Park home heat recovery ventilation & energy improvement pilot
Cheshire West & Chester Council

Technical Evaluation Report

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September 2017

CP777 & CP789

Park home heat recovery ventilation & energy improvement pilot

Cheshire West & Chester Council

Number of households assisted	52
Number of households monitored	12

Background

About National Energy Action

National Energy Action is the national fuel poverty charity working across England, Wales and Northern Ireland, and with sister charity EAS in Scotland, to ensure that everyone can afford to live in a warm, dry home. In partnership with central and local government, fuel utilities, housing providers, consumer groups and voluntary organisations, it undertakes a range of activities to address the causes and treat the symptoms of fuel poverty. Its work encompasses all aspects of fuel poverty, but in particular emphasises the importance of greater investment in domestic energy efficiency.

About the Technical Innovation Fund

NEA believes that there is huge potential for new technologies to provide solutions for some of the 4 million UK households currently living in fuel poverty, particularly those residing in properties which have traditionally been considered too difficult or expensive to include in mandated fuel poverty and energy efficiency schemes. However, more robust monitoring and evaluation is needed to understand the application of these technologies and assess their suitability for inclusion in future schemes.

The Technical Innovation Fund (TIF) which was designed and administered by NEA, formed part of the larger £26.2m Health and Innovation Programme along with the Warm Zone Fund and Warm and Healthy Homes Fund.

TIF facilitated a number of trials to identify the suitability of a range of technologies in different household and property types and had two strands: a large measures programme to fund the installation and evaluation of technologies costing up to a maximum £7,400 per household, and a smaller measures programme with up to the value of £1,000 per household. It launched in May 2015, with expressions of interest sought from local authorities, housing associations, community organisations and charities wishing to deliver projects in England and Wales.

Over 200 initial expressions of interest were received and NEA invited 75 organisations to submit full proposals. Applications were assessed by a Technical Oversight Group, chaired by Chris Underwood, Professor of Energy Modelling in the Mechanical and Construction Engineering Department at Northumbria University who is also a trustee of NEA. In total, 44 projects were awarded funding to trial 19 different types of technologies and around 70 products (although this number reduced slightly as some products proved not to be suitable and were withdrawn).

More than 2,100 households have received some form of intervention under this programme that has resulted in a positive impact on either their warmth and wellbeing, or on energy bill savings. Of course the amount of benefit varies depending on the household make up and the measures installed. In a small number of instances we removed the measures and took remedial action.

Technical monitoring and evaluation

NEA has been working with grant recipients to monitor the application of these technologies and assess performance, as well as understand householder experiences and impacts.

A sample of households from each TIF project was selected for monitoring purposes. Participation was entirely voluntary and householders were free to withdraw at any time. This involved the installation of various monitoring devices within the home which collected data for analysis by NEA's technical team. Some residents were also asked to take regular meter readings. In some instances, a control group of properties that had not received interventions under TIF were also recruited and monitored.

The technical product evaluation was conducted alongside a social impact evaluation to inform our understanding of actual energy behaviour changes, perceived comfort levels and energy bill savings, as well as any other reported benefits. Householders were asked to complete a questionnaire both before and after the installation of the measures which captured resident demographic data including any health conditions. Small incentives in the form of shopping vouchers were offered to maintain engagement over the course of the evaluation period.

The HIP fund was principally designed to fund capital measures to be installed into fuel poor households. A small proportion of the funding enabled NEA to conduct limited research and monitoring of products installed, and was restricted to ensure that the majority of funds were spent on the products. All products included in the trials were deemed to offer costs savings and energy efficient solutions as proposed by the delivery partners. The research and monitoring aimed to provide insights to inform future programme design and interested parties of the applicability of the product to a fuel poor household. We recognise that due to the limited number of households involved in the monitoring exercises and the limited period we were able to monitor a product's performance, we may recommend that further research is needed to better understand the application of these products in a wider range of circumstances over a longer period of time.

The research was conducted according to NEA's ethics policy, which adopts best practice as recommended by the Social Research Association (SRA) Ethical Guidelines 2002.

An accompanying programme of training and outreach work was also delivered to 292 frontline workers to increase local skills and capacity.

Individual project reports are being compiled and will be made available publicly on NEA's website from September 2017, along with a full Technical Innovation Fund Impact Report.

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Legal limitations and disclaimer

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Executive summary

Project overview

The project was delivered by Cheshire West and Chester Council and involved installing measures in 52 park home properties built pre-1996 at the Orchard Park site in Elton. All properties received insulation, with 15 of these also receiving Vent-Axia single room heat recovery systems, usually 1 unit in the bathroom and 1 in the kitchen.

The aims of the project were:

- To establish how Cheshire West and Chester Council could help park home households improve the thermal efficiency of their households.
- To reduce energy bills and improve health and wellbeing for park home households in Cheshire West and Chester (CWaC).
- To produce detailed case studies, establish show homes, and inform national best practice.
- To develop a business case for funding and finances to be better allocated on a local and national basis.

The technologies installed were:

- Alumasc Swisstherm External Wall Insulation System;
- YBS Foil Tech Underfloor Insulation;
- URSA Glasswool (blown loft insulation system);
- Vent-Axia Lo-Carbon Tempra Through-The-Wall Heat Recovery Unit (HRU).

Context

There are an estimated 96,000 UK households in park homes and Age UK estimates that over 100,000 residents are older people[1]. Park homes typically have poor levels of energy efficiency and are frequently not connected to the mains gas grid[2]. The Orchard Park site is off the gas network and connections costing £4,000 per household including the Fuel Poor Network Extension Scheme (FPNES) grant were considered cost prohibitive.

The thermal efficiency of park homes built before 1996 is substantially lower than those built thereafter. The cost of park home insulation is often out of reach for those on low incomes and accessing funding for work under the Energy Company Obligation (ECO) has proved difficult. Households are often reliant on expensive heating fuels like oil, liquefied petroleum gas (LPG) or electricity. This combination leads to high costs for often vulnerable households who can struggle to pay the bills. By cutting back on their heating, the households risk low room temperatures which impact health and wellbeing.

Fuel poverty in CWaC is estimated to be 10.1%, which is slightly lower than the England average

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[1] Don't leave park homes out in the cold http://www.ageuk.org.uk/Documents/EN-GB/Campaigns/winter%20health/4982%20Age%20UK%20ID202741%20Park%20Homes%20Campaign%20Report.pdf?dtrk=true

[2] Scoping ECO for Park Homes, NEA, March 2014 http://www.nea.org.uk/wp-content/uploads/2014/03/Scoping-Eco-for-Park-Homes.pdf

of 11%[3].

The Technology

The technologies being trialled were as follows:

Alumasc EWI Swistherm is a British Board of Agrément approved external wall insulation system designed to increase a building's thermal efficiency. It protects the structural fabric of the building and is completely weather resistant whilst remaining vapour permeable. It has an effective life of over 30 years and is rated Class 0 for surface spread of flame[4].

YBS Foil Tec Underfloor Insulation is an ultra-thin, flexible, easy to install, vapour control membrane which effectively controls condensation and air tightness. It can be used in both walls and roofs, and can also be used independently as an insulation membrane in floor applications[5].

URSA Glasswool helps to keep homes warm in winter and cool in summer. The product itself is a mineral wool with outstanding thermal and acoustic insulation properties. It is extraordinarily fire resistant, making it ideal for safe thermal and sound insulation of pitch roofs, partitions, external walls and ceiling[6].

Vent-Axia Lo-Carbon Tempra Through-The-Wall HRU is a fan which recovers up to 78% of the heat from extracted air and puts it back into the fresh incoming air, thus reducing the home's carbon footprint[7]. The HRUs were installed on this project to test their effectiveness at mitigating the condensation risks associated with solid wall insulation.

The project

CWaC worked with contractor Cornerstone to install insulation measures in 52 park homes on the Orchard Park site between mid-February and mid-June 2016. Of these, 15 properties also received the HRUs. All of the park homes receiving measures were built pre-1996 and are privately owned and off the gas grid.

Twelve households were selected for technical monitoring, 7 of which received the HRUs in late April 2016. 8 households in the monitored group had gas meters installed on their LPG bottles or tanks so we could measure consumption post-installation of the measures. There was no control group.

The households involved are mainly elderly retired couples or single people who have downsized their properties. 75% of households in the monitored group have long term health conditions.

[3] Sub-regional fuel poverty data 2015 https://www.gov.uk/government/statistics/sub-regional-fuel-poverty-data-2017 (accessed August 2017)
[4] http://www.alumascfacades.com/products/external-wall-insulation/ewi-direct-fix-systems/swistherm-ewi-new-build/
[5] http://www.ybsinsulation.com/brands/foil-tec/
[6] http://www.ursa.com/en-us/ursa-offer/our-product-range/pages/ursa-glasswool.aspx
[7] https://www.vent-axia.com/range/lo-carbon-tempra-selv

Findings and insights from the study

The majority of households receiving measures saved energy

- On average, households in the monitored group reduced their gas bill costs by an estimated 27.37% (£202.75).
- The HRU costs an estimated £5.74 to run per year on average (dependent on usage).
- SAP ratings for the households reportedly increased by 24 points, moving from band F to D[8].

The majority of households felt warmer and more comfortable

- There was a significant improvement in perceived comfort in the home post-installation of the measures. 80% of those with insulation only, said their homes felt warmer and more comfortable as well as retaining heat better. 100% of households that received the insulation and HRU said their home felt warmer, more comfortable and retained the heat better.
- The average temperature across households did increase slightly despite reduced energy usage. Those with insulation measures had an average 24hr temperature of 17.94°C and an average temperature of 19.74°C during the 7-10pm desired heating period during winter. Households with the insulation and HRU measures averaged a 24hr temperature of 19.09°C and an average temperature of 19.94°C during the 7-10pm period.
- The HRU made a significant impact on households that previous had issues with mould, damp or condensation, with 67% of the households saying they could see a noticeable improvement.
- The HRU did not appear to have a significant impact on humidity levels.

Conclusions and recommendations

- All of the measures appeared on average to reduce heating bills and increase the thermal comfort of the households by reducing heat loss.
- The HRU did appear to have a positive impact on reducing mould and damp growth, although it did not appear to have a significant impact on the monitored humidity levels.
- The loft, under floor and external wall insulations appear to be ideal for park homes or older households with poor insulation, particularly where households are using expensive fuels like LPG.
- Replacing older windows and doors in park homes will further reduce heat loss in park homes.
- Heat recovery units should be considered when insulating park homes as unwanted ventilation will be reduced together with an associated increase in humidity levels.

[8] The ratings were supplied by Cornerstone Renewables and not a lodged Energy Performance Certificate provided on behalf of the Government.

1. Evaluation background

1.1 Introduction

In November 2014, Cheshire West and Chester (CWaC) carried out a survey on its 29 residential park homes sites to establish how it could help 813 park home households improve the thermal efficiency of their households, thereby reducing energy bills and improving health and wellbeing.

Due to the technical challenges and a historical lack of access to grant funding, no energy efficiency schemes had been rolled out across park homes in CWaC to date. Given that a large proportion of park home residents are older people on low and fixed incomes, fuel poverty is particularly prevalent within park home communities and proven solutions and case studies are urgently needed.

CWaC conducted a park home survey to select homes for the study where there was most need, as defined by:

- Park homes in rural off-gas areas
- Age of park home; built before 1996
- Located in a ward with higher than local average fuel poverty levels

The justification for the age criteria is that 1996 is a critical year in the development of construction standards for park homes. The British Standard for Residential Park Homes (BS 3632: 1995) was introduced in this year. Prior to the British Standard there was no standard for the construction of park homes, which means that the U-values of construction and thermal efficiency of homes built before 1996 is substantially lower than those built post-1996. 59% of park homes in CWaC were constructed before 1996.

The project modelled two scenarios:

1. Properties that had received wall, ceiling and underfloor insulation
2. Properties that had received wall, ceiling and underfloor insulation, together with Heat Recovery Units (HRUs)

CWaC originally intended to work with Climate Energy as installers for the project. However Climate Energy went into administration and Cornerstone were selected as their replacement. This meant that some of the materials identified in the original bid were substituted as a result of Cornerstone's experience. The original project intended to trial 2 approved park home insulation systems by ParaClad and SPS Envirowall, as well as underfloor and loft insulation. However due to a number of issues Alumasc Swisstherm External Wall Insulation was used in the final project.

In addition, 15 homes received 2 Vent-Axia single room heat recovery units; usually 1 in the kitchen and 1 in the bathroom.

This was to reduce the condensation risk associated with solid wall insulation (SWI).

1.2 Aims

The aims of the project were:

- To establish how CWaC Council could help park home households improve the thermal efficiency of their properties.
- To reduce energy bills and improve health and wellbeing for park home households in CWaC.
- To produce detailed case studies, establish show homes, and inform national best practice.
- To develop a business case for funding and finances to be better allocated on a local and national basis.

1.3 Project timeline

This timeline sets out the timescales of the project.

