AREA BASED SCHEMES
EXTERNAL WALL INSULATION
EVALUATION
Retrospective Study

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EXECUTIVE SUMMARY

- A retrospective assessment procedure for ABS properties has been developed
- A total of 78 households were recruited giving an overall response rate of approximately 15%
- The target ratio of privately owned properties to council or housing association properties (60:40) was achieved
- All participants stated that they would recommend the scheme to others

Property conditions

- 92% of respondents agreed that the general condition of their home had been improved by the insulation.
- 90% of respondents agreed that the appearance of their home had “Improved a lot”
- 90% of respondents, based on those who were involved in whole-street projects, also felt that the street or neighbourhood had improved
- 68% of participants who had reported having a problem with condensation or dampness said that this had now been improved following the works

Fuel Costs

- Prior to the insulation upgrades, the mean monthly expenditure on fuel was £130 (±50) compared to £100 (±30) following the insulation work. These figures are however subject to uncertainty are based mainly on self-reports from the householders
- For those who provided sufficient information, 34 properties reported seeing a reduction in their fuel bills while 7 hadn’t noticed a difference and 1 had witnessed a slight increase
- Based on EPC data, prior to the intervention the mean annual fuel cost was £1210 compared to £870 following the insulation. This resulted in an average annual saving of over £300
- Based on the EPC data the fuel poverty rate was 54% prior to the works and had fallen to 35% following the works.

Energy-efficiency

- Prior to the insulation upgrades, the majority (71%) had an EER which was below the national average. Following the intervention, this figure was reduced to 17% for South Ayrshire and 11% for East Ayrshire
- Following the insulation upgrades, the EER was increased by 13 points on average
Thermal Comfort

- 87% of the participants agreed that their property was now able to retain the heat better following the insulation upgrades and 84% found that their home now heated up more quickly.
- A further 67% of the householders felt that there was now a more even distribution of heat in the property while 68% felt that they had more control of the temperature of their home.
- 82% of those interviewed felt that the overall temperature had increased. 50% of the sample described their homes as “much warmer”.
- The majority (72%) also felt that the insulation had improved their level of thermal comfort experienced in the home.

Health

- Individual health data was obtained for a total of 81 participants. There were 10 reports of improvements to existing conditions which may have been linked to the intervention. These included problems with bones, joints or muscles (3), COPD (3), asthma (2) and arthritis (2).
- There were a further 10 reports of reduced colds/flus and 10 reports of improved mood or mental well-being.

Quotes:

“It’s had a good impact….it makes the street look great. Everybody’s happy and it makes you want to do stuff to the building to keep it nice”

Miss F, South Ayrshire

“The bills kept going up and up and I knew that we had to do something about them…I think it’s better. It’s more efficient now. It seems to hold the heating a bit longer”

Mr T, East Ayrshire

“It’s more relaxed. I feel more relaxed at night….Rather than coming in here at night and having to wear a big jumper or a cardigan I can sit about like this and I feel quite comfortable…I don’t need to go wrap up at night”

Mr M, East Ayrshire

“I think with the house being warmer its helped my arthritis a lot cause I’m not as sore now as I used to be….It doesn’t take me 3 hours in the morning now to get moving so it has made a difference”

Ms M, East Ayrshire
1. INTRODUCTION

1.1 Evaluation Project

This report describes a *Retrospective Assessment* conducted as part of a larger evaluation study, the aim of which is to investigate the impacts of insulation upgrades administered through the Home Energy Efficiency Programme for Scotland Scheme (HEEPS): Area Based Schemes (ABS). The project is a collaboration between *NHS Ayrshire and Arran (Public Health)*; the *Energy Agency, South Ayrshire Council* and *East Ayrshire Council*. The retrospective assessment was conducted during 2016 on a sample of households located throughout South and East Ayrshire. This report summarises the results from interviews conducted with households who received insulation upgrades through the ABS scheme during 2015.

1.2 Pilot Study – Qualitative Interviews

As part of an earlier feasibility study which took place between April and September 2015, a series of semi-structured interviews were conducted with 8 households who had already participated in the ABS scheme. The purpose of these pilot interviews was to explore outcomes which could be related to the insulation upgrades. This included improvements to the environmental conditions of the property, changes in heating patterns and fuel usage as well as differences in physical health or mental well-being. Some of the positive impacts reported included reduced fuel bills, increased warmth and comfort within the home, reduced noise and an improvement in the external appearance of the property. In cases where such benefits were not as apparent, this was usually attributed to another element of the property which was in a poor condition (e.g. windows or roof). Some health impacts were also evident with 2 reports of improved physical health and 3 reports of an improved mood following the insulation upgrades.

Overall the pilot study highlighted that there would be value in exploring these potential outcomes in more detail within a larger sample, taking into account confounding factors such as the baseline quality of the properties and any changes made to the properties following the insulation upgrades. The retrospective study was therefore designed taking into account the responses and conclusions from the qualitative interviews. Further details of the findings of the feasibility can be found in a separate report (Hooke, 2015).
2. METHODS

2.1 Aims and Objectives

A collaborative working group involving the **NHS Ayrshire and Arran (Public Health)**; the **Energy Agency**, **South Ayrshire Council** and **East Ayrshire Council** has been established in order to further investigate the impacts of the ABS programme in the West of Scotland. The particular aims of the project are to:

1. Evaluate the impacts of external and internal wall insulation upgrades in relation to improvements in **energy efficiency**, the **health** of the occupants and any other significant benefits

2. Obtain perspectives from households who have participated in the **Area Based Schemes** regarding their experiences of the initiative

3. Develop a methodology for **continued evaluation** to be incorporated into future schemes

In relation to the above aims, a **retrospective study** involving a sample of households located throughout South and East Ayrshire has been developed. The specific objectives of this study include:

- Recruitment of a suitable **random sample** of households
- Development of an appropriate **retrospective evaluation procedure**
- **Data collection** and **analysis**

2.2 Population

The target population for the study was households in South and East Ayrshire who had received either external or internal wall insulation upgrades through the ABS 2 initiatives. These local authority areas are located in the West Coast of Scotland. Further information regarding the characteristics of these areas can be found in the Interim Report.
2.3 Sampling and Recruitment

Eligible households who had previously participated in the scheme were randomly selected and initially contacted by letter. Interviews were then arranged with households from which a signed consent form for the study was returned. Non-responding households were also contacted by telephone in order to further increase the recruitment rates. An incentive (inclusion in a free-prize draw for £100 worth of shopping vouchers) was also offered to participating households.

