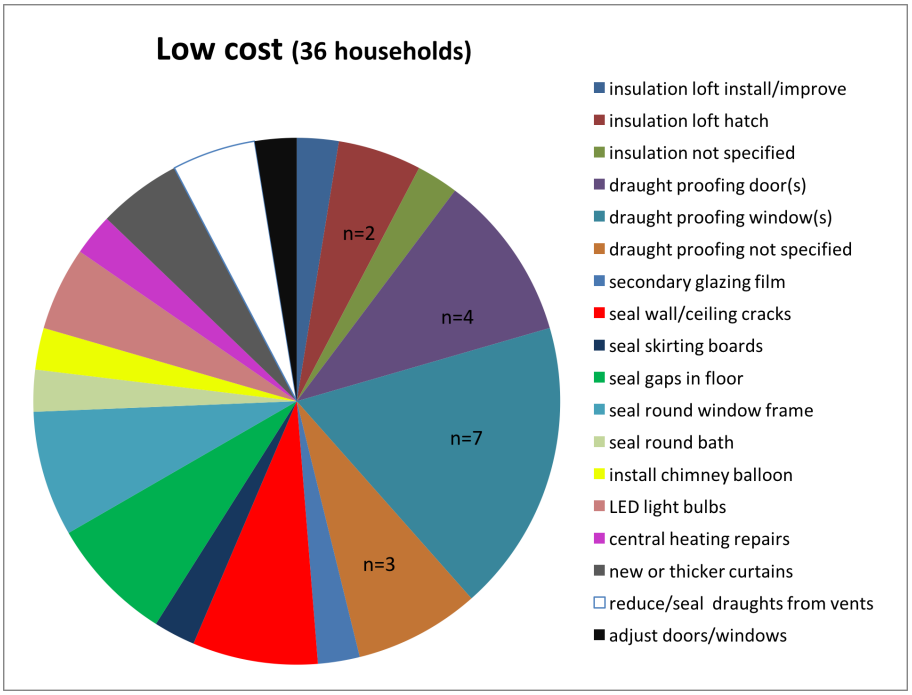
Survey results

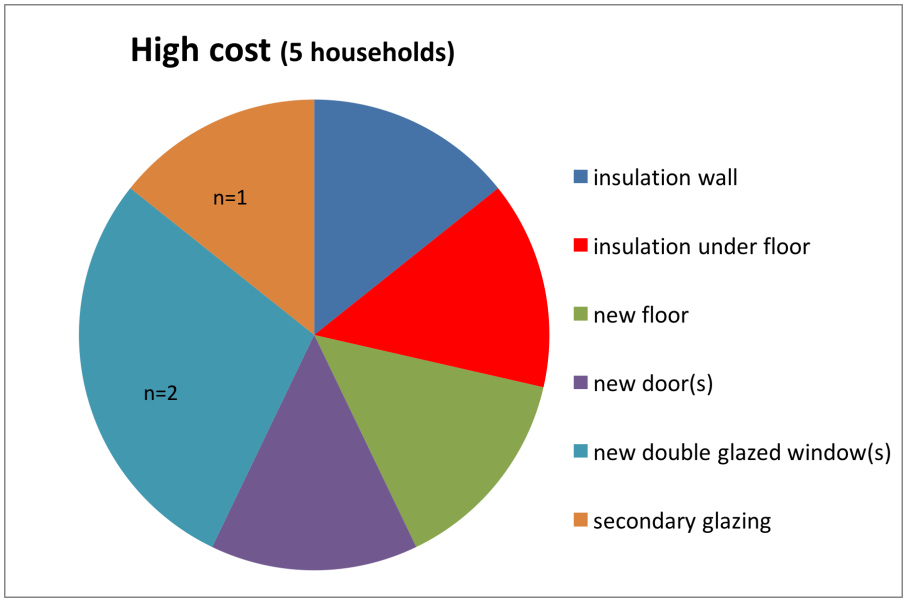
In this section, we highlight trends in the results of 49 surveys. The results of the remaining surveys will be included as they are collected and analysed.