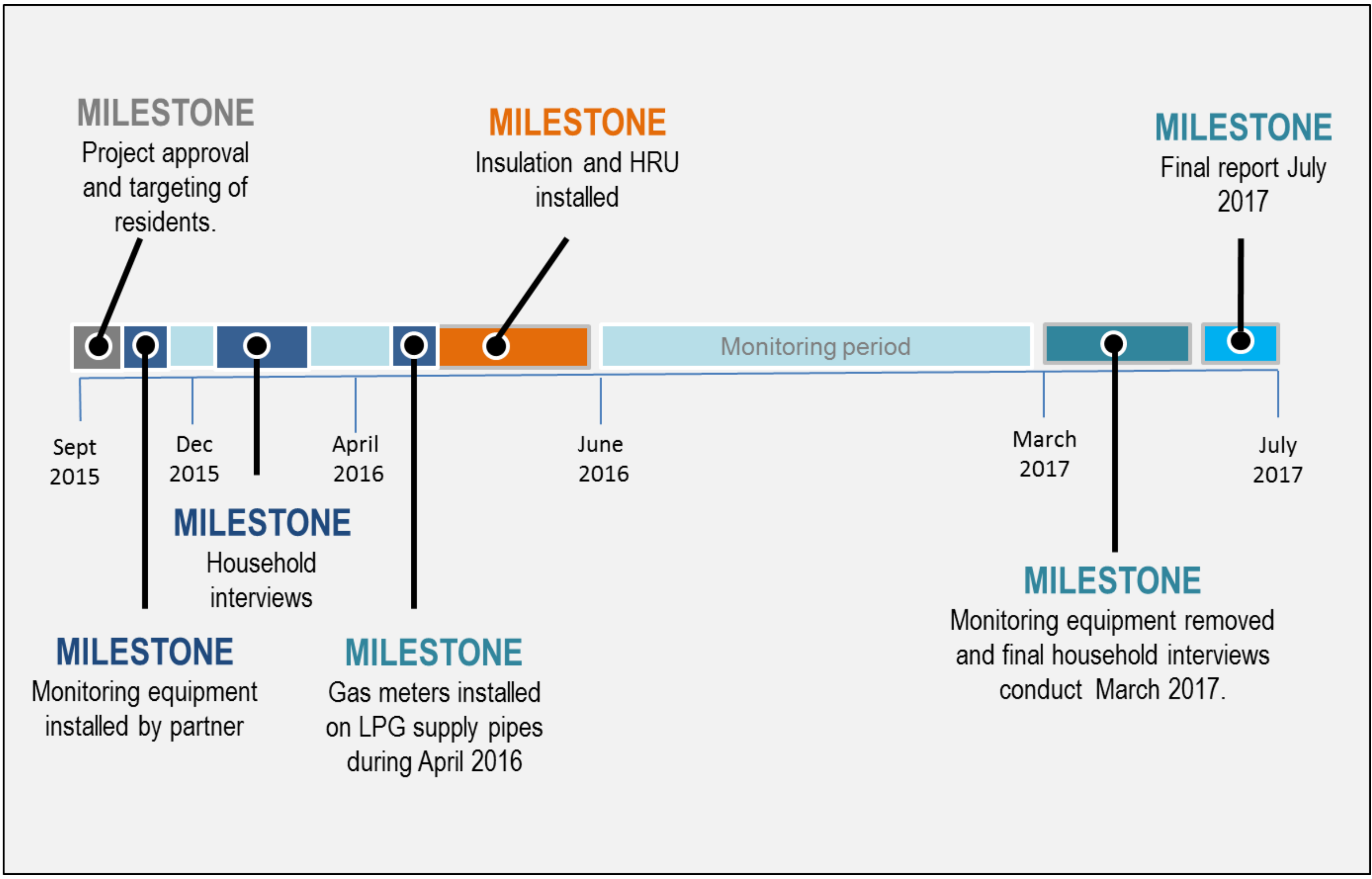

Figure 1.1 Project timeline

1.4 Attracting beneficiaries and establishing the monitored group

The original bid named 2 sites as targets for the project. There were complications with 1 of the sites as it was at the time being sold, and had some further issues that needed to be addressed (e.g. the homes were too close together to comply with fire regulations and were having to be moved). Homes on the other site had also received external wall insulation within the last 5 years. Orchard Park was chosen as it is 1 of the oldest and largest sites in the Borough and offered economies of scale for product testing.

12 households were selected for monitoring purposes, 5 of which just received insulation measures and 7 of which had insulation and HRUs. Thermal and humidity data loggers were installed by the Council and 8 households also had gas meters installed on their LPG tanks or bottles in order to monitor changes in heating fuel use.

1.5 Factors affecting the evaluation methodology

Issue	Description and mitigation
Size of monitoring group	Originally 9 households were due to have gas meters installed. Unfortunately 1 of the households identified was not happy with the positioning of the meter, so that installation did not take place, and a replacement household was not engaged.
Comparison of the two EWI systems	There were issues with the condition of 1 of the EWI systems originally identified for the properties, as well as training issues for the installers. After the pilot property was completed, the householders were not happy with the quality of the product or the installation, so this system was removed and replaced with the Alumasc. The householders were happy with this and were further offered the opportunity to choose their own paint colour in compensation. This meant that we could not compare the 2 systems as originally planned, and we were not able to insulate the metal park homes as the Alumasc system is only suitable for wooden homes. This caused some displeasure amongst householders who were no longer eligible for the insulation, which had to be carefully managed by the park manager and the Council.
Monitoring equipment issues	The gas meter event loggers were outside and at risk of water damage, so these were swapped in September 2017 and encased in plastic bags. The HRU units are outside and monitoring kit needed to be installed both internally and externally to record the temperature difference between the air going in and out. This required a data logger to be attached to a smooth round external surface, and a step ladder and a range of cable ties were needed to install this securely. Monitoring of the HRUs was installed in early 2017 and continued until May.
Control group	No control group was identified for this project. However the monitoring kit was installed November 2015, thus covering the

	winter period pre-installation.
Electricity meter readings	The park owner buys electricity for the whole park and sells it on to the households, who do not have access to their meters. Instead the park manager reads the meters every quarter and sends out a bill with an admin charge included. This meant that we had limited access to electricity data.
Managing expectations	The original bid was for 30 park homes to be insulated. However 2 further amounts of funding became available during the project, so a total of 52 homes were helped. Inevitably there were some residents who would have benefitted from the insulation, but unfortunately missed out on the funding at each stage. This caused some friction on site during the installation, as well as afterwards, as 2 of the insulated homes has since gone up for sale.
Gas meter readings	As gas meters were only installed in April 2016, we only have anecdotal feedback on gas use before the measures were installed. Households were not given meter reading log books at the time of installation, so we only have meter readings from August 2016.

2. Technical evaluation methodology

2.1 Introduction

12 households out of a total of 52 were monitored. 7 of the monitored households also had heat recovery units (HRU) installed, enabling us to compare the effect of these on the humidity of the households by using data loggers. These data loggers were installed in December 2015 by CWaC. 8 of the monitored households had gas meters installed on the LPG tanks/bottles in April 2016, enabling us to monitor the amount of fuel used to heat the home. The gas meters have been left in situ to help households monitor their own fuel use moving forwards. The insulation of the properties began mid-February 2016 and finished mid-June 2016. All heat recovery units were installed on 21st April 2016.

In order to protect the privacy of the households, data in the study has been anonymised, each being allocated an identification number.


Figure 2.1 Photographs of an insulated (left) and uninsulated (right) park home

Monitored Household.	SAP (Standard Assessment Procedure for home energy efficency). Before Measures Rating.	SAP After measures Rating.	Measure installed.
T-01	F	D	Insulation only.
T-02	F	D	Insulation & HRU.
T-03	F	D	Insulation & HRU.
T-04	F	D	Insulation & HRU.
T-05	F	D	Insulation & HRU.
T-06	F	D	Insulation only.
T-07	F	D	Insulation & HRU.
T-08	F	D	Insulation only.
T-09	F	D	Insulation & HRU.
T-10	F	D	Insulation only.
T-11	F	D	Insulation & HRU
T-12	F	D	Insulation only.

Table 2.2. Showing the SAP ratings before and after the measures were installed provided by Cornerstone Renewables.

2.2 Technical monitoring

Of the 52 households, 12 agreed to allow us to monitor and assess the performance and impact of the insulation and HRU measures over a 12 month period including a full winter period. Installation of the monitoring equipment began in December 2015 in order to monitor the winter period before the measures were installed. Each monitored household had at least 3 different types of monitoring equipment installed: a thermal and humidity logger; USB-5 data logger; and a gas meter attached to the LPG gas bottles.

2 of the 12 households had 6 additional pieces of monitoring equipment in order to more closely monitor the impacts of the HRUs. This included: 2 thermal probes placed internally and externally of the HRU; 1 Tiny Tag placed outside of 1 of the households; 1 additional thermal and humidity probe placed near the living room HRU within the household; 1 watt-hour meter to measure the energy consumption of the HRU; and an Optipulse logger placed on the watt-hour meter to monitor events.

As well as the fitting of monitoring equipment, it was also required to have back-billing/meter reading data from these households in order to be able to compare their energy before and after installation of measures. Because there was no gas meter fitted until after the measures were installed, the only way of knowing what consumption levels were before would be through historic records of the number of LPG gas bottles purchased.

Monitoring equipment

There were several types of monitoring equipment used in the study:

- USB-2 data loggers which monitored temperature and humidity levels every hour in the room that they were placed in;
- Norstrom gas meters with Lascar event loggers attached (USB-5);
- USB-TP loggers which monitored the temperature of the air entering and leaving the HRUs;
- Landis and Gyr watt hour meters to measure electricity used;
- Omega Pulse 101 loggers to measure the number of pulses from the watt hour meters;
- Tiny Tag external temperature data loggers.

Figure 2.2a Lascar thermal USB-2 logger

Figure 2.2b Gas meter and data logger

Figure 2.2c Watt hour meter and Optipulse

Figure 2.2d Thermal probe on external HRU vent

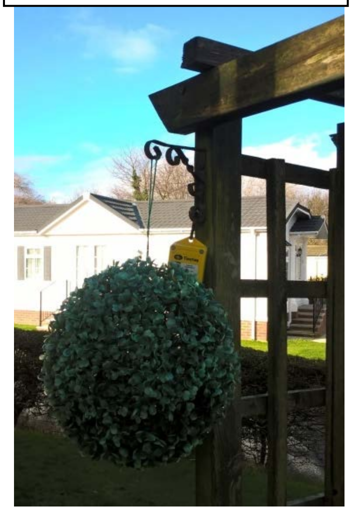

Figure 2.2e Tiny Tag external temperature logger

Thermal data loggers

Every household had 1 temperature and humidity logger placed in the living room. 2 of the households with HRUs had an additional thermal humidity logger, 2 USB thermal probe loggers and a Tiny Tag placed outside 1 of the households with HRU monitoring to measure outside temperature as mentioned earlier.

Electricity consumption meters

Standard electricity consumption or watt hour meters were fitted on 1 of the wires to the heat recovery unit to record the total electricity consumption in kWh. These were fitted on 2 of the heat recovery units.

Gas consumption meters

8 households had gas meters installed on their LPG bottles/tanks.

Optipulse sensors

The watt hour meter has a LED which flashes due to electricity consumption. An Optipulse sensor was fitted over the LED of each of the watt hour meters to capture the kWh consumption by time.

Household Type	Monitoring Equipment	Number of households
Monitored	USB Thermal and humidity data loggers. 1 will be placed in each household. 2 households will receive 2 of these loggers.	12
Monitored	Gas meters and loggers to measure total gas consumption	8
Monitored	Electricity Meters with Pulse sensors to measure HRU consumption	2
Monitored	Temperature loggers on HRU vents (inside and out)	2
Monitored	Tiny Tag external logger	1

Table 2.3 Summary of monitoring equipment

Schematic diagrams of the layout of the monitoring equipment layout of the households are shown in Figures 2.4a and 2.4b.

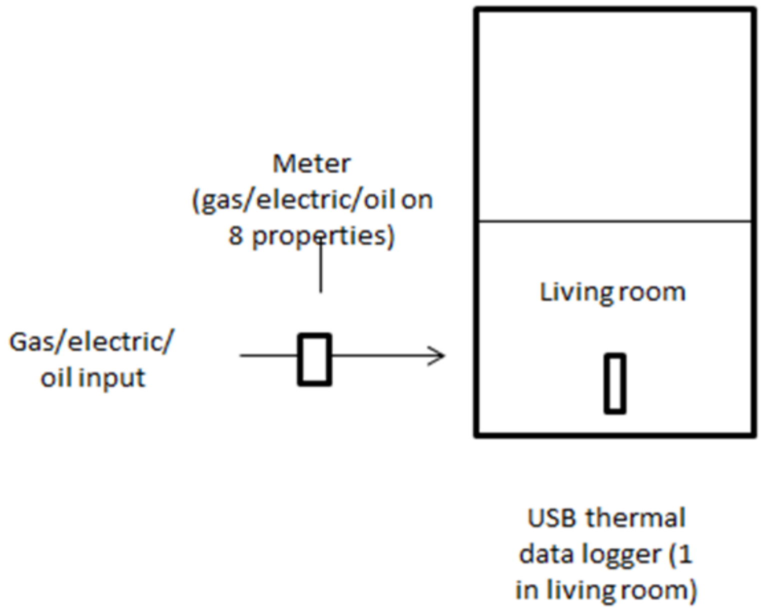

Figure 2.4a Schematic diagram of the monitoring equipment that will be placed in all households.

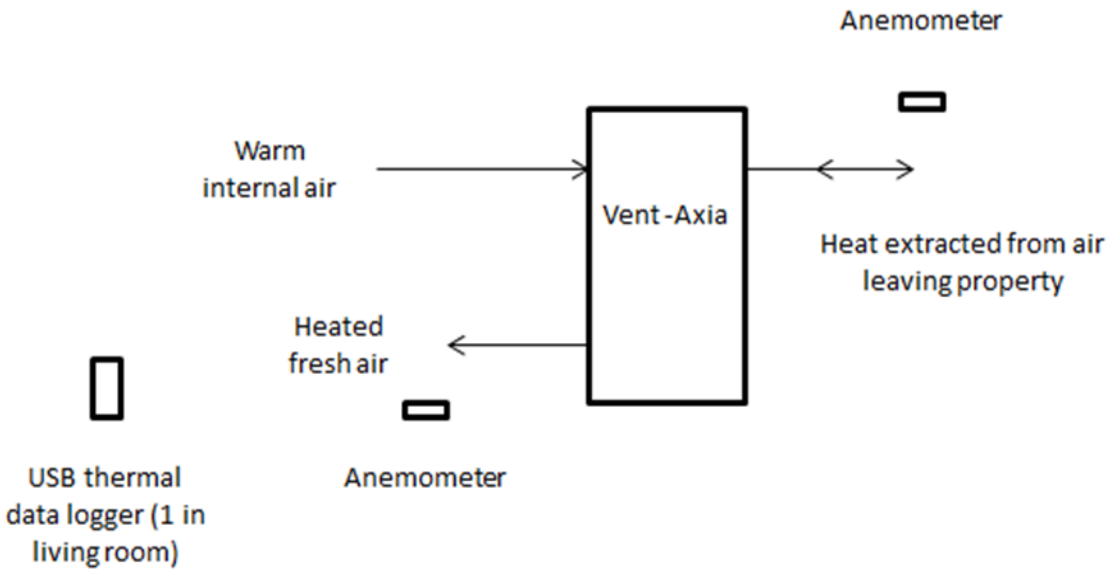

Figure 2.4b Schematic diagram of the HRU unit and monitoring equipment that will be placed in all households that receive the HRU.