For each local authority, eligible households were stratified into 4 sub-groups: owner-occupiers, council tenants, private tenants and rural properties. A boosted sampling strategy rather than proportional sampling was used in order to ensure that approximately 40% of the group consisted of council properties. The rural properties were also analysed separately as these vary widely in terms of their size, construction and costs and although they represent only a small proportion of all eligible properties, it was important that the impacts of the scheme on rural properties were sufficiently explored. All of the eligible rural properties were therefore lettered for each area in order to maximise the number of respondents within this group. The number of recruited households for each group and the overall response rates are shown in Table 1 and Table 2, respectively. Overall, 16% and 14% of the lettered households in East and South Ayrshire respectively, agreed to take part in the study. This gave a total sample of 78 households of which 71 were interviewed and 7 completed the questionnaire by post. It should be noted that 15 of the households who did not want to take part in the study commented that they were pleased with the overall work. Responding households from East Ayrshire were located primarily in Stewarton, Cumnock, New Cumnock, Auchinleck, Drongan, Galston and Gatehead. For South Ayrshire the principal areas were Tarbolton, Annbank, Girvan and Ayr.

<table>
<thead>
<tr>
<th>Owner Occupiers</th>
<th>Private Tenants</th>
<th>Council Tenants</th>
<th>Rural Properties</th>
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<tr>
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<tr>
<td>South Ayrshire</td>
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<tr>
<td>Total</td>
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<td>2</td>
<td>27</td>
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<thead>
<tr>
<th>Owner Occupiers</th>
<th>Private Tenants</th>
<th>Council Tenants</th>
<th>Rural Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Ayrshire</td>
<td>16%</td>
<td>7%</td>
<td>9%</td>
</tr>
<tr>
<td>South Ayrshire</td>
<td>14%</td>
<td>4%</td>
<td>15%</td>
</tr>
<tr>
<td>Total</td>
<td>15%</td>
<td>5%</td>
<td>12%</td>
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</table>
2.4 Assessment Tools

The outcomes measured during the study, and the specific tools employed to capture this information are shown in Table 3. All data was processed using appropriate protocols and signed consent was obtained from each participant prior to any data collection.

Interview

The majority of the data was collected during a face to face interview with the main householder. This involved questions regarding household demographics, occupancy patterns, the general condition of the property, household income, expenditure on fuel and the performance of the heating system. Both open and closed questions were included in the interview, allowing the participants to share their individual experiences and provide more detailed answers for some of the questions. For the majority of topics, the respondent was asked to reflect upon the conditions in their home prior to the insulation works and then compare this to the most recent winter period. A separate health questionnaire was also completed by the main householder. This included questions regarding any noticeable changes in either their own health, or the health of any of the other occupants within the household. All participants were required to sign a consent form prior to the interview and their responses were recorded using a dicta-phone where permission to do so was granted by the participant.
Documentary Evidence

In the case of fuel expenditure, participating households were asked to provide copies of their fuel bills for the previous 2 years. Where possible, data on the annual expenditure and consumption was then compared for the winter periods preceding and following the insulation works. Pre- and Post-intervention EPCs were also analysed for each property by comparing baseline Energy Efficiency Ratings (EER), Environmental Impact Ratings (EIR) and estimations of annual energy costs with the revised values.

Statistical analysis

Raw data collected from both the household questionnaires and health questionnaires were converted form hard-copies to a digital format. For closed questions, responses were coded and inputted to SPSS 20.0 allowing responses individual questions to be analysed against demographic, socioeconomic or other relevant variables. For the more open-ended questions, the individual responses were transcribed and synthesised narratively.

Table 3: Assessment Tools

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>ASSESSMENT TOOL</th>
<th>INTERVIEW</th>
</tr>
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<tr>
<td>Temp/RH change within the home</td>
<td>Interview</td>
<td>Section A: General Household Details</td>
</tr>
<tr>
<td>Thermal comfort experienced in the home</td>
<td>Interview</td>
<td>Section B: Property conditions</td>
</tr>
<tr>
<td>Changes in home temperature management</td>
<td>Interview</td>
<td>Section C: Heating, Temp. &amp; Comfort</td>
</tr>
<tr>
<td>Changes in fuel consumption</td>
<td>Interview Energy Bills</td>
<td>Section D: Satisfaction with scheme</td>
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<tr>
<td>Changes in household expenditure on fuel</td>
<td>Interview Energy Bills</td>
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<tr>
<td>Changes in energy efficiency</td>
<td>Interview</td>
<td>Section E: Health</td>
</tr>
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<td>Impact on general health</td>
<td>Interview</td>
<td></td>
</tr>
<tr>
<td>(Where relevant) Impact on respiratory and circulatory diseases</td>
<td>Interview</td>
<td></td>
</tr>
<tr>
<td>Impact on mental wellbeing (particularly emotional mood).</td>
<td>Interview</td>
<td></td>
</tr>
<tr>
<td>Personal and Social Use of Home Space</td>
<td>Interview</td>
<td></td>
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<tr>
<td>Other impacts</td>
<td>Interview</td>
<td></td>
</tr>
<tr>
<td>Views of the scheme and experiences of the installation process</td>
<td>Interview</td>
<td></td>
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</tbody>
</table>
3. RESULTS

3.1 Interviews

The data collected from the interviews is presented in following sections. The topics covered included household occupancy, general property conditions, heating patterns and fuel costs, the environmental conditions and the health of the occupants.

3.1.1. Household Occupancy

As illustrated in Figure 3, the size of the households was found to range between 1 and 7 occupants although the majority had either 1 or 2 occupants. A total of 50 households (64%) had at least 1 pensioner or a child under 16.

![Figure 3: Household Demographics](image-url)

In terms of socioeconomic status, the aim was to include a mixture of owner/occupiers, council tenants and private rented properties since this information was known prior to sampling. The target ratio of 60:40 (owners:tenants) was more or less achieved (Figure 4). During the interview, additional socioeconomic information, such as the employment status of the interviewee was also gathered. Over half of the group had a retired head of household while around 61% of the working age adults interviewed were in employment.
The reported annual incomes for the participating households are shown in Figure 6. Only 59% of households were both willing and able to provide this information. From this reported data and the known occupancies, the percentage of households in relative poverty was also calculated based on the median income in Scotland of £24,000 (based on a couple with no children). As shown in Figure 7, 21-22% of those interviewed were found to be in relative poverty. This is slightly higher than the national average of 14%¹ based on 2013/2014 figures. Despite these relatively low incomes, in response to the question regarding current financial management the majority (54%) selected the response of “Get by Alright” with only 4 households reporting any major financial difficulties (Figure 8).