Definitions:

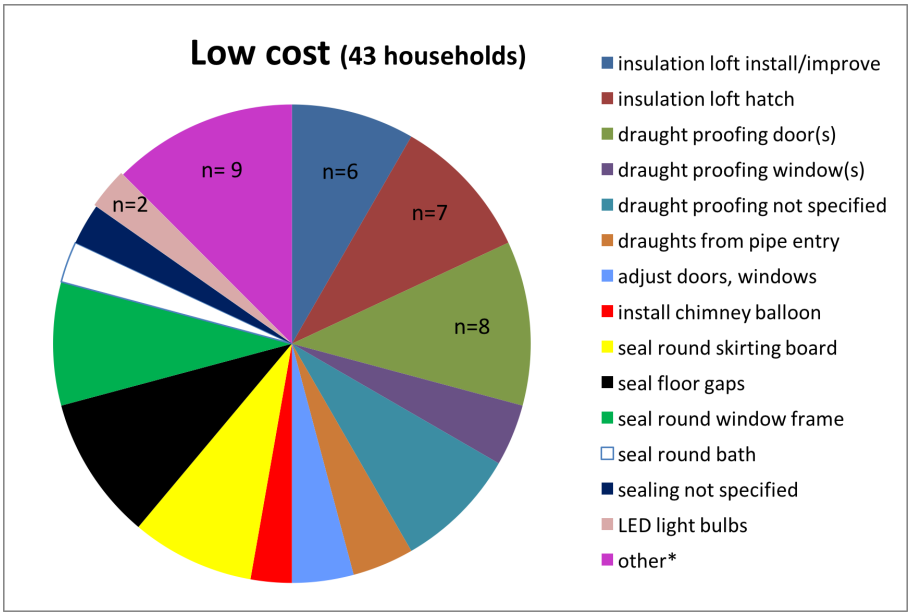
- **Low cost** – relatively inexpensive (ca £250 or less) and can be implemented by a competent DIY person.
- **High cost** – expensive (> ca £250) and/or likely to require a specialist installer.

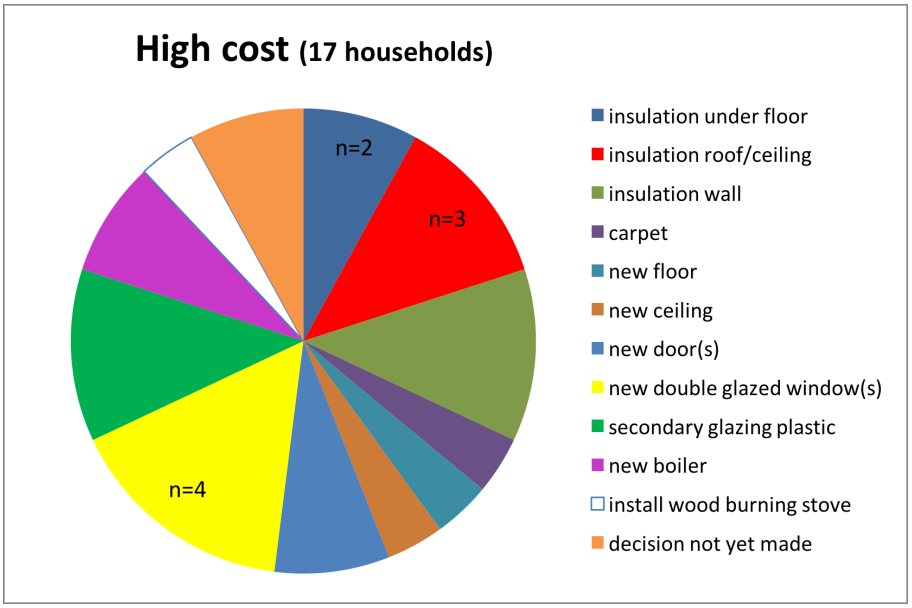
Improvements already implemented 1-3 months after survey





Improvements planned 1-3 months after survey





Other (white sections): insulation not specified, insulation pipes, reduce draughts from vents, wall/ceiling cracks sealed, radiator reflector.

Behavioural change following loan of CHEESE energy box

1-3 month follow-up, 49 Households.

Spontaneous comments	Number of households
1. Increased awareness of usage of electricity by appliances (mentioned were kettle, power shower, oven, children's games, appliances on stand-by, electric heaters, LED vs halogen bulbs, toaster, washing machine)	8
2. Change to LED as result of energy monitor use	3
3. Stopped using power shower	1
4. Now puts less water in the kettle	1
5. Motivated to monitor gas and electricity use	2
6. Purchased own electricity monitors	1
7. Used thermometers in box to decide when to switch heating off	1
8. Used thermometers in box to measure room temperature	3
9. Now uses microwave more often	1
10. Now keeps water hot in thermos flask	1
11. Haynes Eco Manual informative and useful	6

Other behavioural change	Number of households
Awareness of importance of draughts	3
Awareness that many solutions are inexpensive	1
Motivated action to make improvements	3
Tenant better equipped to deal with landlords to make improvements	1
Switched on underfloor heating in extension and warmer (not previously used)	1

Analysis by Sue Nicholls.