2.3 Social evaluation

A voluntary questionnaire was conducted with the monitored householders before and after technology measures were installed. Personal details about age, work status, and health conditions were collected along with household attitudes and feelings towards saving energy, worrying about paying energy bills, and staying warm. Structural details of the home such as the number of rooms, insulation levels, and boiler age were also collected along with energy bill data such as supplier, tariff, and method of payment. The questionnaire was completed during face-to-face interviews between the householder and NEA's project development co-ordinator. If a householder could not answer a question, it was left blank and recorded as a missing value. Of the monitored households, all 12 questionnaires were collected both before and after the study. Any deviation in sample size seen in accompanying charts and diagrams indicate missing values were present.

Householder demographic details

Householders' age, occupation and health conditions were analysed independently, and the results are shown below.

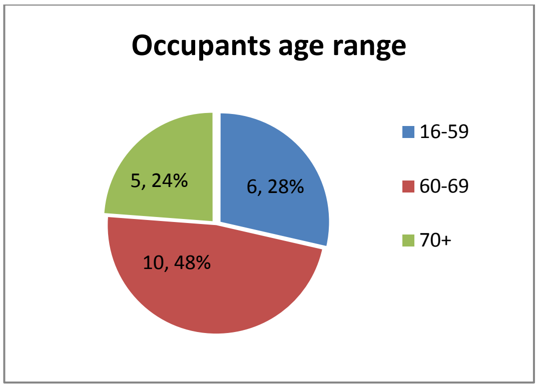

Figure 2.5a Occupants age range

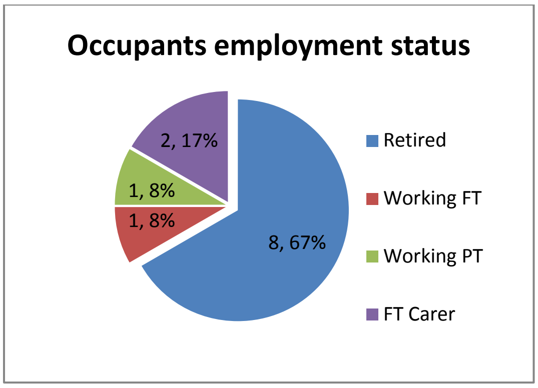

Figure 2.5b Occupants employment status

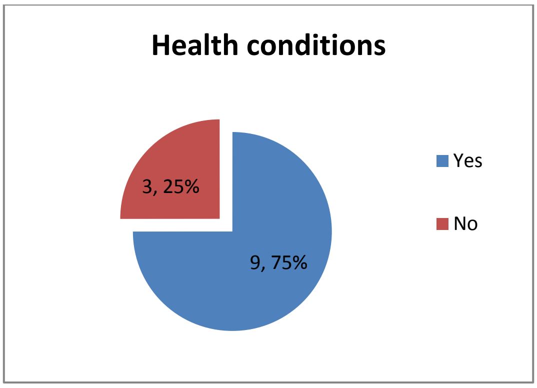

Figure 2.5c Health conditions of occupants

Figure 2.5a shows that within the 12 households monitored there are 21 residents of which most are in the age range of 60-69 (10 residents). Figure 2.5b shows that the majority of households are retired (8 households) whilst 2 households are carers. This impacts on the heating needs of the household, as occupants in these groups tend to spend more time in the home. Only 2 households (16%) had an occupant who was working either full time or part time.

9 of the households (75%) have health conditions which are exacerbated by living in cold homes. These health issues cover a wide range of conditions including arthritis, diabetes, Reynard's disease, cardiac and respiratory conditions, fibromyalgia, cancer, brain tumours and asthma. All of these conditions may result in a higher heating demand than usual.

All the park homes are 1 storey, however there was a range of sizes of home with the most common being 2 bedroomed (7 homes or 58%). The site is off gas, and all households have gas boilers running on LPG.

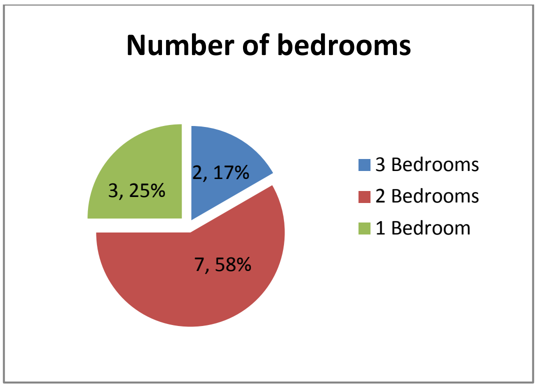

Figure 2.5d Number of bedroom in the study group homes

Qualitative feedback given pre-installation of the insulation and HRUs

Before installing the technologies, it was important to define the heating period to be used for the technical analyses. Respondents were asked when it was important to have a warm home and responses varied between households with some reporting heating the home for 24 hours per day, and others reporting intervals as short as just 5 hours per day. The heating period with the highest frequencies is 19:00-22:00 as seen below in Figure 2.6.

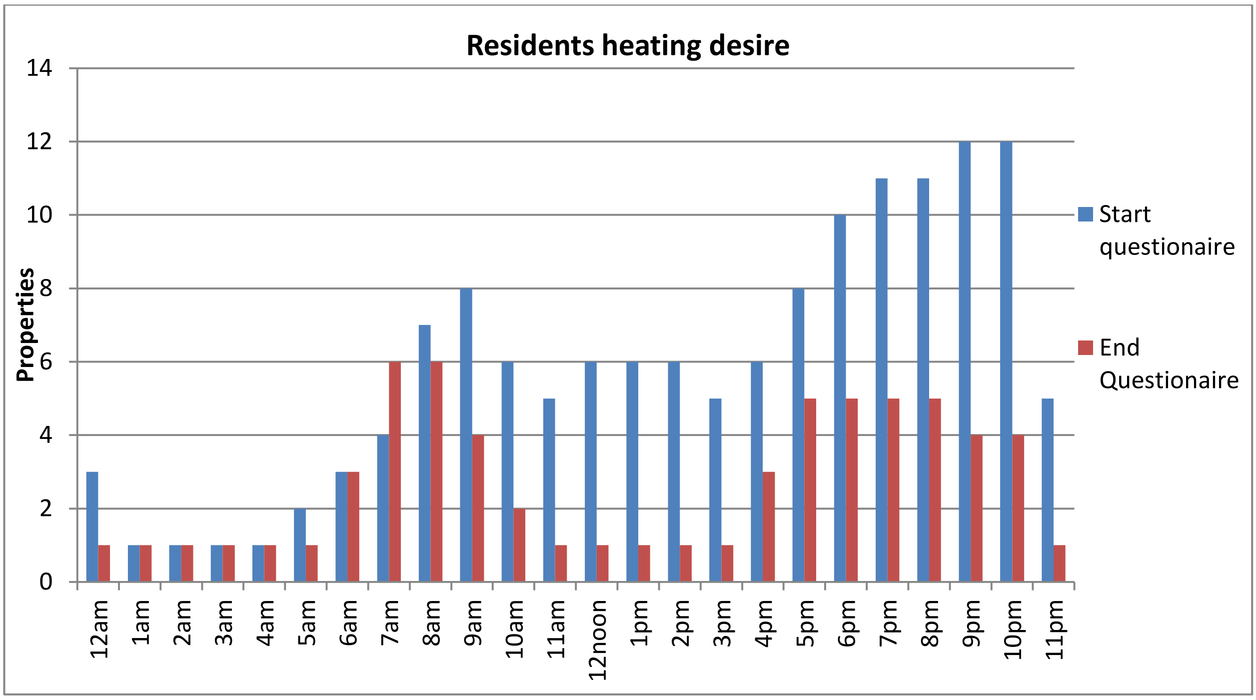

Figure 2.6 Times when it was important for the Households to have a warm home

Qualitative feedback given post-installation of the insulation and HRUs

Of the 12 questionnaires, there were no reported changes to household heating requirements or the number and age profile of households. No households reported any changes in employment status and income levels. However 2 households reported a change in their health conditions (T03 and T04). Both of these households now had occupants who have a health condition exacerbated by the cold. In terms of heating demand there was a noticeable change since the measures were installed. Generally, it appeared that households demanded less heating than they did originally. The period between 19:00 and 22:00 was still reported as the main heating period, but fewer households said they needed heating during this period after the measures were installed. It may be concluded that this was because the home was retaining the heat better than it previously did, as shown in Figure 2.7.

Resident acceptance and satisfaction

Households were asked to rate their satisfaction levels with their home's warmth and heating system using 1 of the following responses: 'very dissatisfied'; 'dissatisfied'; 'neutral'; 'satisfied'; and 'very satisfied'. Each response was assigned a score where 'very dissatisfied' scored 0 and 'very satisfied' scored 100. An average (mean) score of between 0 (very dissatisfied) and 100 (very satisfied) was then calculated across the sample. Figures 2.8 below shows the results of the households' perceived comforts and benefits before and after the technologies were installed.

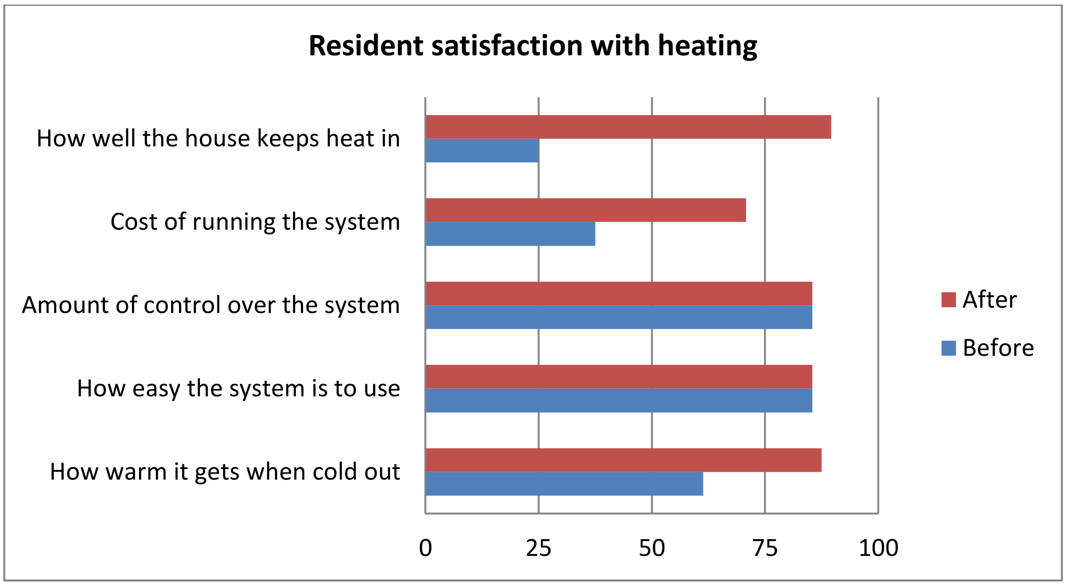

Figure 2.7 Households' satisfaction with their home's warmth and heating system

As can be seen from the chart above, there is a significant increase in the households' satisfaction with how well the home keeps the heat in, post installation. There is also an increase in satisfaction around how warm the home gets when it's cold outside and the cost of running the system. As expected, there is no change in satisfaction with the heating system, as this was not changed by the installation of measures.

Perceived cost

Households were asked a series of questions relating to how they feel about keeping warm at home, and the cost of heating their home. They were asked to rate their responses using 1 of the following responses: 'strongly disagree'; 'disagree'; 'neutral'; 'agree'; and 'strongly agree'. Each response was assigned a score where 'strongly disagree' scored 100 and 'strongly agree' scored 0. An average (mean) score of between 0 and 100 was then calculated across the sample. Figures

2.8 below shows the results of the households' responses on warmth and paying for fuel before and after the technologies were installed.

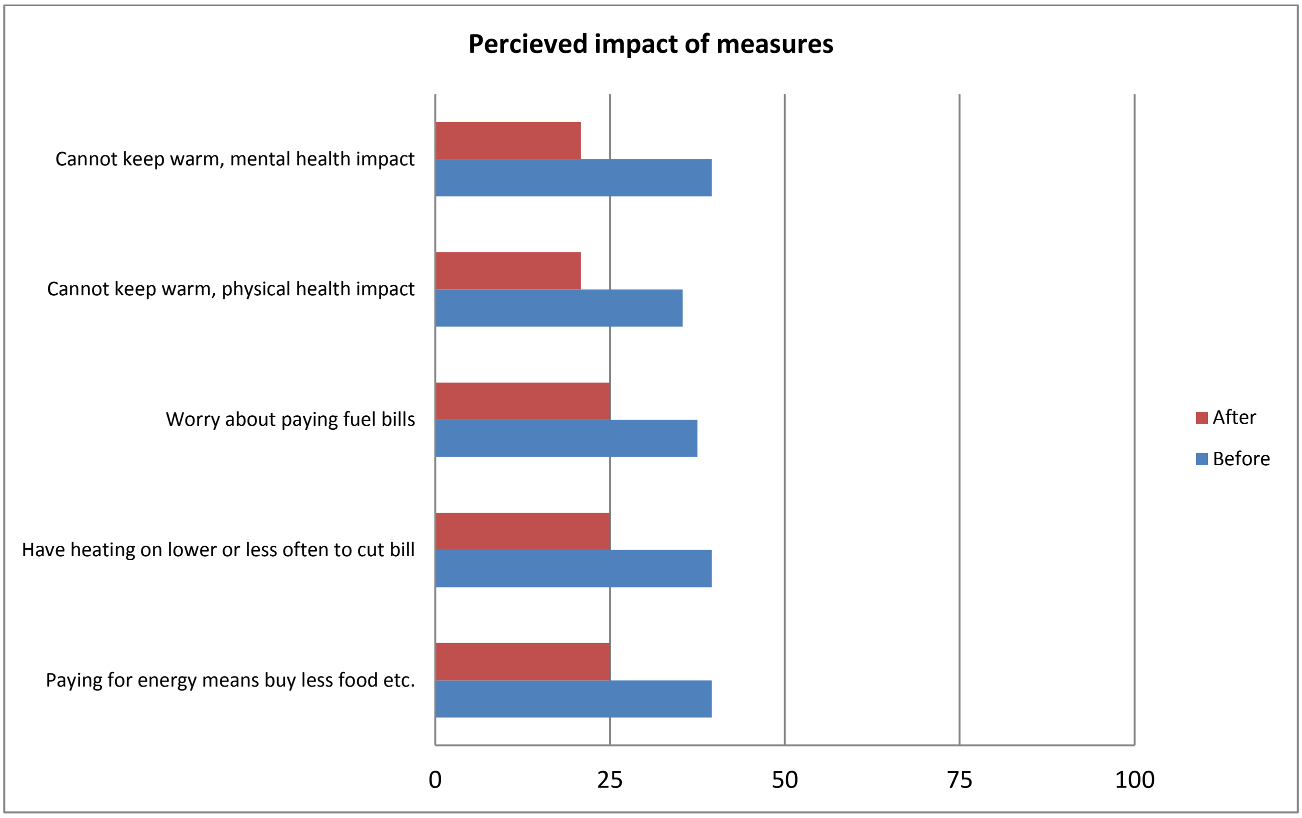

Figure 2.8 Agreement with statements about affordability of fuel bills

As can be seen, across all of the questions, households are feeling less worried about their bills and there is reduced impact of cold homes on both mental and physical health.