¹ Scottish Government (2015)
Figure 6: Household Income

£5000 - £7500
£7500 - £10000
£10000 - £12500
£12500 - £15000
£15000 - £20000
£20000 - £25000
£25000 - £30000
£30000 - £35000

Figure 7: Relative Poverty

- Households in Rel. Poverty
- Households potentially in Rel. Poverty
- Households not in Rel. Poverty
- No Income Data

Figure 8: Financial Management - Control Group

- Manage Very Well
- Manage Quite Well
- Get By Alright
- Don't Manage Very Well
- Have Some Financial Difficulties
3.1.2. **Property Conditions**

The baseline conditions of the properties studied are dependent on factors such as the property type and construction, the age of the property and how well it has been maintained. The existing building fabrics included a range of solid constructions (stone, solid brick and no-fines concrete) and well as timber and steel frame constructions (Figure 9). As shown in Table 4, the sample also included a mix of flats and houses, with the largest group being semi-detached properties.

![Figure 9: Construction Types](image)

- Solid Brick: 27%
- Weir Timber: 8%
- No-fines Concrete: 1%
- Other System Build: 15%
- Hard-to-treat Cavity: 22%
- Solid Stone: 27%

![Figure 10: Property Images](image)

*Weir Timbers and HTT Cavity (Flats)*

<table>
<thead>
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<th>Table 4: Property Types</th>
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<tbody>
<tr>
<td>Flat</td>
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<tr>
<td>------</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
During the interview, participants were also asked to identify any known issues with the property, prior to the insulation upgrades. As shown in Figure 11, the most commonly identified issues are draughts (40%), cold spots in the property (36%) and poor windows (14%). Approximately half (51%) of those who had a reported problems relating to draughts or the temperature of the house noted that these problems were no longer present following the insulation works. A further 92% of respondents agreed that the general condition of their home had been improved by the insulation while 65% thought that the upgrades had added value to the property.

Another aspect which was commented upon frequently throughout the interviews was the improvement which the insulation had made to the external appearance of the building. As illustrated in Figure 12, 90% of respondents agreed that the appearance of their home had “Improved a lot” while a further 8% stated that that appearance had “Improved a little”. In the one case where the householder felt the appearance was now worse, this was attributed to the external pipework rather than the actual insulation. Another participant commented that she did not like the colour of the finish.

In reviewing some of the positive comments made, there were several remarks about the transformation of the property:
“It’s like the outside of a book, you know, it’s nice when you open up the pages and go in feeling different” - SA24

“Oh it’s much better looking…Mines was the first to be done and when I seen mine done compared with the rest of them…it looked a million dollars” – EA19

This also appears to have had knock-on effect on the participants’ sense of pride in their homes and provided motivations to make other improvements:

“I always liked it to be nice but now I take more pride in it…I even got my hedge cut shorter so everybody could see my house…I think it’s lovely” – SA14

“Aye you are a bit prouder to let people come over and not ‘oh my god the outside looks just a disgusting and dirty building’” - EA34

There were also several reports relating to the reduced maintenance requirements following the insulation work:

“It’s gonna save me a lot of bother now cause I’ll never need to paint it again” - SA17

Similarly, there were also several positive reports regarding the impact of the scheme on the neighbourhood as a whole. 90% of the sample (based on those who were involved in whole-street projects) felt that the area had been improved (Figure 13) and some specific comments were made regarding changes observed in the neighbourhood.

“More folk talk because they’re talking about the houses. Folk speak to you that’s never spoke to you before” – EA21

“It’s had a good impact….it makes the street look great. Everybody’s happy and it makes you want to do stuff to the building to keep it nice” - SA9

Figure 13: Impact on Neighbourhood

- Improved a lot
- Improved a little
- No difference
- Don’t know
3.1.3. Fuel Costs

A total of 18 households (23%) cited a reduction in fuel costs as one of their main motivations for participating in the insulation scheme. Information regarding expenditure on fuel and any concerns or difficulties regarding fuel costs was therefore gathered during the interviews. Where possible, reference was made to documentary evidence such as the homeowner’s domestic energy bills or receipts although in many cases the information was self-reported. Even where bills were provided, some of the costs were based on estimated readings rather than actual consumption figures. The reported fuel costs are therefore indicative only. Where sufficient information was available, a comparison of the reported fuel costs prior to and following the insulation upgrades was calculated. A mean monthly cost of £130 (£±50) was reported for the period prior to the insulation upgrades with a value of £100 (£±30) was reported for the post installation period. A further breakdown of the monthly costs by fuel type and heating system is shown in Figure 14.

![Figure 14: Average Winter Fuel Bills (Monthly)](image)

These figures look very broadly at the group however greater insight into individual circumstances is needed in order to fully investigate the links between the insulation scheme and these reported savings. A discussion of the individual cases is therefore provided below. In total 36 households reported seeing a reduction in their fuel bills while 11 hadn’t noticed a difference and 1 had witnessed a slight increase.

Reduction in costs

For those who did experience a reduction (36), the estimated annual saving ranged between £36 and £1200 with an average saving of £360. It should be noted that in 3 of the cases, the savings were attributed partly due to the reduction in the price
of heating oil. Indeed domestic heating oil prices have decreased from approximately 37 pence per L to 22 pence per L between the winter of 2014/15 and winter 2015/16 (DECC, 2016). Therefore even if the annual usage were to remain the same following the insulation upgrades, a 40% reduction in cost could still be expected. In some cases there were also other contributing factors to the costs savings such as the changing of energy provider (6), upgrades to the heating system (2) or additional insulation measures (2).

In reviewing some of the individual cases, there were a few notable examples where the participants made a direct link between the reduction in their fuel costs and the insulation scheme. For example a retired couple living in an electrically heated terraced house (SA21), noted that they had received a rebate of almost £500 in addition to a £30 reduction in their monthly direct debit. Although they had also installed a log burner and made some draught-proofing improvements since the insulation work had been completed, this is still a significant saving.