CHEESE survey testimonials 2016-17 season

A really valuable service, represented excellent value for money. The friendly, very helpful surveyors suggested simple remedies that will make a big, positive impact on the warmth of our house. A massive thank you to all involved.

I just wanted to say how BRILLIANT the Cheese Survey experience was!

Jamie and Boycee made a fantastic team - they were polite, great at listening, helpful and interesting in a perfect balance.

I got so much out of it. I have already started sealing gaps and stuffing holes under skirting boards - I swear its warmer already! I think it might be a bit addictive ....funny there are little holes everywhere I never saw before! Please pass on my thanks to them - it was inspiring. I will spread the word.

It was really excellent and revelatory!

The energy tracers were very professional and polite. The memory stick is very useful to keep looking back on and checking what happened on the day and being able to refer back to as you don't take everything in at the time. The cheese box gave me some good information and lots of practical advice in the book.

Excellent. I am stunned that I had never thought about how big an effect draughts could have on heat loss.

Many more thanks for the visit that you and Salvador made and all advice given. I found the survey incredibly informative and your suggestions for simple, easily applied improvements were exactly what I wanted and need!

Has given the survey "10/10" and that if the survey hadn't been done she "wouldn't know where the money is going".

I thought the whole organisation of the survey was well done, and the energy tracers efficient and friendly. I particularly appreciated the opportunity to see what was being discovered on the tablet as it was happening.

She is "100% happy" and that she would "recommend the survey to anyone".

Survey was well worth the money and very interesting. – It was fun!

Next door neighbour has already signed up!

Very good to see heat loss with tenants, which helped raise energy awareness with tenants, which was an important aspect for [Housing Association].

Initially sceptical about the value of the survey, but it "added loads - things never seen before". Amount of time the surveyors spent meant it represented good value and would recommend it to others.

"I'm so happy with what you did, you should do it to everyone, especially when people are buying houses". The experience of seeing the thermal images was "mind boggling", "it says it all", "it opens your eyes to everything". - XX is copying the CHEESE video to send to the council regarding the works to his house. - XX has lived in the house for 15 years but didn't understand/know about any of the faults until he had the survey. - XX reckons CHEESE should be extended to survey all houses in Bristol!!

The Cheese survey was inspiring and motivated me to get on and do stuff.

Using the fan and TI camera was an "amazing system".

Really happy the survey happened. The video is great, with lots of practical/ DIY tips rather than just recommendations for contractors to do improvements.

"Great and incredibly cheap." He thought the survey was "Phenomenal". It was recommended to him and he would recommend it to others.

Perfect really. the two guys that came were brilliant and very helpful.

The most striking aspect of the survey for me was the focus on cold draughts, which is probably not what most people first think of, but is also probably easiest to do something about.

I think this is a particularly positive message as the kind of things that usually come to mind are big and potentially daunting projects like getting double glazing or insulation of some kind.

Energy Tracers marvellous and professional. Result of survey interesting. lots of small niggles to solve.

Can't thank you enough for your time and efforts. Very friendly, professional and courteous tracers. Providing a great service to minimise wasted energy and improve home warmth.

Surveyors were "absolutely lovely". Survey was "great". Overall "really grateful and enjoyed the survey".

Current relationships with community organisations

Acorn
Developing referral for surveys this winter.

Ambition Lawrence Weston
Segment partner, now ALS Avonmouth, Lawrence Weston Shirehampton. New surveyors being trained.

BCR Energy Group
Segment partner, Spin off from Sustainable Redland for CHEESE.

Bedminster Energy Group
Potential CHEESE Segment 2017-18.

Bristol Green Doors
Two-way referral and sharing contacts for surveys.

Citizen Sensing
Discussing development of humidity testing with our own kit being developed.

Centre for Sustainable Energy
Data sheets giving advice on remedial action pre-loaded onto memory sticks given to our customers.

Easton Energy Group
Original Segment partner/central office funded by BGC for TCP.

North Bristol Advice Centre
Helping with referrals.

North Bristol Food Bank

Helping with fuel-poor referrals.

REPLICATE
TCP has bid to integrate CHEESE surveys with 3 –year scheme.

Re:work
Segment partner Knowle/Filwood, 2 surveyors trained.

SUSWOT
New segment partner for 2017-18.

Talking Money
Developing referral for surveys this winter.