3 households commented that they had seen a reduction of gas bottle usage, with 1 saying that they had went from changing 2 47Kg bottles of gas 4 times a year to changing 2 47Kg bottles of gas twice a year.

Perceived comfort and benefits

Figure 2.9 shows the perceived benefits of households that received insulation only and Figure 2.10 shows households that received insulation and HRUs.

All (100%) of the households with insulation and the HRUs and 80% of the households with insulation only felt that their homes were warmer and more comfortable as well as being able to hold heat better. These are key attributes to identify if the insulation installed was having a positive impact.

62% of the households with insulation and HRUs said they felt the measures had reduced their bills, while only 40% of the households with insulation only, said that they felt their heating bills had been reduced. The large difference is unexpected as it was thought that the HRUs would have a bigger impact on reducing damp than reducing bills. One household with the HRU devices had new external doors fitted, which may have helped to further reduce energy bills.

71% of households with HRUs and insulation said they felt their homes got warmer quicker compared with 60% of those with insulation only. Depending on how often the households used the HRUs device and what mode they used, it could supply a heating boost which would help to the room get warmer a little quicker but overall; the insulation would play a bigger role in keeping the home warm by reducing heat loss.

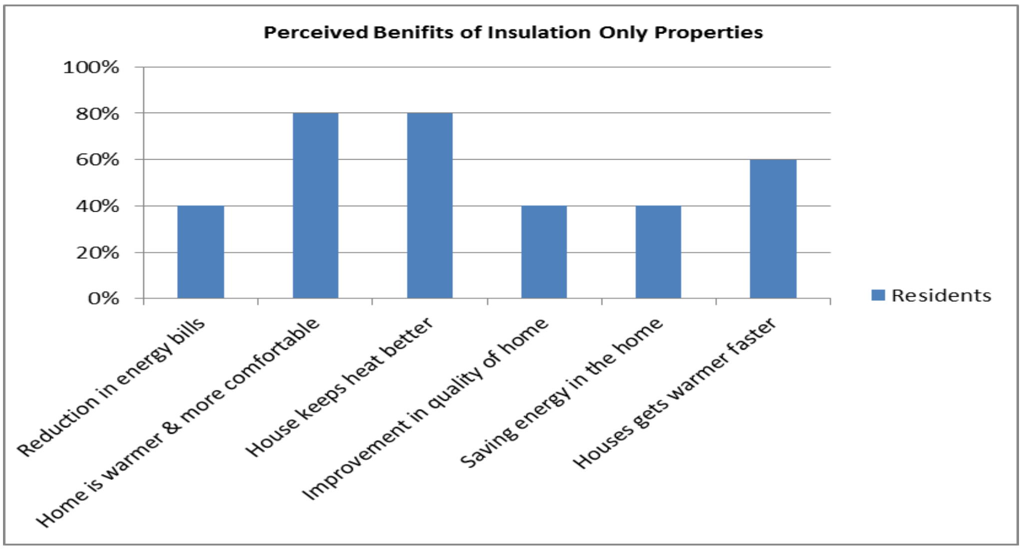

Figure 2.9 Benefits experienced by Households after installation of insulation only.

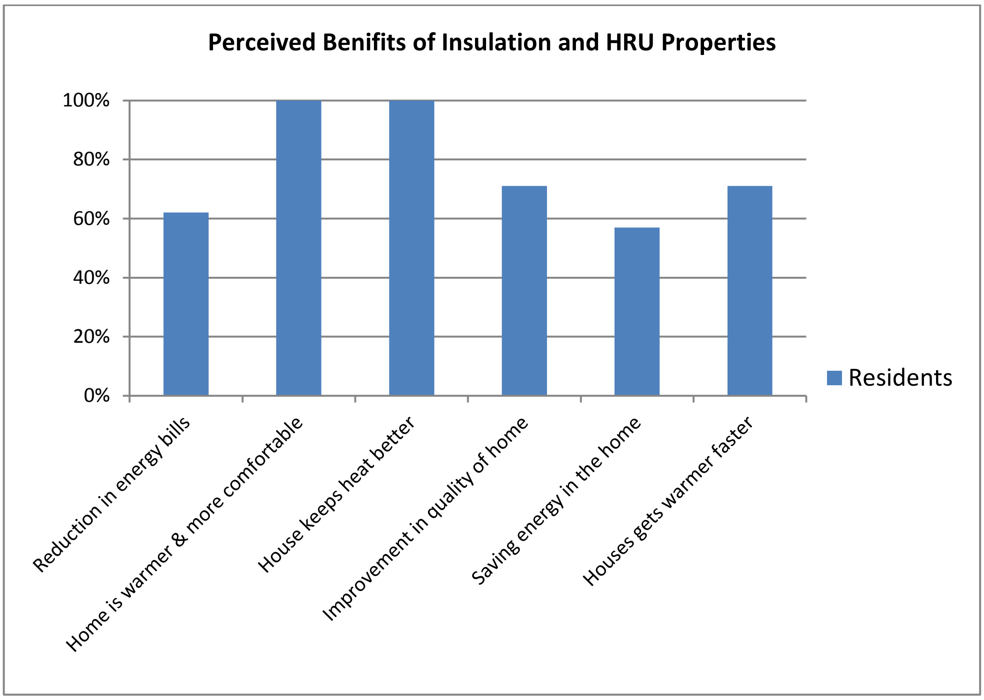

Figure 2.10 Benefits experienced by Households after installation of insulation and HRU.

3. External wall insulation, under floor insulation, loft insulation and heat recovery unit technical evaluation

3.1 Monitoring results

Cost

Electric and gas meter reading data was provided by households during the monitoring period. We also asked for this data covering the period before the installation of measures. The before period is any time before 10th June 2016, the after period is beyond this date. Unfortunately, only 2 households (T-01 and T-05) provided electricity data for the prior measures period, with some households saying they had not been told to record meter readings.

The first electric meter readings for households having only insulation measures were available from August 2016 (Table 3.1). A theoretical price of 16p per kWh for electric cost calculations was used.

To properly analyse energy use for indoor space heating, account must be taken of the weather. An external temperature of 15.5°C is accepted by energy professionals as the outside temperature where if the outside temperature is below, then indoor heating will be required. When the outdoor temperature is above 15.5°C then no indoor heating is necessary.

Degree days (DD) are the heating requirement i.e. the number of degrees below 15.5°C that the average temperature is on each day during a given period. For example, when the average outside temperature drops to 14.5°C, this is classed as 1 DD and if the average outside temperature drops to 13.5°C in 1 day, that is classed as 2 DD and so on. Degree days are added together for the given period of time to give the total number of degree days for that period. Different periods can then be compared to view energy consumption and the results used to predict energy consumption are on a normalised basis taking into account the outside temperature for those different periods. Degree day data was obtained from Liverpool Airport weather station EGGP.

Calculating LPG consumption

It was not possible to calculate costs for gas consumption prior to the installation of measures for households as they used LPG. Most were either gas storage tanks or 47Kg cylinders of propane LPG. After measures were installed a gas meter was supplied to the household in order to monitor the gas usage. The gas meter readings were available from August/September 2016 (Table 3.3). A significant hurdle with the analysis of the gas cost was the fact it was LPG not natural gas, therefore a new formula needed to be created using the calorific value of propane LPG in its gaseous form; this was calculated and confirmed by Calor Gas to be 25.89kWh/M³. A theoretical price for LPG was formulated by calculating that a 47kg gas cylinder contained 93.82 litres of gas and that 1 litre of propane was equivalent to 7.113kWh[9], with the equivalent cost of 1 47Kg cylinder of propane LPG being £50, the theoretical cost of 7.5p/kWh was used for periods both before and after installation of measures.

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[9] BOC. 2015. Cylinder propane factsheet. Assessed August 2017. https://www.boconline.co.uk/internet.lg.lg.gbr/en/images/602115-MI%20Propane%20cylinder%20data%20sheet_03410_168592.pdf?v=2.0

20 year average degree-day comparison of savings						Region		Elton, Chester			20 year average			2224	
Insulation Only	"Before" period							"After" period							Comparison
Tech Ref	Period	Days	Total Period (kWh)	Cost per 30 days	Degree days	kWh per Degree Day	Estimated annual cost#	Period	Days	Total Period (kWh)	Cost per 30 days	Degree days	kWh per Degree Day	Estimated annual cost#	Estimated Saving#
T-01		0	0		0			21/9/16-22/5/17	243	4953.74	45.87	1704.80	2.91	484.68	
T-10		0	0		0			11/8/16-22/5/17	235	7199.70	68.93	1693.70	4.25	709.05	
T-08	13/2/15-16/3/16	397.00	12433.52	70.47	2092.10	5.94	991.31	21/9/16-10/3/17	170	7280.22	96.36	1326.50	5.49	915.45	7.65%
T-06		0	0		0			21/09/16-22/5/17	243	7053.68	65.31	1704.80	4.14	690.14	
Average		99.25	3108.38	70.47	523.03	5.94	991.31		222.75	6621.83	69.12	1607.45	4.20	699.83	7.65%
# 12 month estimated costs based on 20 year degree-day value for the region stated															

Table 3,1 Analysis of **gas** costs based on meter readings before and after the **insulation** measures were fitted.

Table 3.1 shows the gas consumption of households who received insulation only and who gave sufficient meter readings to be included in this section of the analysis. Household T-12 did not receive a gas meter and this was why they were excluded. It was possible however to calculate some pre-installation consumption data using bills and feedback supplied by the households of how much LPG they routinely bought before the insulation was installed.

As can be seen in Table 3.1 only household T-08 supplied sufficient pre-installation data of the insulation only group. T-08 made an estimated 7.65% (£75.86) saving on their gas bill post-installation when taking degree days into account. Household T-01 and T-10 both said they were satisfied with the cost of their heating system since the measures were installed. Household T-01 also received new doors which may have also helped improve heat retention and thermal comfort. They also said they do not heat the bathroom and spare room but do heat the household on a low heat when they are out. Household T-10 said that before the measures were installed they would buy 1 cylinder of gas per week but since the measures had been installed they were buying 1 cylinder of gas approximately once a month. Unfortunately because it is not specified what size cylinder this household used, it can only be used as anecdotal evidence, but it is a potentially positive indicator that the insulation measures have helped to reduce the cost of heating the home. Household T-06 however did not feel there had been a change in their heating bills since the insulation measures were installed, stating that they used approximately 5 47Kg cylinders of LPG between September 2016 and April 2017.

Table 3.2 shows the pre- and post-installation gas costs of households that received insulation and HRUs. Households T-02 and T-11 were excluded from this part of the analysis as they did not receive gas meters so consumption could not be measured. T-05 was the only household that had a full set of pre- and post-installation consumption data. The analysis indicated that the household potentially made a significant saving of 47% (£470.79) post-installation of the measures after degree days were taken into account. This saving may be exaggerated as the bill data shows how the number of litres of LPG the resident purchased during the pre-installation period, but this may not equate to actual usage.

Household T-04 provided some LPG bill data which gave an estimated annual expenditure on LPG pre-installation. Unfortunately the householder did not take meter readings post-installation. The householder reported anecdotally that they had seen no reduction in their heating bill since the measures were installed but this may have been due to the fact this resident had been prescribed some medication for a health issue that made them feel colder, so they were using the heating a little more than normal. The resident also stated that they kept the heating on while they were not at home.

Household T-07 said they had replacement windows put in just after their measures were installed. They also said that they did not heat 1 of the bedrooms. The resident said that they felt very satisfied with the cost of their heating system and saw a noticeable reduction in the running cost since the installation of the HRU and insulation measures as well as the new windows. Unfortunately, the householder spent a period of time in hospital, during which the meter reading recording booklet supplied by NEA was lost, making this data only anecdotal.

Household T-03 reported that before the measures were installed, they would buy 8 47Kg cylinders of LPG on average, reducing to 4 cylinders post-installation. This is a significant reduction although because no dates or specific usage information was given, this is anecdotal rather than concrete evidence. As can be seen from Table 3.2, the annual *estimated* cost of gas for T-03 is much higher than the cost of 4 47Kg cylinders of LPG (reported as *actual* consumption). This is because the analysis has taken into account heating habits and the degree days during a winter period, which may mean the estimated cost is higher than reality.

Household T-09 said they used a gas fire alongside the main gas heating system which could help explain why they have a higher gas bill than anyone else. This resident said they noticed no change in their gas bill.

	20 year average degree-day comparison of savings					Region	Elton, Chester			20 year average				2224	
Insulation and HRU	"Before" period							"After" period							Comparison
Tech Ref	Period	Days	Total Period (kWh)	Cost per 30 days	Degree days	kWh per Degree Day	Estimated annual cost#	Period	Days	Total Period (kWh)	Cost per 30 days	Degree days	kWh per Degree Day	Estimated annual cost#	Estimated Saving#
T-05	7/3/15-7/3/16	427	14581.85	76.84	2432.90	5.99	999.73	11/9/16-21/5/17	274	5446.09	44.72	1717.40	3.17	528.94	47.09%
T-07		0	0.00		0.00			10/8/16-22/5/17	285	8753.15	69.10	1726.00	5.07	845.90	
T-03		0	0.00		0.00			11/8/16-19/5/17	281	9531.71	76.32	1714.00	5.56	927.59	
T-09		0	0.00		0.00			11/8/16-11/5/17	273	12617.28	103.99	1696.70	7.44	1240.39	
T-04	1/1/15-1/1/16	365	6406.48	39.49	1836.90	3.49	581.74	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Average		158.4	4197.67	58.16	853.96	4.74	790.74		278.25	9087.06	73.53	1713.53	5.31	885.71	47.09%
# 12 month estimated costs based on 20 year degree-day value for the region stated															

Table 3.2 Analysis of **gas** costs based on meter readings before and after the **insulation and HRU** measures were fitted.