A family of five living in a terraced property with GCH heating (SA15) also reported a reduction in their dual fuel bill. They had previously been on a 2 year fixed tariff but their monthly direct debit had now been lowered based on their reduced consumption:

“My gas and electricity has gone from £140 to £79 pounds and that’s not because I got windows in April, I think that’s because of the insulation” – SA15

In another property (EA10), similar savings of £32 a month were reported. Although the participant’s daughter had moved out of the property since the insulation was installed, she commented that she had not changed her heating patterns and therefore attributed the fuel cost savings to the improved energy-performance. It was also noted that these fuel savings also gave her additional peace of mind and compensated for the fact that she now had to pay the fuel bills on her own:

“Well I wouldn’t say I’ve used it any less but my payments have gone down…So the only thing I can say is the cladding because I run my heating the same way….It means I can live a wee bit easier now” – EA10

In other cases, less tangible savings were evidenced only through the accumulation of credit on the household account. For example one participant (SA9) noted that she had previously been stressed about how much oil she had been using but that this was now less of a concern:
“Oil was extortionate at one time so it does stress you out when you see how much it’s gonna be...I don’t need to check as much cause I know there’s credit lying” – SA9

No difference

As mentioned previously, 11 of the households did not notice a major difference in their fuel expenditure. In most cases this could be attributed to confounding factors. For example, one property (SA4) contained electric storage heaters which were noted to be particularly old and inefficient. Similar reports were found for two council properties (EA30 & EA28), both of which had electric wet systems on an Economy 10 tariff. These properties were occupied by elderly residents who were highly dissatisfied with their heating systems which they found very expensive to run. An on-going problem with the heating system was also cited as a possible reason for the lack of fuel savings in another property (EA26). In all of these cases it is likely that the impacts of the improved building fabric were offset by the inefficiencies of the heating system.

In another property (EA6), despite also having a new boiler installed since the insulation work had been completed, the occupants found that they were still losing heat through the ground-floor of the house as this was not insulated and was noted to be particularly cold.

One family (EA31) also noted that they had their heating on slightly more during the winter of 2015/16 due to the fact that there was a new-born baby in the house. Again this may have cancelled out energy savings due to the improved fabric and explain why there had been no decrease in their fuel bills in comparison to the previous year.

In another household where a pre-payment gas meter was used (EA32), although the occupier still topped up the meter in the same way (frequency and amount), credit had now accumulated on the account. This therefore represents a hidden saving which is not necessarily experienced as a monthly reduction in expenditure. Furthermore, this participant also noted that the overall temperature of her home had now increased. This so called rebound or ‘take back’ effect is known to occur in energy-efficiency interventions. In fact for solid wall insulation upgrades, it has been estimated that on average 30% of the savings may be taken back through increased consumption (BRE, 2014a). While this is applicable to all properties, the impacts will likely be greater for low income families and homes which were previously under-heated. In these cases the take back factor may be as high as
60% (Boardman, 1991). This may explain the minimal savings observed for many of the households included in this study.

There was also one household (EA36) where the occupant was noted to restrict his electricity use, both prior to and following the insulation. His thermostat was set particularly low (13-14°C) and so his baseline energy demand was also below average. In this case the so called ‘pre-bound’ effect may have played a part since the energy-efficiency measures cannot save energy that is not being consumed in the first place.

There were also a few households where, in addition to the external wall insulation, improvements had also been made to the heating system, and yet no change in fuel expenditure had been observed. For example, EA8 had new boiler installed during the summer of 2015 but cited his frustration at not having noticed any changes in the monthly fuel costs. On the other hand, this participant did note that his property was now “much warmer” and so it again is likely that this take back effect is at least partially responsible for the apparent lack of fuel savings. In another case where the heating system had also been upgraded, although the monthly expenditure had not changed, cost savings were again experienced in other ways. This particular participant (SA13) was on a pre-payment system reported that she had received a large annual rebate.

In one of the oil heated properties (SA37), it was also noted that there had been no noticeable difference in fuel costs despite the insulation upgrades and reduction on the cost of oil. While it was noted in this property that the temperature was now a little warmer, it is unclear why greater savings were not experienced in this case, especially with the drop in oil prices.

**Increase in Costs**

There was only one report of an increase in fuel costs (SA24). While the increase was small (equivalent to £6 per month), this particular participant noted that she had not noticed a difference in the temperature of the house and yet her energy consumption appeared to have increased following the insulation work. There were no obvious changes in occupancy patterns to explain this increase in consumption. Indeed her gas consumption between October and April increased from 6755 kWh in 2014/15 to 7990 kWh in 2015/16. The occupant did however comment upon the poor double glazing in the property:

“In the bedroom particularly from the window cill I can feel the draught” - SA24
It may be possible that the issues with the double glazing have mitigated the impacts of the insulation. This particular property was also a ground floor flat with an uninsulated, suspended timber floor. It is therefore possible that there are still significant heat losses through this element of the fabric.

In summarising the results for all properties, where changes were unlikely to be due to other confounding factors, the average reduction equated to around £30 per month which equates to over £300 per year. A further breakdown of the reported annual savings, categorised by property type, is provided in Figure 15. These are compared with the range of savings quoted by the Energy Saving Trust.

It should be noted that for the detached group, which show lower savings than those predicted by EST, this included only 2 households both of which were relatively small bungalows. Consideration should also be given to the fact that for the other property types, there was considerable variation around the mean values. For example for semi-detached and end terrace properties, which were all of a similar size, annual savings were found to range between £36 and £732. No standard deviation value is shown the semi-detached bungalow category since only one property was included for this group. However the report from this one property was relatively close to the EST estimates. It should also be noted that the EST estimates are based on gas heated properties whereas the results from this study include properties with other fuel types. Given the difficulties encountered in obtaining accurate data from the customers’ bills, the fuel cost data should be

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2 [http://www.energysavingtrust.org.uk/home-insulation/solid-wall](http://www.energysavingtrust.org.uk/home-insulation/solid-wall)
treated with caution at this stage and more detailed information would be required for further statistical comparisons to be performed. A further discussion of how these reported costs compare with the modelled fuel costs from the EPCs is also provided in Section 3.2.