Table 3.3 shows the gas consumption data of all of the monitored households (i.e. those receiving insulation only, and those receiving insulation and HRUs). On average those with the HRUs spent £177.14 more on their gas bills than those without the HRU. The HRU would not have had a direct impact on the gas consumption as it was electrically powered, so the cause of that difference will be a result of various other factors such as supplementary heating use, heating habits and health issues.

Household T-01 had the lowest gas cost, whilst household T-09 had the highest estimated gas cost. Across all of the monitored households an estimated average annual saving of 27.37% (£ .75) of gas bills can be seen. Combining this estimation and the anecdotal data it can be suggested that the loft, under floor and external wall insulation installed in all households has reduced gas consumption, which is supported by Figure 2.7.

Table 3.3 The **gas** cost across **all** monitored households before and after the measures were fitted.

20 year average degree-day comparison of savings							Region				20 year average			2224	
	"Before" period							"After" period							Comparison
Tech Ref	Period	Days	Total Period (kWh)	Cost per 30 days	Degree days	kWh per Degree Day	Estimated annual cost#	Period	Days	Total Period (kWh)	Cost per 30 days	Degree days	kWh per Degree Day	Estimated annual cost#	Estimated Saving#
T-01		0	0.0		0.00			21/9/16-22/5/17	243	4,953.7	£45.87	1,704.80	2.906	£484.68	
T-10		0	0.0		0.00			11/8/16-22/5/17	235	7,199.7	£68.93	1,693.70	4.251	£709.05	
T-08	13/2/15-16/3/16	397	12,433.5	£70.47	2,092.10	5.943	£991.31	21/9/16-10/3/17	170	7,280.2	£96.36	1,326.50	5.488	£915.45	7.65%
T-05	7/3/15-7/3/16	427	14,581.9	£76.84	2,432.90	5.994	£999.73	11/9/16-21/5/17	274	5,446.1	£44.72	1,717.40	3.171	£528.94	47.09%
T-07		0	0.0		0.00			10/8/16-22/5/17	285	8,753.2	£69.10	1,726.00	5.071	£845.90	
T-03		0	0.0		0.00			11/8/16-19/5/17	281	9,531.7	£76.32	1,714.00	5.561	£927.59	
T-09		0	0.0		0.00			11/8/16-11/5/17	273	12,617.3	£103.99	1,696.70	7.436	£1,240.39	
T-06		0	0.0		0.00			21/09/16-22/5/17	243	7,053.7	£65.31	1,704.80	4.138	£690.14	
T-04	1/1/15-1/1/16	365	6,406.5	£39.49	1,836.90	3.488	£581.74	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Average			3,376.922	73.652	565.625	5.968	995.520		250.50	7854.45	71.33	1660.49	4.75	792.77	27.37%
# 12 month estimated costs based on 20 year degree-day value for the region stated															

Ins	1st Dec 16-31st Mar 17	
Gas USB-5	24hr	7-10pm
Property	Total kWh	Total kWh
T-08	2515.89	303.18
T-01	1356.91	200.51
T-10	1997.61	369.72
T-06	2007.60	457.13
Maximum	2515.89	457.13
Minimum	1356.91	200.51
Average	1969.50	332.64
Std Dev	474.71	108.32

Ins & HRU	1st Dec 16-31st Mar 17	
Gas USB-5	24hr	7-10pm
Property	Total kWh	Total kWh
T-09	3100.82	458.59
T-07	2300.12	492.92
Maximum	3100.82	492.92
Minimum	2300.12	458.59
Average	2700.47	475.75
Std Dev	566.18	24.28

Table 3.4 Shows the total kWh during the 2016-2017 winter period for those with just insulation and those with insulation and HRU.

The USB-5 loggers attached to the gas meters also measure consumption. The USB-5 loggers proved to be accurate for the households who supplied data; this could be checked by comparing the exact dates from meter readings.

Performance graphs

Where sufficient data was available during the monitored period, it was possible to plot a graph of gas consumption (kWh) against the number of degree days to illustrate the heating requirement. Using this information, 2 prior performance graphs were created illustrating gas consumption before and after measures were installed.

The performance graphs show how well the households are controlling the use of their heating systems. Ideally this would be compared against a pre-installation period to see how the measures impacted the households' use and performance of the heating system, but this is only possible where sufficient data is available. The graphs use gas consumption (kWh) gained through the supplied meter readings and degree days to form a gradient of energy use for a given amount of degree days. The line of best fit indicates if households are using their heating efficiently, i.e. when the outside temperature is below 15.5°C which is when heating is required according to energy professionals[10]. Good lines of best fit show efficient use or control of the heating system. A poor line of best fit indicates over use (over heating) or under heating, which could be poor efficiency of the household or not heating the home enough.

Figure 3.7 below, shows performance lines of T-05 before and after the insulation and HRU measures were installed. Figure 3.8 shows performance lines for T-08 before and after the insulation was installed. Figure 3.10 shows households T-09 (HRU and insulation), T-06 & T-10 (insulation only) post-installation only performance graphs. The line of best fit shows the relationship between gas consumption and degree days, a better line of best fit would show that heating is being used when required i.e. when the outside temperature falls below 15.5°C. The Y-value indicates that the resident has used the heating a lot when it is perhaps not necessary in order to reach a comfortable temperature. Ideally the Y-value would be between a range of +50 and -50, which would take hot water heating and gas cooker use into account.

Figure 3.7 shows household T-05 before and after the HRU and insulation were installed. T-05 only had a few pre-installation bills showing gas usage which shows that a lot of LPG was bought at certain periods of time throughout the year. When looking at the post-installation period there is much more data. This performance graph shows a very strong line of best fit and Y-value (27.18). There is still some very slight over-heating indicated, but this is likely as a result of cooking and hot water use. Unfortunately because of the lack of pre-installation data, it is difficult to make a true statistical comparison of what the impacts of the measures have been on the households' control and efficiency of their use of the heating systems. However, it was indicated in the social analysis that the measures had significantly impacted on effectively keeping heat inside the home (Figure 2.7) this would suggest a reduced need for the heating to be on. The householder in question did report that they keep the heating on all the time so their heating habits have not changed as a result of the installation, but it is possible that the heating is on lower than before.

[10] Beggs, C. June 2012. Energy: Management, Supply and Conservation. Routledge publishing. P271

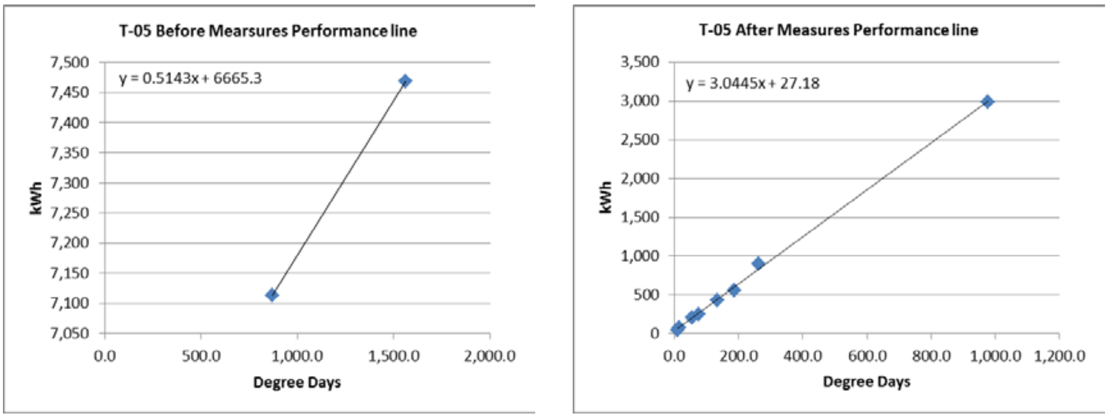

Figure 3.5 Performance graphs of T-05 before and after the Insulation and HRU measures were installed.

Figure 3.6 shows household T-08 before and after the insulation was installed. The before period Y-value was 627.9 and after the measures were installed the Y-value drops dramatically to 29.8. This would indicate that the households' control of their heating system has significantly improved as it appears to be used in relation to degree days when heat is required. This is a positive indication of the impact of the insulation increasing the efficiency of the households and in turn reducing how much heating the resident required, which is also seen in T-08's reduction in estimated gas bill (Figure 3.4). The impact of the insulation is supported by the resident saying they had no other structural changes to their home such as new windows or doors since the measures were installed, and they said they had seen almost a £100 reduction in their gas bill.

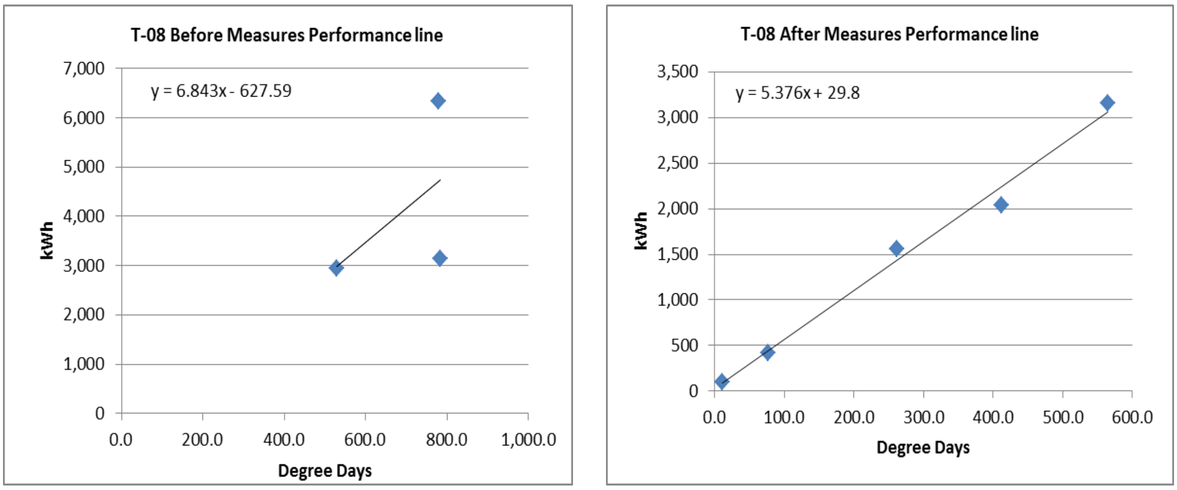

Figure 3.6 Performance graphs of T-08 before and after the insulation only measures were installed.

Figure 3.7 shows the performance graphs post-installation of households T-06 and T-10 (insulation only) and household T-09 (insulation and HRUs). All 3 households show a relatively strong line of best fit which does indicate a good level of control over their heating system in comparison to degree days (when heating is required). Household T-06 had a Y-value of -117.39 and even though household T-06 shows good line of best fit, the negative Y-value indicates that this household is under heating their home. The resident of this household said that they have a habit of turning the thermostat up full until the house is warm then turning it down to a temperature of 16-

18°C. This is an inefficient and ineffective way of heating[11], however, since the installation of the insulation this resident did say they felt that their household got warmer faster (Figure 2.9), which could have reduced how long the resident kept their thermostat on full.

Household T-10 had a Y-value of -68.89. Again, T-10 had a good line of best fit but this negative Y-value suggests that the household is under-heating their home, although not by as much as T-06. The resident of T-10 had said that they had reduced both their normal temperature setting and how long they had the heating on, which could have increased the efficiency of their use and control of the heating system. This cannot be confirmed as there is no performance comparison for the pre-installation period, but it is a potential reason for the negative Y-value. Ideally the Y-value would be between +50 and -50 so household T-10 is not under heating by a large degree.

Household T-09 also appears to have a good line of best fit indicating a good level of control over their heating system and using it when required according to the degree day data. Despite this, the household has a Y-value of 133.43 suggesting this household could be over-heating the home and using more gas than they need according to the degree day data. A possible reason for this is that this resident has a gas room fire which they use alongside the main heating system which would increase their gas consumption (kWh). The household did reduce their heating demand time after the measures were installed, which may mean control of their heating system has improved, hence the good line of best fit. Unfortunately, this cannot be confirmed without a prior period performance graph.

The households receiving insulation only and the households receiving insulation and HRUs appear to be very similar in terms of performance. The HRUs would not impact on the gas consumption as they are electrically powered and they do not appear to have impacted the households' usage of the main heating system as there does not seem to be a pattern of performance to back this up. For example both T-05 and T-08 show low, ideal Y-values whilst T-06, T-10 and T-09 are under-heating or over-heating by varying degrees. It could be suggested that heating habits and using the heating systems effectively are potentially more likely to influence the performance than the addition of the HRUs. Due to lack of energy data on the properties with HRUs the energy savings made in these households as a result of the HRUs cannot be determined. Overall both sets of households show a good level of control and efficiency of their use of their heating systems since the measures were installed which is supported by the social analysis (Figures 2.7, 2.9 and 2.10). Households T-05 and T-08 show a clear and significant improvement on performance since the measures were installed.

[11] Centre for Sustainable Energy. 2013. True or false? The energy myth buster. https://www.cse.org.uk/advice/energy-saving-tips/energy-mythbuster Accessed July 2017.