3.1.4. Fuel Poverty (reported)

In order to further investigate the impact of fuel savings, an estimate of the fuel poverty status for each household was calculated based on the reported expenditure on fuel and reported household income. This is an indicative calculation which does not use the same methodology as standard Fuel Poverty Index (FPI) calculations which are based on a standard heating regime, as set out in the Scottish Fuel Poverty Statement (Scottish Executive, 2002). This will be discussed further in section 3.2.3. Figure 16 illustrates the estimated FPI value (annual fuel costs/annual household income) for properties where both pre and post data was obtained.

![Figure 16: Fuel Poverty Index (Reported Fuel Costs)](image)

From these estimates, it was found that 65% of the 31 households with sufficient data were found to be spending more than 10% of their income on fuel. Following the insulation upgrades, this figure was equivalent to 52-58%. Although these are only estimated figures which are subject to uncertainty due the reliance on self-reported data from the participants, the results do suggest that in the majority of cases the improvements in energy-efficiency are not sufficient to alleviate fuel poverty given that the occupants have yet to experience significant savings. This may be due to the aforementioned discrepancies in fuel costs or the fact that theoretical savings may have been recouped through improved comfort in the
home. Further investigation using a larger sample of households and more accurate consumption data would however be useful in confirming these findings.

Participants were also asked about any difficulties in paying their fuel bills, both prior to and following the insulation works. There were some apparent shifts in the responses in terms of the number who found it ‘very easy’ to pay their bills (Figure 17 and Figure 18) or the number of people reporting that they had ‘never’ felt stressed or anxious about their fuel bills (Figure 19 and Figure 20) however the differences were not found to be statistically significant.

During the interviews some specific comments were also made in relation to the stress and anxiety associated with high fuels costs. This occurred even in cases where the insulation was noted to have reduced the fuel costs. For example EA3 reported a saving of £21 per month but expressed that that their expenditure on fuel was still a concern:
“There’s been a slight reduction but we’ve still got to watch what we’re doing. It’s maybe a wee bit easier” – EA3

Savings of approximately £20 per month were also found for EA20. The respondents again voiced concerns about the rising cost of fuel but noted that the insulation had helped:

“We noticed that the bills kept going up and up and I knew that we had to do something about them…I think it’s better. It’s more efficient now. It seems to hold the heating a bit longer” – EA20

These cases, along with the results of the fuel poverty analysis, indicate that although for the majority of households the improvements to the building fabric have helped to reduce the expenditure on fuel, in some cases the cost of fuel is still a concern when combined with a relatively low household income. This re-iterates the fact that energy-efficiency improvements alone are not sufficient to remove all of the households in the study out of fuel poverty.

3.1.5. Heating Patterns and Energy-efficiency

The types of heating system included in the study are shown in Figure 21. As illustrated, although the majority had gas central heating, some of the areas included in the study are not connected to the mains gas network. Electric, oil and solid fuel heating systems were therefore also present.

Figure 21: Type of Heating System
Around 74% of households had a full range of heating controls including a central thermostat, programmable timer and TRVs. For properties with a controllable thermostat, the occupants were asked what temperature this would typically be set to during winter, referring to the most recent winter period (2015/16). As illustrated in Figure 22, the temperatures were found to range between 13 and 30°C with the majority falling within the recommend range of 18 - 21°C.

In terms of winter heating patterns, again referring to the most recent winter period, the participants were asked to estimate the typical number of heating hours for both weekdays and weekends. The responses are summarised in Figure 23. Following the questions regarding the most recent winter, respondents were then asked to compare these winter heating patterns to the previous winter, prior to the insulation being installed. In total 50 households reported having made at least one change with a decrease in the number of heating hours being the most commonly cited modification.
In analysing these changes in more detail, participants were also asked to elaborate further on how these changes had affected their household. Many of these comments centred around the fact that the properties were found to be retaining the heat more effectively:

“We maybe put it on for an hour or so. Since this [insulation] got put up, the house seems to hold the heat” – SA6

Indeed it was found that 89% of the participants agreed that their property was now able to retain the heating better following the insulation upgrades. A further 84% found that their home now heated up more quickly once the heating was turned on (Figure 25).

Households were also questioned regarding the extent to which they monitored their energy use. It was found that 42% of the households reported that they did not monitor their energy use at all (Figure 26).
Some households did note that they had changed their level of monitoring with 3 reporting that they now monitored their energy use more while 10 monitored their energy use less. The latter case may again explain why some of households did not experience fuel savings. 12 of the households (15%) were found to own a smart meter, 6 of which were installed after the insulation upgrades.

### 3.1.6. Environmental Conditions

Participants were also asked more specifically about the environmental conditions within their property. Respondents were asked whether their heating kept them warm enough during the past two winters. For the winter prior to the insulation upgrades, only 47% of households indicated that they were always able to keep warm (Figure 27) however this figure was increased to 76% following the insulation upgrades. Furthermore, 12% of the households who had problems keeping warm identified it as a “serious problem” while 22% reported that it was a “bit of a problem” (Figure 28). When asked the same question in reference to the most recent winter period, the respective figures were 5% and 3%.
There were also some particular comments made regarding the change in the thermal comfort of the properties. For example, as shown in Figure 29, 83% of those interviewed felt that the overall temperature had increased with the majority claiming that their home was now “much warmer”. In all of these instances it is likely that the previously discussed rebound effect will have played a part in the management of the heating system.

For those who did report a noticeable difference in temperature, this was usually associated with improved comfort:

“It’s more relaxed. I feel more relaxed at night…Rather than coming in here at night and having to wear a big jumper or a cardigan I can sit about like this and I feel quite comfortable…I don’t need to go wrap up at night” – EA19

“The house is more comfortable…I’ll no say it wasn’t comfortable before but we’re probably not having to use the heating to the same extent to get the comfort level that we had” – EA3
In cases where the improvements were less dramatic, this was often attributed to the fact that the conditions were already satisfactory prior to the insulation or that there were other problems in the property that had not been rectified by the insulation. For the 13 households who commented that they had not noticed a discernible difference in temperature, 2 attributed this to the fact that winter of 2015/16 had been relatively mild and so they had found it difficult to directly compare the conditions (SA17 & EA36). In reviewing historic weather data, the average temperature for December 2016 was indeed 2°C higher than that of the previous year while temperatures for the other months were relatively similar. It is therefore possible that the warmer December had contributed to their observations. This problem has also been encountered in other EWI evaluations (Dickie et al., 2015). In 6 cases, the lack of improvement in temperature was linked to other problems with the building such as the heating system or windows (SA23, SA24, SA28, EA24, EA28 and EA30). A further 2 households described that the baseline conditions were already very good with regards to temperature. Some of the specific comments are highlighted below:

“It’s hard to tell because it’s not been too bad a winter” – (SA17)

“I think the problem in here is because that double glazing is ancient. I think that’s the problem. I think a lot of heat gets through the windows” - (SA23)

“I think it’s just the same, cause we always had a warm house” - (EA29)

In another case the participant commented that the house was occupied only in the evenings and so it was difficult to establish any changes:

“There must be but I haven’t noticed it…it’s not something I’m actively thinking about” – SA20

There were a further 2 cases where, although the respondent had not noticed an overall temperature increase, they did make comments on the overall heating dynamics, highlighting that they were now able to heat their home to the desired temperature more quickly:

“Now I would say its heating up and its staying at a good temperature for a while ...It’s keeping the temperature better” - SA39

It should also be acknowledged that 4 of the households who had reported no difference in the overall temperature also appeared to have experienced a reduction in their fuel costs. In these cases the benefit is that the households are
able to heat their home to the same standard while reducing their overall expenditure on fuel.

There were also some notable changes in regards to coping strategies adopted during winter, with some participants commenting that they no longer had to use additional methods to keep warm. The requirement for supplementary heating systems in particular, such as portable halogen heaters and electric fires, was almost halved. Significant reductions were observed in the use of blankets, additional clothing and hot water bottles.

![Coping Strategies](image)

Other secondary benefits relating to the improved thermal comfort included changes to the number of rooms used and the general use of the home. In total 5 households reported that they were using more rooms in the house. For example, one participant noted that the useable space in her home had been increased due to the more even distribution of heat:

“I spend more time in the kitchen. I, believe it or believe it not, spend more time in my bedroom…the house is just lovely and warm no matter where you go” - SA14

A mother of three also noted that the increased warmth in the bedrooms had allowed her children to use their own bedrooms more often:

“Before we actually all just used this room [living room]. They didn’t use their rooms to play in. It’s better because we’re not all on top of each other all the time” – SA15
In another more extreme case, a family of three noted that they had previously resorted to sleeping in the living room during winter due to the inhospitable conditions in the bedrooms:

“the upstairs is used, whereas the last couple of winters it hasn’t been…. We were all sleeping in here but last winter we were in our own rooms” – EA21

The same family also reported that they were now more likely to have guests over to the property. A further 3 households also cited this as a secondary benefit.

There were also a few comments made changes during the summer season. For example one household (SA11) reported having improved thermal comfort during the summer since the insulation helped to prevent over-heating in warm weather. However in some other cases the insulation was actually described as having a negative effect on the internal conditions during summer, either by making the house too cool or too hot:

“It is certainly a bit warmer in the winter….but I find it very, very cold in the summer… it’s stopped the heat coming in” - SA30

“Especially in the summer when the sun’s out it’s much, much warmer. On occasion we have to put a fan on” - EA39

These inconsistencies are likely due to characteristics of the individual properties such as the orientation, amount of glazing, shading and ventilation habits, all of which will affect the extent of thermal solar gains during summer. The location plans for the previously mentioned properties are shown in Figure 31, with the blue line indicating the glazed wall of the main living space and grey indicating a neighbouring property.

Figure 31: Locations plans (selected properties)
For property SA30, the main glazed area of the building is orientated towards the East (ESE, 110°) and therefore out with the recommended 150 - 210° for maximising solar gain. Following the insulation work, which increases the thickness of wall and the depth of the window recess, the availability of solar gain may have been further reduced thereby explaining the reported reduction in summer temperatures. Furthermore, the most southerly facing wall for this property has no windows. The addition of EWI with a light-coloured render to this fairly large wall area may even increase the proportion of the incident light or radiation that is reflected by the wall surface. This effect is reported elsewhere by Gupta and Gregg (2012) and by the Energy Saving Trust (2010) and may have again contributed to reduced temperatures during the summer. EA39 on the other hand is a south-facing property where the glazing forms around 20% of the area of the south facing wall. High solar gains during summer would therefore be expected for this property. These gains in combination with the increased level of thermal insulation are likely responsible for the increased summer temperatures. For SA11, where more comfortable temperatures were reported during summer, the main living space had a WNW orientation. This property would therefore be less sensitive to fluctuations in solar gain which may explain the more consistent temperatures experienced. This is consistent with findings by Porritt et al (2012) where overheating in EWI properties was found to be less of an issue where the main living space was on a west facing wall.

In terms of other environmental factors, participants were also questioned regarding their ventilation habits and usual methods for drying clothing. The aim of this was to ascertain the level of air flow within the property and any behaviours which may affect the indoor relative humidity as well as any changes in ventilation or laundry habits resulting from the insulation works. In the case of ventilation, 8 households reported that they were now able to open their windows more frequently and were less concerned about heat loss:

“I never used to open them [windows] ‘cause it was freezing. They used to always be shut” – SA32

In these circumstances the increased level of ventilation would likely improve indoor air quality. There are however concerns with external wall insulation upgrades that wrapping the building envelope in this additional layer of material could reduce air-infiltration rates if sufficient ventilation practices are not adopted. This can lead to increased levels of indoor pollutants as well as high moisture contents which can in turn lead problems with condensation, dampness and mould. As well as having a detrimental impact on the building fabric, poor ventilation rates have also been linked to negative impacts on health (Bone et al., 2010).
Although air-tightness, CO$_2$ and relative humidity were not measured in this study, participants were asked about the presence of condensation or damp within the property, both prior to and following the insulation works (Figure 32). There were some reports of improvements to stained and steamed/wet walls suggesting that these previous problems were linked moisture ingress through holes or cracks in the existing fabric which had now been sealed by the new insulation and render. Similar improvements have been reported for other EWI projects (Dickie et al., 2014; Prince, 2014).

It should be noted that for the wall mould category, for the 3 households who reported this prior to the insulation, 1 found that the problem had been improved following the works. The additional report of wall mould for the post-intervention question thus originated from another household. In this case it was noted that black mould had appeared on the lower part of the wall in the living room since the insulation work had been complete. This particular case has been part of an ongoing investigation and has likely arisen due to an existing defect in the wall which has resulted in a thermal bridge at the base course. In other cases the comments were more positive with the participants making direct links between the insulation and the eradication or improvement of previous problems. One household (EA37) described problems with dampness at the gable end of the property which now seemed to have been resolved. A similar improvement to dampness in the bedroom was also discussed by EA23.