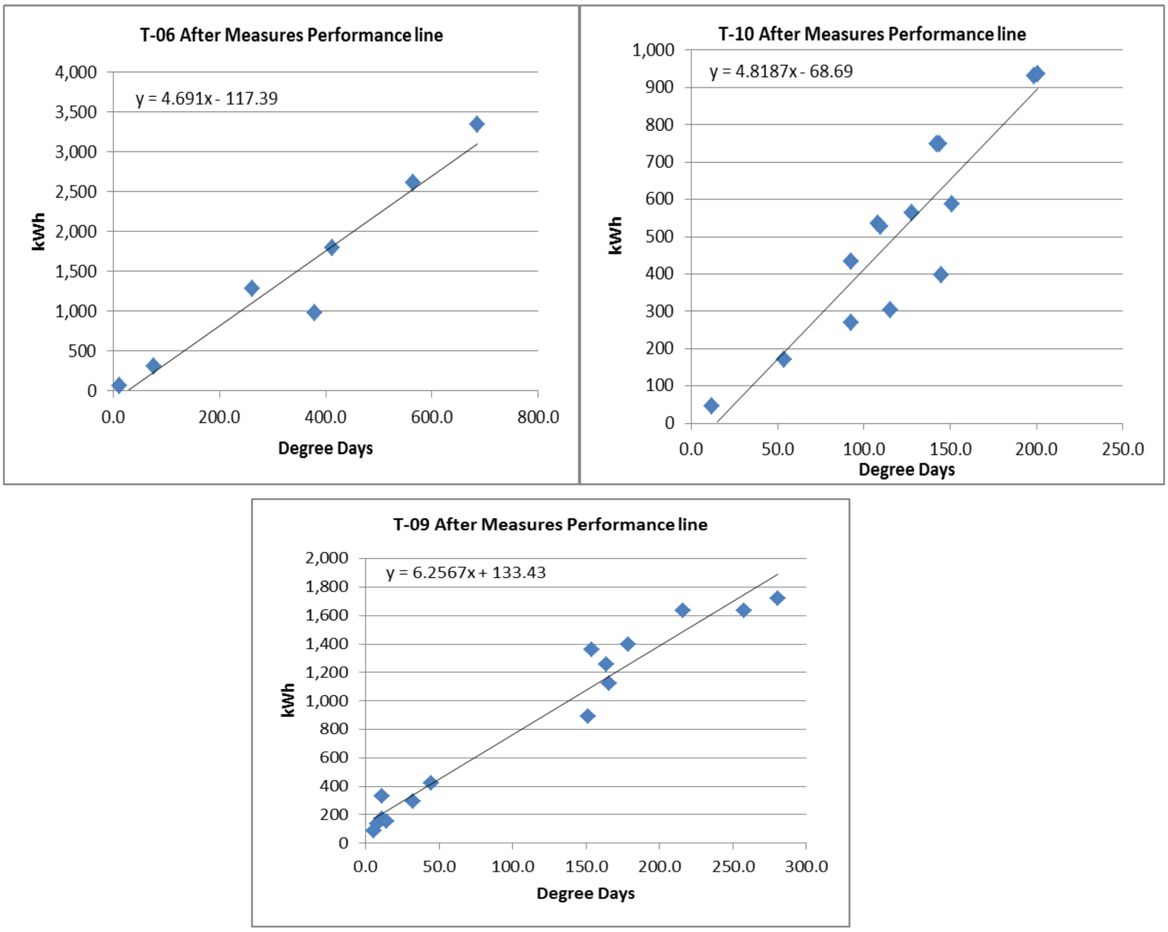

Figure 3.7 Performance graphs of T-06, T-10 (**insulation only**) and T-09 (**insulation and HRU**) after the measures were installed.

3.2 HRU temperature monitoring

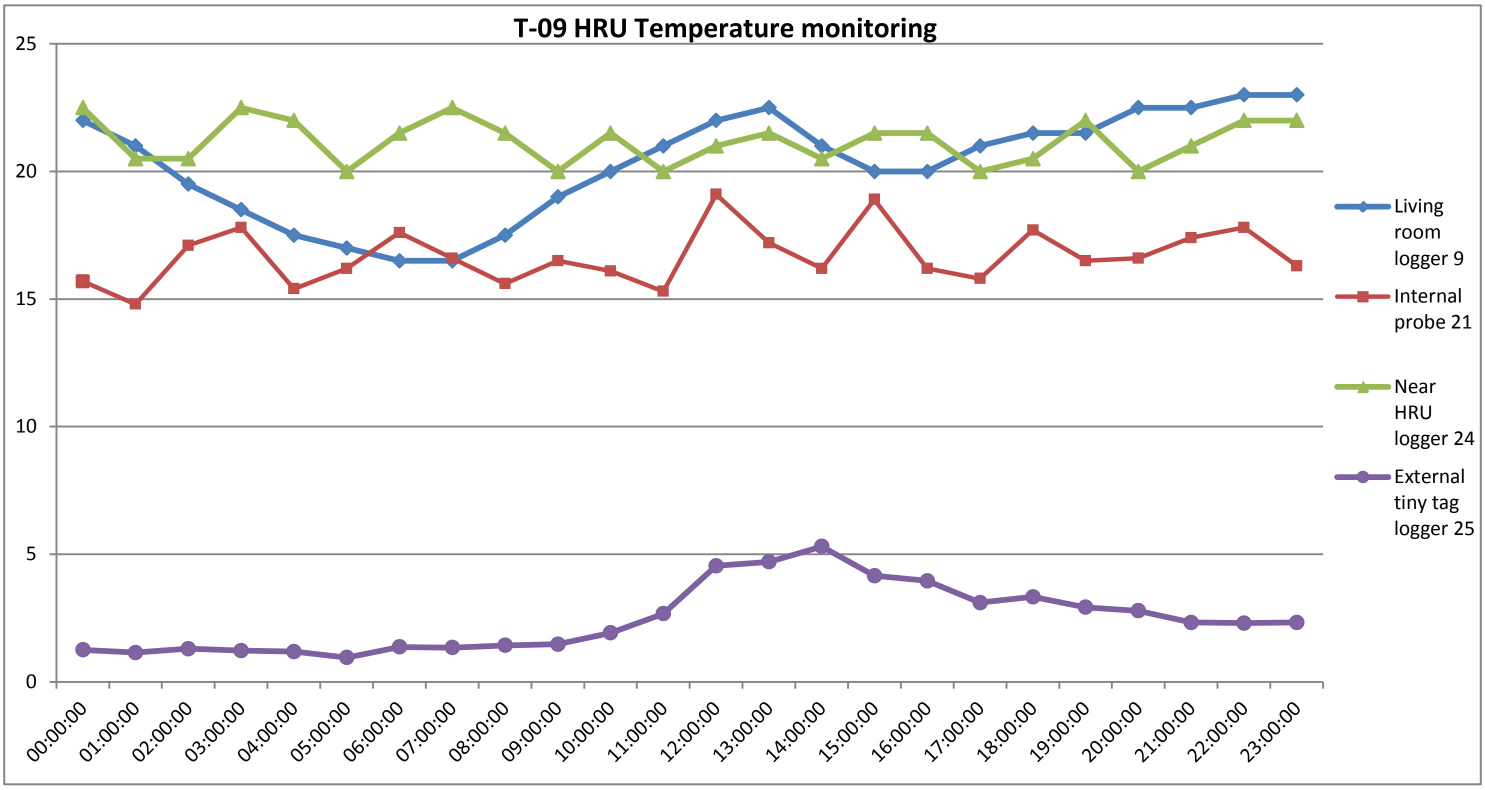

Figure 3.8 Temperature monitoring of T-09 HRU and the area around the heat recovery unit throughout 10th February 2017.

Monitoring of T-09's HRU temperature was done by using the various loggers and probes in and around the household during the coldest day that the HRU were monitored. The coldest day was determined by degree days to be 10th February 2017 which had 12.80 degree days. This was to try to determine when the HRU was used during a cold day and how often the HRU was used.

Figure 3.8 shows the living room temperature (living room logger 9), the temperature next to the HRU in the living room area (near HRU logger 24), the temperature inside the HRU (internal probe 21) and the temperature outside of the household near the HRU vent (external Tiny Tag 25). This graph indicates when the households used the HRU device. When the internal probe's temperature reading raises, the HRU device is off and not being used. When the internal probe's temperature reading drops the HRU is on and being used. This is because when the HRU is on it brings in air from outside that is colder than the living room temperature (logger 9); this would lower the living room temperature slightly. However, if the main heating system is on when the HRU is on, the reductive impact of the HRU is minimal because the main heating system is more powerful and influential over the temperature of the house than the HRU. The internal probe and logger near the HRU will begin to measure the room temperature rather than the temperature of the cooler air coming in from the HRU. When the heating is on and the HRU is on it can be seen at 19:00 that the temperature near the HRU (logger 24) exceeds the living room temperature (logger 9) as the HRU is a source of additional heat to the room. It can also be seen at 14:00 that the external temperature is at its highest (5.3°C) and that temperature the HRU brings in is also at its highest at 16.2°C (logger 21 at 14:00), which can be compared to the lowest external temperature (1.1°C) and the lowest internal probe temperature (14.8°C) at the same time (01:00).

Using Figure 3.8 we can estimate that during this particular day the HRU device was used for approximately 10 hours, mostly for 1 hour periods. These occurred at 1am, 4am, 8am, 11am, 2pm, 4pm, 5pm, 7pm, 8pm and 11pm. The HRU is said to run as low as 3.2watts (0.0032kWh) per hour on low trickle mode[12], high trickle mode 5.7watts (0.0057kWh) or boost 26.6watts (0.0266kWh). During a 10 hour period this would cost 0.005p on low trickle, 0.009p on high trickle and 0.04p if each hour was on boost mode. Unfortunately, it is not known how the households differed in the use of the different modes of the HRU so it is difficult to confirm exactly how much the HRU costs households per day. However, during the period of time that T-07 and T-09 had their HRU devices monitored separately the total cost of running the HRU can be seen in table Table 3.9.

Tech Ref	Period	Days	Total Period (kWh)	Cost per 30 days	Degree days	kWh per Degree Day	Estimated annual cost#
T-09	20/5/16 - 22/5/17	367	32.67	0.43	1813.20	0.02	6.41
T-07	20/5/16 - 22/5/17	367	25.86	0.34	1813.20	0.01	5.08
Average		367	29.27	0.38	1813.20	0.02	5.74

Table 3.9 Estimated cost of T-07 and T-09 Vent-Axia HRU using meter reading data between May 2016 and May2017.

Temperature and thermal comfort

A temperature and humidity logger was placed in each of the monitored homes during the study. The logger was located in the main living room. The logger was placed in January 2016 before the homes received any measures and stayed in the properties until the end of the project in 2017. This enabled a comparison to be made as to whether there was any improvement in thermal comfort as a result of the measures, as well as comparing the thermal comfort of households with only the insulation and those with insulation and HRUs. Data from the loggers was analysed for the periods between 11th January – 31st March 2016 (a pre-installation partial winter period) and 1st December 2016 - 31st March 2017 (a post-installation partial winter period).

Temperatures vary throughout the monitored households. As can be seen in Table 3.11, 3 households were below the recommended range for comfort and good health of 18-21°C before the insulation measures were installed on a 24hr average, and 2 were below during the heating desire period of 7-10pm. This improves after the insulation measures were installed, particularly in households T-06 and T-01, both of which said they felt their homes were warmer and kept heat in better than before. Household T-01 did have replacement doors put in so this may have also led to improvement in temperature. Some households did see a slight reduction in temperature which may be because 80% of the households with insulation only said they felt their homes were more comfortable and held more heat (Figure 2.9) so it is possible that households reduced how often they felt they needed to turn the heating on. Household T-10 has decreased the most; the reason for this is likely to be that this resident lowered their desired temperature setting from 18-21°C to 16-18°C. This was also the case for household T-08. Overall, the average 24hr and 7-10pm temperatures for households with insulation only also increased slightly.

[12] Vent-Axia. Lo-carbon Tempra / Selv Specification. Accessed July 2017. https://www.vent-axia.com/range/lo-carbon-tempra-selv

Average Temp °C	Winter period	BEFORE
Living room	11th Jan 2016 - 31st Mar 2016	
Property	Insulation 24hr	7-10pm
T-12	19.72	22.01
T-10	17.04	19.25
T-08	19.60	21.40
T-06	16.21	16.43
T-01	14.46	17.40
Maximum	19.72	22.01
Minimum	14.46	16.43
Average	17.41	19.30
Std Dev	2.26	2.43

Average Temp °C	Winter period	AFTER
Living room	1st Dec 2016 - 31st Mar 2017	
Property	Insulation 24hr	7-10pm
T-12	19.89	21.82
T-10	16.15	17.27
T-08	19.20	20.63
T-06	18.69	20.76
T-01	15.75	18.25
Maximum	19.89	21.82
Minimum	15.75	17.27
Average	17.94	19.74
Std Dev	1.87	1.90

Table 3.10 shows a prior measures winter period and an after winter period for the households that received just insulation measures.

Table 3.11 shows the temperatures before and after the installation of measures for the households that received HRU and insulation. Before measures were installed, 2 households were below the recommended range for comfort and good health of 18-21°C for a 24hr period and during the 7-10pm heating desire period. This improved to only 1 household falling below that range after the measures were installed. The resident of T-02 kept their normal living room temperature set at ~16°C which would explain why they had the lowest temperature of the households with the HRU measures as all the other households set their temperatures to 18-21°C. Temperatures lower than 18°C are a concern and could have health impacts[13]. Overall, the average temperatures for the 24hr period and 7-10pm heating desire period did increase slightly.

The average temperatures for the different group of households showed that those with the HRU and insulation were slightly warmer than the households with insulation only. This would make sense as the HRU is an additional heat source whereas the insulation primarily increases the home's ability to keep heat in. However, this is very dependent on the residents' habits. Some households commented that they did not use the HRU too much because of the noise, so this might help explain why there is not a significant difference in the average temperatures between the households with insulation only and households with insulation and HRUs.

Average Temp °C	Winter period	BEFORE
Living room	11th Jan 2016 - 31st Mar 2016	
Property	Insulation & HRU 24hr	7-10pm
T-11	18.14	19.21
T-09	20.60	22.60
T-07	18.96	20.78
T-05	21.96	22.80
T-04	18.59	19.45
T-03	16.93	16.86
T-02	14.86	14.38
Maximum	21.96	22.80
Minimum	14.86	14.38
Average	18.58	19.44
Std Dev	2.33	3.04

Average Temp °C	Winter period	AFTER
Living room	1st Dec 2016 - 31st Mar 2017	
Property	Insulation & HRU 24hr	7-10pm
T-11	18.18	18.92
T-09	20.66	21.96
T-07	19.87	21.03
T-05	21.92	22.87
T-04	19.80	20.82
T-03	19.03	19.62
T-02	14.17	14.35
Maximum	21.92	22.87
Minimum	14.17	14.35
Average	19.09	19.94
Std Dev	2.47	2.80

Table 3.11 shows a prior measures winter period and an after measures winter period for the households that received insulation and HRU measures.

[13] The Health Impacts of Cold Homes and Fuel Poverty, Marmot Review (2011) https://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf Accsessed July 2017.