In relation to noise, although the majority of households claimed that they were not previously bothered by noise, there were 17 households who had noticed a reduction in the level of noise. Excluding those who claimed that they were “Never” bothered by noise prior to the works, this figure equates to 45%. Noise reduction may therefore be considered as potential secondary benefit.
3.1.7. Installation process

Participants were also asked about the overall installation process and given the opportunity to share their experiences. In broad terms, 51% gave a positive account of the works while 7% had primarily negative comments. The remaining households (42%) gave mixed reports whereby the participants were generally happy with the finished product but had some specific problems which were encountered during the process.

Positive:

In the case of the positive responses, the most frequent comments were related to the work ethic of the contractors on site (25) and the speed of the installation (15):

Contractors

“They had made an excellent job of it...I just couldn’t find fault in any of them. They cleaned up after them as well which was really good” - SA8

“I don’t think we’ve ever been as happy with any workmen because we’ve had workmen for many years… and some of them make a damn mess and some of them are first class. But they boys were unbelievable” - EA17

“It was fine. I was in crutches at the time but the people that were doing it were really good. I was at home most of the time and whenever I’d had to go out they always cleared away and helped me” - SA6

Timescales

“‘I can’t remember it taking long at all actually. It seemed like they were putting up the foam, and then the next day they were plastering it...it was quite seamless. We weren’t haven’t to wait too long.” – SA15

There were also several positive comments made about the finished product and quality of the work:

“I couldn’t fault the men’s work or how they went about it...I was pleased with the general outlook of my house” - SA14

“I would recommend it to anybody cause I really think they made a great job of it” - EA15
Negative:

In reviewing the negative comments, as shown in Figure 33, most of these were related to the mess left either during or after the works, damage to property, disputes with specific contractors and delays.

![Figure 33: Reported Issues](image)

**Mess**

Around a fifth of the households reported mess as an issue. For example there were comments made with regards to general untidiness on site and the lack of clean ups (SA5) as well as rubbish being left in gardens (SA34). In a more extreme case the participant had to pay to have her garden paved due to the mess from the roughcasting process that was left on her previous shingles:

“I cleared up as much as I could but all the white and the mess, it just looked like an old council building, even though it was lovely at the front it looked worse than it was... They should have covered it up you see, it was a mess both front and back” - SA24

**Damage**

With regards to damage, the reports included problems with gutters and drainpipes (5), external lights (3), roof tiles (3), windows (2), fences/gates (2), vents (1) and TV aerials (1). In total 15% reported an issue with damaged property. One of the more serious cases included significant damage to an oil-fuelled boiler (SA19).
There were also some particular comments made regarding issues with gardens (7), including damage to grass and broken paving stones:

“Everything for the block was in my garden....That gardens ruined” - SA29

“I've got a broken slab out there that’s never repaired yet but that’s the only thing I've got over-hanging” - EA10

Disputes with Contractors

In terms of disputes with specific contractors, negative comments were generally related to the previously cited problems with damage and mess. There were however a few comments made regarding the management of the works:

“Overall the lads themselves they were great, it was the management that was causing the problems” - SA21

In one case (EA3) the householder commented that problems arose due to the inexperience of the contractor and the fact that the property was initially insulated using the wrong material (50mm insulation panel instead of 70mm). In another case a dispute arose due the fact that part of the gable of the property was initially not included in the works however this was eventually resolved (EA12). For another household, problems were encountered between the ABS contractors and other workers who were making separate roofing repairs (EA10).

Delays

Although some delays in work were reported, this represented only 9% of the sample. Furthermore in most cases it was accepted that that the delays were due to circumstances beyond the control of the contractors. In one instance (SA27) the scaffolding was erected but the start of the work was then delayed due to the occupants of a neighbouring property being in holiday. In one case the work was delayed by several months:

“I did take a little longer than we actually was planning. They told us it was due to start in the February…and I think it was June or July…It went on for a few months which was starting to get a wee bit irritating.” - EA39

Overall it would appear that many of the negative reports could have been avoided with greater care and organisation on site. Furthermore there were contradictory reports regarding issues such as mess and the behaviour of the workers,
highlighting the wide variation in the performance of different teams and contractors. Within this particular sample there were 5 different contractors working on the different project areas. The percentage of households with positive, mixed or negative reports about the installation process in relation to the main contractor is shown in Figure 34. Again this highlights the variation in performance, even within the same organisation. This is similar to reports by Prince (2014) for other solid wall insulation projects located in Scotland.

Nonetheless, all of those interviewed stated that they would recommend the scheme to other people. While there will inevitably be a degree of inconvenience due to the nature of the work and the fact that the properties are still occupied while the work takes place, on the whole this does not appear to be a major issue given that all of the participants felt that the scheme had been beneficial overall. Indeed comparing the comments obtained during the interview to the results from the customer satisfaction surveys, which are sent out upon completion of the works, the initial responses relating to satisfaction with the installation and the overall process are shown in Figure 35. Only 27 households of the 78 included in the study completed an initial satisfaction survey however the results still confirm that the majority were satisfied with process and gave either an “Good” or “Excellent” rating.
In addition to the householder’s experience of the installation process, the actual quality of the work is important in determining how effective the insulation will be. Within the ABS programme, although the work is supervised by a quality inspection officer, this does not completely eliminate the potential for defects. For instance sub-standard workmanship such as gaps in the insulation or poor execution of junction details can in turn lead to the creation of thermal bridges. These localised variations in thermal performance can result in discrepancies between the modelled and in-situ U-values (Rye and Scott, 2012). Underlying issues with the existing building fabric can also hinder the potential thermal performance. Many of these issues can be identified through thermographic surveys (Energy Saving Trust, 2000). For example Atkinson (2015) used this technique for various EWI properties in Wales and identified problem areas, particularly around window areas, where there were still visible heat losses. While these tests were not included as part of the ABS study, there may be value in assessing the construction quality as part of the evaluation in order to further explain any discrepancies between the predicted and actual performance.

3.1.8. Health Data

Individual health data was obtained for a total of 81 participants. Where other members of the household were not present, the main interviewee was also asked about any changes in the health status of the other occupants. Of those who completed individual health questionnaires, 51 (63%) were female and 30 (37%) were male. The first question asked participants to report on their current general health status (Figure 36). The majority of participants reported that their health was either “good” or “very good”. They were then asked to compare their current health...
status to that of a year ago. The majority noted that their health was ‘about the same’ as the previous year.