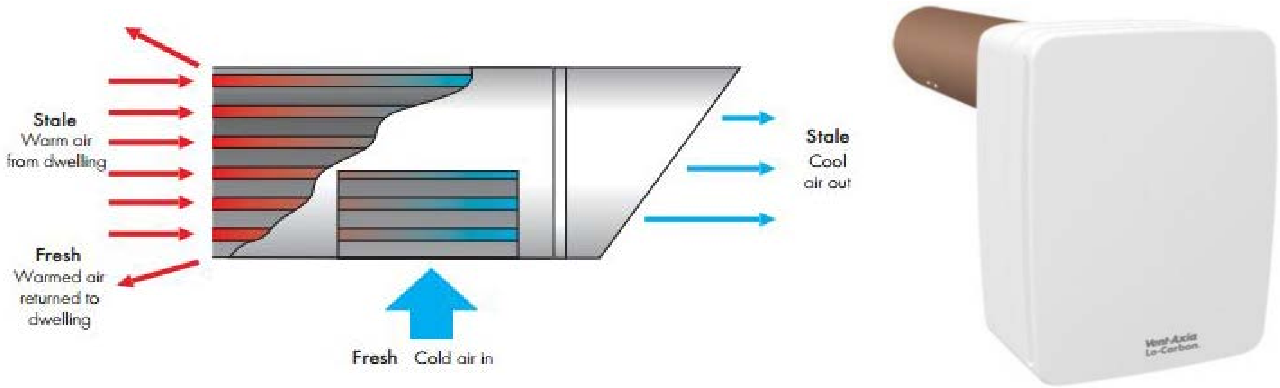

Figure 3.12 Cross section of how the Vent-Axia HRU works and a picture of the Vent-Axia unit fitted.

Figure 3.12 shows a cross section of the HRU that was fitted. The warm air is blown into the household via vents on the top and bottom of the white casing.

Only households T-07 and T-09 were fitted with monitoring equipment to specifically monitor the temperature and cost of the HRU device. Unfortunately due to performance issues with monitoring equipment, the only household that could be analysed in this way was T-09. Table 3.15 shows the average temperature between 8th February 2017 and 31st March 2017 in different locations. The external HRU Tiny Tag was placed outside of the household to monitor the external temperature, the internal probe was placed inside the vent where warm air is emitted, the living room logger was positioned in the room measuring general temperature and humidity, and the logger next to the HRU was inside the living room on a shelf as close to the HRU as possible. As can be seen, the living room logger has the highest average temperature this is because the main heating system would impact the living room temperature more than the HRU. However, when comparing the external logger and internal probe it can be seen that on average the HRC was heating the external cold air by 10°C which was pushed into the property. This average is likely to vary depending on which mode the HRC was being used in (low trickle, high trickle or boost). It is likely during a period when the heating was off; the HRU would produce air that was warmer than the air already in the living room. Nonetheless, the HRU is still a relatively efficient small source of heat which can help to maintain recommended temperatures and improve comfort. It also recirculates air reducing the amount of stale or stuffy air in the room, which is a factor of poor indoor air quality. Reducing stale air can reduce odours, potential illness and discomfort in breathing[14].

Average Temperature °C	8th Feb 17 – 31st Mar 17.			
Household	External HRU logger (25)	Internal HRU probe (21)	Living room logger (9)	Logger next to HRU in living room (24)
T-09 (24hr)	8.07°C	18.00°C	21.11°C	20.70°C
T-09 (7-10pm)	8.04°C	18.78°C	22.17°C	22.02°C

Table 3.13 Average temperatures of the HRC temperatures and around the HRC of household T-09 during the monitoring period Feb 17- Mar 17.

[14] EPA. January 2017. Fundamentals of Indoor Air Quality in Buildings. Accessed July 2017. https://www.epa.gov/indoor-air-quality-iaq/fundamentals-indoor-air-quality-buildings

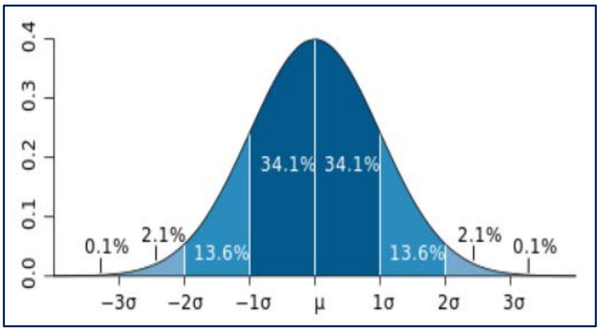

Figure 3.14 Illustration of mean (μ) and standard deviation (σ) in a normal distribution

Humidity

Humidity is the percentage of water vapour held by the air compared to the saturation level. Water vapour is not usually considered to be an indoor contaminant or a cause of health problems. In fact, some level of humidity is necessary for comfort. The relative humidity of indoor environments over the range of normal indoor temperatures of 19 to 27°C can have both direct and indirect effects on health and comfort. The direct effects of relative humidity are related to impacts on physiological processes, whereas the indirect effects of relative humidity are related to impacts on pathogenic organisms or chemicals. Figure 3.15 illustrates the optimum humidity levels as cited by Anthony Arundel *et al* 1986[15]. The study concludes that maintaining relative humidity levels between 40% and 60% would minimise adverse health effects relating to relative humidity. The indirect health effects of relative humidity may be growing in importance as a result of the continuing construction of energy efficient sealed buildings with low fresh air ventilation rates.

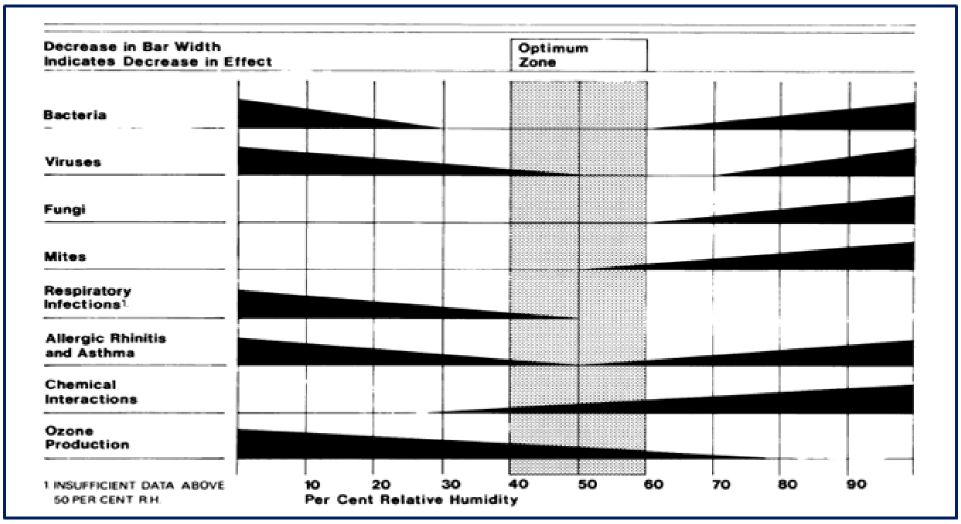

Figure 3.15 Optimum humidity levels to reduce indirect effects from pathogenic organisms or chemicals.

[15] Anthony V. Arundel,* Elia M. Sterling, Judith H. Biggin, and Theodor D. Sterling. 1986. Indirect Health Effects of Relative Humidity in Indoor Environments: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1474709/ Accessed July 2017.

Relative humidity is reliant on temperature and moisture level. The higher the relative humidity the more water moisture is in the air. Cooler temperatures often will mean higher relative humidity because the air has a lower capacity to hold moisture; warmer temperatures increase the capacity to hold moisture. High levels of relative humidity can be damaging to the interior of the household and potentially harmful to health. The Building Regulations part F suggests the average monthly maximum humidity levels for domestic dwellings during the heating season to be 65%[16]. As stated above the recommended humidity levels are between 40-60%.

The USB-2 data-loggers placed inside the households were able to monitor humidity of the households. As mentioned high humidity levels can be harmful to health because they can increase the growth of condensation and mould. 1 benefit of the HRU is that it recirculates air within the room it is placed in, which helps to reduce stale air and also should help to keep relative humidity levels at a comfortable level[17].

Average Humidity %	Winter period	BEFORE
Living room	11th Jan 2016 - 31st Mar 2016	
Property	Insulation 24hr	7-10pm
T-12	46.67	45.81
T-10	46.76	45.08
T-08	51.84	51.61
T-06	53.41	53.79
T-01	64.57	63.07
Maximum	64.57	63.07
Minimum	46.67	45.08
Average	52.65	51.87
Std Dev	7.31	7.28

Average Humidity %	Winter period	AFTER
Living room	1st Dec 2016 - 31st Mar 2017	
Property	Insulation 24hr	7-10pm
T-12	50.42	49.50
T-10	54.55	54.56
T-08	56.21	56.47
T-06	46.93	45.86
T-01	67.41	67.25
Maximum	67.41	67.25
Minimum	46.93	45.86
Average	55.10	54.73
Std Dev	7.78	8.15

Table 3,16 Average humidity in the monitored households with just insulation measures with readings taken between 11th Jan 16 & 31st Mar 17.

Table 3.16 show the relative humidity experienced in the households with insulation only, both before the measures were installed (11th January to 31st March 2016) and after the measures were installed (1st December 2016 to 31st March 2017). Humidity and temperature have shown to have a relationship as T-12 has the lowest 24hr average humidity levels but on average the 24hr highest temperature and T-01 has the highest humidity levels and the lowest temperature during the before measures period.

Household T-01 still had the highest 24hr average humidity levels and temperature. This household generally put the heating on in the evening and kept it on low when they were out of the home. Although this resident did say they felt their home was warmer and more comfortable, things like cooking and washing with poor ventilation can increase humidity levels. Household T-06 had

[16] The Building Regulations. 2010. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/468871/ADF_LOCKED.pdf Accessed July 2017.

[17] Vent-Axia Lo-Carbon Tempra. https://www.vent-axia.com/range/lo-carbon-tempra-selv Accsesed July 2017.

the highest humidity levels after the insulation was installed, but this household did not have the highest average temperature so there are several other potential explanations for this. If the resident opened doors whilst cooking for example, this would reduce humidity levels or if the resident used a dehumidifier this would also reduce humidity levels without increasing temperature. The specific reason can only be speculated and cannot be confirmed as there was no comment given by the resident to indicate these reasons.

Overall, the average humidity across all of the insulation households did rise slightly but so did the average temperature, so it is unclear why. But the levels of humidity are still within the recommended comfort humidity levels of 40-60% and the Building regulations recommendations of 65%. It must also be noted that the standard deviation is fairly large which would indicate a higher level of variability in the humidity levels of the households which does put the households at risk of damp, condensation or mould growth. Improving ventilation is a key factor in reducing this risk.

Average Humidity %	Winter period	BEFORE
Living room	11th Jan 2016 - 31st Mar 2016	
Property	Insulation & HRU 24hr	7-10pm
T-11	52.73	51.14
T-09	42.49	41.96
T-07	55.72	56.57
T-05	52.50	52.82
T-04	63.01	63.57
T-03	70.62	70.68
T-02	67.56	70.98
Maximum	70.62	70.98
Minimum	42.49	41.96
Average	57.80	58.25
Std Dev	9.83	10.75

Average Humidity %	Winter period	AFTER
Living room	1st Dec 2016 - 31st Mar 2017	
Property	Insulation & HRU 24hr	7-10pm
T-11	57.89	56.85
T-09	46.33	46.94
T-07	52.88	54.46
T-05	51.60	52.34
T-04	58.88	59.90
T-03	68.61	68.95
T-02	66.51	68.00
Maximum	68.61	68.95
Minimum	46.33	46.94
Average	57.53	58.21
Std Dev	8.04	8.08

Table 3.17 Average humidity in the monitored households with HRU and insulation measures with readings taken between 11th Jan 16 & 31st Mar 17.

Strangely, the households with the highest 24hr average humidity do not have the highest 24hr average temperature both before and after the measures were installed. During the heating demand period, household T-02 does have a slightly higher humidity than household T-03, which can be explained by the low heating setting that household T-02 uses. Household T-03 is the only household working full time, so there is a possibility that the increased humidity could be due to clothes left to dry inside during the day with poor ventilation. Likely causes of increased humidity are behavioural aspects such as cooking, washing/drying clothes or showering without opening a window or using the HRU. When comparing households, those with more people residing can increase the moisture to the air by breathing alone[18].

The HRUs don't appear to have had a significant impact on the humidity levels. There is a very slight improvement on humidity levels and the overall average humidity across the households

[18] NEA. 2015. Dealing with Damp and Condensation. https://www.yhn.org.uk/wp-content/uploads/2016/03/NEA-Dealing-with-Damp-and-Condensation.pdf Accessed July 2017.

receiving the HRUs is within the recommended humidity range of 40-60% and the Building Regulations recommended 65%. For the households exceeding these levels it is recommended that they try improving ventilation e.g. opening a window or using an extractor fan while cooking, or using the HRU.

Speculation on the above results comparing the average results for those properties with insulation only, and those with insulation and HRU, suggest that the insulation reduced unwanted gaps in the structure of the park home which, whilst increasing the thermal efficiency by reducing heat loss also reduced the moisture it contained. The homes with insulation and HRU would have the added benefit of allowing the moisture to exit but recovering some of the heat.

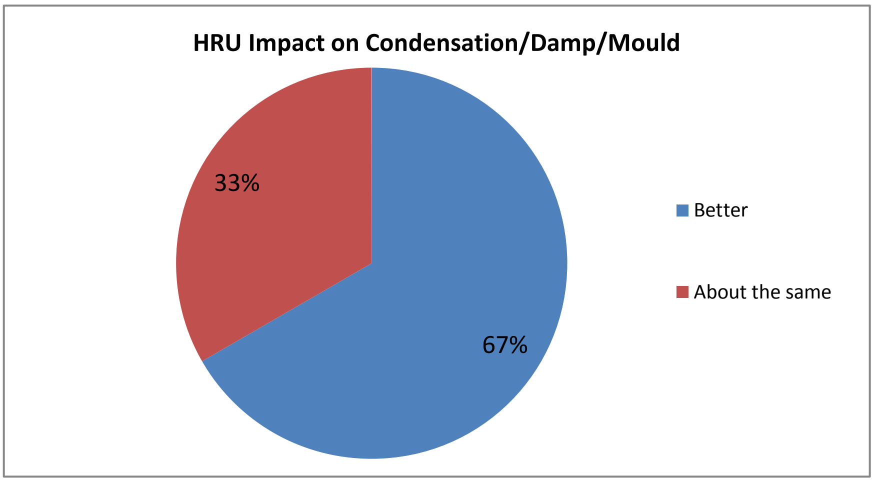

Figure 3.18

Although the HRU did not appear to have a significant impact on the humidity levels of the households that had them installed, it did seem to have a significant impact on the condensation, damp or mould growth in the properties. This is because the HRU recirculates the air, bringing fresh air into the living room/kitchen area and helping to prevent humid air migrating to other rooms.[19]. Figure 3.18 shows that 67% of the households that received the HRU have felt that the HRU had helped to improve damp, condensation or mould. Household T-11 said their damp issue had not improved and stayed the same, most likely because the damp was in the bedroom. Household T-09 also said there was no improvement on their damp issue, an explanation for this could be that this household used a supplementary gas fire. Depending on the type of gas fire, it may have added moisture to the air when used[20] which would potentially counter the effect of the HRU.

Overall it appears that the HRU has had a positive effect on damp, with the resident of household T-04 saying that they could visibly see a reduction of the mould within their household which may be beneficial to resident's health as a result of the reduction[21].

[19] Vent-Axia Lo-Carbon Tempra. https://www.vent-axia.com/range/lo-carbon-tempra-selv
Accessed July 2017.
[20] Rentokil. 2013. Condensation in your property. http://www.rentokil.co.uk/assets/content/files/condensation-information-leaflet.pdf
Accessed July 2017.
[21] World Health Organisation. 2009. Damp and Mould: Health risks, prevention and remedial actions. http://www.euro.who.int/__data/assets/pdf_file/0003/78636/Damp_Mould_Brochure.pdf

4. Conclusions and recommendations

4.1 Conclusions

- Across all monitored households the average annual estimated saving on gas bills was 27.23% (£202.75).
- Any savings attributed to the HRU could not be determined through this project due to a lack of energy data.
- The average electricity consumption of 1 HRU was estimated at £5.74 annually.
- Using a combination of feedback, anecdotal data, meter reading and bill data there is an indication the insulation applied to all of the households has reduced heating bills. 62% of those with the insulation and HRUs perceived a reduction in heating cost, 40% with insulation only perceived a reduction in cost, meaning 58% across all households perceived a reduction in heating costs.
- There has been evidence across all households that there has been a significant improvement in how well the house keeps heat in. Every resident was either satisfied or very satisfied with how well the home kept heat in after the measures were installed; before the measures were installed only 3 households out of 12 said they were satisfied.
- 67% of all households said they were satisfied with the cost of running their heating systems after the installation of the measures. Beforehand only 17% were satisfied. 57% of households with insulation and HRUs said they were satisfied with the cost of running their systems. 80% of those with insulation only, said they were satisfied.
- Using degree days to determine the coldest day during monitoring of the HRU devices, it was shown that during the coldest outside temperature (1.1°C) the HRU recirculated warmed air at 14.8°C. During the warmest outside period (5.3°C) the HRU recirculated air into the household at 16.2°C.
- The HRU devices did not appear to make any significant difference to humidity levels in the living room. Further study with humidity loggers in rooms such as bathroom or kitchens may give a better indication of the impact of the HRU on humidity as humidity loggers were only placed in the living room.
- The HRUs did make an impact on condensation, damp and mould. Of the 6 households that had damp issues prior to the installation of the HRUs, 67% (4) of these said that they could see a visible improvement since the measures were installed. No residents who received EWI reported an increase in damp or condensation.
- Technical analysis suggests that insulation alone can increase humidity levels; Insulation AND HRU suggests improved energy efficiency without increased humidity.
- Energy performance assessments carried out by Cornerstone Renewables illustrate the SAP ratings for the households increased by 24 points, moving from F to D.
- Overall, the social analysis and the slight increase in average temperature is an indication that the insulation installed across all households has likely improved the thermal efficiency of the households. This may also have helped to increase the comfort of the households in their own homes.

4.2 Recommendations for potential future installations

- Further study is recommended to confirm the conclusions with a higher degree of confidence.

Accessed July 2017.

- When undertaking future projects it is important to determine the suitable technologies for the households in advance. Examining spacing requirements, construction types and suitability of building type for certain technologies at the outset will avoid delays and potential disgruntlement amongst households.
- External wall insulation, loft insulation and under floor insulation have shown benefits to the comfort, home efficiency and bill cost of park homes. It is recommended that funding for these types of projects in park homes becomes more readily available.
- A further study could consider also replacing older windows and doors of park homes to further increase the efficiency of the park homes.
- When identifying suitable park homes for EWI, it is important to check the spacing between properties early on to ensure that minimum spacing requirements are maintained after addition of the insulation to the property
- Older park homes benefit more from EWI as these had poorer level of insulation at the time of manufacture - it should be possible to determine the date of manufacture of the park home from a label on the property
- Reduction in moisture levels should be addressed as part of any planned insulation to avoid any excessive increase due to reduction in unwanted ventilation
- It is important to have a supportive park home site owner for the process to run smoothly
- Installers should plan to complete insulation within a few days as extended installations risk the good will of residents as does not clearing up properly at the end of the job
- External wall insulation has been shown to provide many benefits to residents living in park homes and accessing grants to fund installations should be made easier

4.3 Impact on fuel poverty

Park homes often have poor levels of insulation and are not usually connected to mains gas and instead rely on bottled gas such LPG which is an expensive fuel to heat homes in comparison to gas or electricity. The lack of insulation can lead to lower degrees of thermal comfort, particularly during the winter. Households living in these properties have been found to be mostly of retirement age, with 67% of households in this study confirmed as retired. This can then lead to an increased likelihood of the households being vulnerable and living with a health condition.

The impact of the insulation appears to have reduced overall gas bills by 27.23% and significantly increased the comfort and the households’ ability to maintain heat and reduce heat loss since the insulation was installed. The insulation will also produce even greater savings should future price increases take place. The impact of the insulation is particularly strong from the analysis of our social evaluation.

The lack of insulation in park homes, particularly older homes can mean they are quite susceptible to mould, damp and condensation. This can lead to further health issues as a result of this increasing the vulnerability of households living in park homes.

The installation of the HRU appeared to make significant impacts in reducing damp and mould growth by recirculating air and adding a further boost of heat. 67% of households that received the HRU measures said that they could noticeably see an improvement on the damp or mould issues they had prior to the insulation of the measures. It is worth mentioning that the insulation will have also provided some protection and mitigated effect to mould and damp growth in the park homes[22].

[22] Community Energy Plus. Park Homes. Accessed August 2017. https://www.cep.org.uk/information/park-homes/

Appendix 1: Glossary of Terms

CWaC	Cheshire West and Chester council
DD	Degree Days
ECO	Energy Company Obligation
EPC	Energy Performance Certificate
EWI	External Wall Insulation
FPNES	Fuel Poor Network Extension Scheme
HIP	Health and Innovation Programme
HRU	Heat Recovery Unit
LPG	Liquefied Petroleum Gas
NEA	National Energy Action – the National Fuel Poverty Charity
SAP	Standard Assessment Procedure (for assessing home energy efficiency)
SWI	Solid Wall Insulation
TIF	Technical Innovation Fund

Appendix 2: Case Studies

Mr and Mrs A

Mr and Mrs A own a park home in which they have lived for the last thirteen years. They were visited by NEA as part of the TIF programme and provided with advice and information about how to keep their home warm affordably. NEA informed Mr and Mrs A about the Charis Grants Park Home Warm Home Discount which they subsequently applied for and received. This provided them with an extra £140 to help them pay their energy bills during the winter.

As a result of receiving advice they have now also replaced their windows with more energy-efficient glass panels as well as installed LED lights throughout the house to increase their cost savings. Mr A says that receiving the visit from NEA and getting more information has spurred him into further action!

Both Mr and Mrs A have suffered a number of health issues including respiratory and circulatory illnesses that are exacerbated by living in a cold home. Both report improvements in their health since the measures were installed and Mrs A told us that she has not suffered a cold at all during spring 2016 which is the first time in years that she has managed to keep well.

Since they had insulation installed they both report that their home feels a lot warmer and they have not had to use the heating as frequently as in previous years. They have noticed an increase in the ambient temperature (because they have a thermometer in their living room). They are also sleeping better and do not need to wear bed socks anymore. Their home is now also quieter due to the improved insulation levels as well as looking much better aesthetically.

The SAP rating of the property has also moved from band F to band D.

Mr and Mrs W

Mr and Mrs W (pictured below) are 80 and 78 respectively and live on a well-established park home site in the Cheshire West and Chester Council area. They received the Alumasc external wall, underfloor and loft insulation.

During the coldest spell of winter 2016/17 Mr and Mrs W's boiler broke down and they had to wait four days until a new one could be installed. However, because of the insulation that their home had received as part of the TIF project, they found themselves able to live quite comfortably in their home even without the heating for that period of time. It was a little chilly in the mornings but because of the Alumasc insulation the house soon warmed up from the winter sun.

Mr and Mrs W said: "The insulation definitely did its job!" as over the 12 months that have passed since the installation they have noticed that they don't need to use their heating as much and as a result they are spending half of what they used to on LPG. Over the warm summer months they reported that their home was much more comfortable to live in as the insulation has also helped to regulate the internal temperature.

The SAP rating of the property increased from an F-rating (pre installation) to a D-rating (post installation).

Appendix 3: Project CP777 summary.

Park home energy improvement pilot

LEAD AGENCY:	**Cheshire West and Chester Council**
OTHER PARTNERS:	
PROJECT SUMMARY:	External wall, underfloor (and loft, if present) insulation will be fitted in 52 park homes in off-gas households in the Cheshire area. Alumasc Swisstherm External Wall Insulation System is being trialled. All suspended park homes will receive underfloor insulation, and those with lofts will receive loft insulation. 15 of the homes will then have heat ventilation recovery units installed (part of a separate project –CP789).
EVALUATION METHODOLOGY:	Interviews will be conducted with a sample of households to capture energy consumption behaviour and previous energy expenditure. Household interviews will be supplemented by thermal data-logging using recognised calibrated standalone devices, electricity meter readings will also be provided by the park home manager. 7 households that are off-gas and are heated by LPG systems or oil will be provided with appropriate flow meters to gauge energy usage in the park home. Monitoring will be carried out for 12 months, which will include a full winter heating period.
PROJECT OUTCOMES:	• The project will improve the thermal efficiency of park home households, reduce energy bills and improve health and well-being of occupants. • Park homes have previously been unable to access funding, with fuel poverty particularly prevalent within such

LEAD AGENCY:	**Cheshire West and Chester Council**
	communities, so proven solutions and case studies are urgently needed. • These installations will provide detailed independent case studies, and inform national best practice to influence future funding mechanisms.
REGION IN WHICH PROJECT WILL BE DELIVERED:	North West
LOCAL AUTHORITY AREA/KEY LOCATIONS IN WHICH PROJECT WILL BE DELIVERED:	Cheshire West and Chester Council
DETAILS OF TECHNOLOGIES TRIALLED:	• Alumasc Swisstherm External Wall Insulation System • YBS Foil Tech Underfloor Insulation • URSA Glasswool (blown loft insulation system)

ELIGIBLE HOUSEHOLDS ASSISTED

NEA GRANT WITH MATCH FUNDING	MATCH	TOTAL
52	—	52

Published on 02-02-2017

Appendix 4: Project CP789 summary.

Park home heat recovery ventilation

LEAD AGENCY:	**Cheshire West and Chester Borough Council**
OTHER PARTNERS:	
PROJECT SUMMARY:	This project is to install heat recovery ventilation units to 15 Park homes following on from a large measures project to install thermal insulation. 2 units will be installed per household, in the bathroom and kitchen/living area, to combat the potential increase in condensation risk associated with SWI installations. The project will assess improvements in resident health and well-being that ties into Public Health England (PHE) strategies; the change in the SAP rating per household, to determine what improvements are required for park homes to achieve Band C on average; the change in resident energy bills over a 2-year period to determine the impact of the measures
EVALUATION METHODOLOGY:	This project is directly connected to CP777, hence the monitoring regime for that project will continue into this project. In 2 of the insulated households in project CP777, where the heat recovery ventilation has been installed, thermocouple data loggers will monitor the temperature of the air entering and leaving the household via the heat recovery ventilation system. Watthour meters will be installed to measure the energy used per unit.
PROJECT OUTCOMES:	To reduce the increased condensation and mould risk following full insulation of park homes. Proven solutions and case studies are urgently needed as fuel poverty is particularly prevalent within such communities. These installations will enable the

LEAD AGENCY:	**Cheshire West and Chester Borough Council**
	production of detailed case studies, establish show homes, inform national best practice and enable funding and finances to be better allocated on a local and national basis
REGION IN WHICH PROJECT WILL BE DELIVERED:	North West
LOCAL AUTHORITY AREA/KEY LOCATIONS IN WHICH PROJECT WILL BE DELIVERED:	Cheshire West and Chester Borough Council
DETAILS OF TECHNOLOGIES TRIALLED:	Silavent Energex single room heat recovery system

ELIGIBLE HOUSEHOLDS ASSISTED

NEA GRANT WITH MATCH FUNDING	MATCH	TOTAL
15	—	15

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Appendix 5: Health and Innovation Programme 2015 – 2017

The Health and Innovation Programme (HIP) was a £26.2 million programme to bring affordable warmth to fuel poor and vulnerable households in England, Scotland and Wales.
The programme launched in April 2015 and was designed and administered by fuel poverty charity National Energy Action as part of an agreement with Ofgem and energy companies to make redress for non-compliance of licence conditions/obligations. To date, it remains the biggest GB-wide programme implemented by a charity which puts fuel poverty alleviation at its heart.

The programme comprised 3 funds

- **Warm and Healthy Homes Fund (WHHF)**: to provide heating, insulation and energy efficiency measures for households most at risk of fuel poverty or cold-related illness through health and housing partnerships and home improvement agencies

- **Technical Innovation Fund (TIF)**: to fund and investigate the impact on fuel poverty of a range of new technologies

- **Warm Zones Fund (WZF):** to install heating and insulation and provide an income maximisation service to households in or at risk of fuel poverty, delivered cost-effectively through partnership arrangements managed by NEA's not-for-profit subsidiary Warm Zones Community Interest Company

What it involved

- **Grant programmes** to facilitate the delivery of a range of heating and insulation measures and associated support. Grant recipients were encouraged to source match and/or gap funding to increase the number of households assisted and to enhance the support provided to them
- **Free training** to equip frontline workers with the skills needed to support clients in fuel poverty
- **Outreach work and community engagement** to provide direct advice to householders on how to manage their energy use and keep warm in their homes

In addition we undertook substantial **monitoring and evaluation** work, to assess the effectiveness and measure the performance of the technologies, and to understand the social impacts of the programme. Our **communications programme** helped partners to promote their schemes locally as well as share best practice with others. The programme generated a considerable amount of **knowledge and insight** which will be made freely available to help support future policy and delivery.

Proper investment of advanced payments allowed us to generate interest which, along with efficiency savings, was reinvested back into the programme in the form of additional grants and support which helped us further exceed our targets.

For more information see www.nea.org.uk/hip

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Action for Warm Homes