In considering existing long term health issues, participants were asked to identify whether they were suffering from any of the conditions listed in Figure 38. The “Other” category refers to any other long term health problem or disability expected to last more than 12 months. It was found that 78% of the respondents were found to have at least one long term health problem. The most frequently reported conditions were high blood pressure, arthritis and other problems of the bones, joints or muscles. Those who were found to be suffering from a long term condition were then asked if they had noticed any changes in their condition, or changes in their medication use, following the insulation work. There were 7 reports of improvements in specific conditions and 2 reports of conditions which had worsened. The remaining participants had not noticed any change.
For those who did note an improvement, this was related to problems with bones, joints or muscles (3), COPD (3), asthma (2), arthritis (2) and eczema (1). In the latter case, the improvement was partly attributed to a change in medication however for the other reports specific comments were made linking the improvements to the insulation. For example one participant, who had been recovering from a knee operation following the insulation works, noted that she had been able to heat the home to a higher temperature during this period, to compensate for her sedentary behaviour, without having to worry about the costs:

“When I had that operation, I could just sit there and have the heating on all day if I wanted, you know, because I wasn’t moving about. That was good. That was good that I didn’t have to worry about that...I think it’s been good health wise for me” - SA14

There were also two participants who linked the improved environmental conditions in their homes with improvements in their respiratory conditions. One of these reported having fewer problems with wheezing in the morning (EA25), while another also described an improvement in their COPD:

“With the dampness…its helps my breathing a lot dear and I sleep better” - EA17

In another instance, a participant who suffered from arthritis commented that the increased temperature of the house had also eased her pain, improved her mobility and decreased her medication requirements:
"I think with the house being warmer its helped my arthritis a lot cause I'm not as sore now as I used to be...It doesn't take me 3 hours in the morning now to get moving so it has made a difference" - EA33

Aside from pre-existing health conditions, participants were also asked to comment on any other noticeable changes in their health following the insulation upgrades. The majority (88%) had not noticed any discernible changes apart from 10 reports of decreased colds and flus:

"We haven't had as many colds. I used to get colds quite a lot." - SA29

There were also some reports regarding health changes for other occupants in the household. In one particular case, the interviewee commented that her son, who suffered from asthma, had been using his inhaler less (SA35). For the same household it was also mentioned that another family member who suffered from COPD was previously unable to visit the house due to the poor quality of the internal environment. This was however no longer the case following the insulation works. In another instance, the participant noted that her partner and two children previously suffered from various respiratory problems which now have been alleviated to a certain extent due to the eradication of dampness in the bedrooms:

"My kids and my husband, probably up until all this started getting done, used to get tonsillitis all the time...My husband used to get chest infections quite regularly...we genuinely believed that those [condensation and damp issues] were factors in how unwell we were in the house. And I think it has improved" - SA15

Aside from physical health, there were also several comments made relating to mental health and mood. Overall 10 participants reported that the insulation had had a positive impact on their mental health status. This was generally linked either to the increased level of comfort in the home or enhanced external appearance of the property, or both in some cases:

"Before you didn't want to come home and now, aye, you're quite happy" - EA21

"It makes me a lot happier. I think it's a lot warmer so it lightens my mood" - EA6

Overall, while the reports regarding improved health in this part of the study are anecdotal and limited by the participants' recall ability, there is some evidence to link the insulation scheme to health outcomes. The most notable improvements are those relating to mobility/musculoskeletal problems, respiratory conditions or improvements in general mood. However, given that the study was not specifically targeted at those with these conditions, the sample sizes were too small to make
definitive conclusions. The majority of those included were already in reasonably good health and so it is unlikely that measurable improvements would have been observed. The results from this retrospective study will therefore be supplemented by a separate prospective study which is both controlled and uses a standardised questionnaire to obtain more quantitative health scores rather than just anecdotal evidence.

3.1.9. Summary

In collating the information collected during the interviews, a summary matrix covering the key outcomes has been provided for each local authority area (Figure 39 and Figure 40). In each category, green indicates a positive response while orange indicates a neutral response and red is a negative response. In the fuel cost category, the light green colour has been used for households where there has been a reduction in costs but where other confounding factors may have contributed to this reduction. Furthermore, the lime green colour has been used in the “Temperature” and “Appearance” categories to represent a mid-range response (i.e. improved “a little” rather “a lot”). Although this represents a somewhat simplified version of the results, it provides an ‘at a glance’ look at the overall responses. It highlights the fact that none of the households reported more than one negative response in these key areas and every household gave a positive response in at least 2 of the categories.
**Figure 39: Summary Matrix – South Ayrshire**

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- **Positive**
- **Positive**
- **Neutral**
- **Negative**
- **Insufficient Data**
## Figure 40: Summary Matrix – East Ayrshire

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<th>ID</th>
<th>Fuel Cost</th>
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<th>Heat Retention</th>
<th>Comfort</th>
<th>Appearance</th>
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- **Negative**
- **Insufficient Data**
3.2. Documentary Evidence

3.2.1. Energy Bills

In addition to the information regarding expenditure on fuel, as discussed in Section 3.1.3, data on actual fuel consumption was also collected where possible. This required statements which covered comparable winters periods which, unfortunately, very few of the households where able to provide. This was mainly due to the fact that many of the participants had pre-payment accounts and therefore only receive a statement once per year. Only one participant was able to source these statements for both the pre- and post-install periods. Even for those who paid by direct debit, the majority received online statements instead of paper bills. Again obtaining sufficient usage data was difficult, even in cases where the pre and post direct debit amounts were known. For example, in some cases the interviewee did not have access to the account and others had not provided recent meter readings meaning that consumption figures were estimated. In addition to these issues for gas and electricity accounts, for other fuel types like oil, receipts for purchases were even more difficult to source. Even where purchase costs were known there was generally insufficient historical evidence to calculate changes in actual consumption.

Overall sufficient consumption data was obtained for 5 gas heated properties and 2 electrically heated properties. These are summarised in Figure 41 with the period of the year for which the data was obtained shown above each column. Where possible the data was obtained for the winter period however there are slight disparities between properties due to the different bill dates and periods covered (i.e. quarterly or 6 months).

![Figure 41: Energy Consumption Summary](image-url)

<table>
<thead>
<tr>
<th>Property</th>
<th>Gas Consumption (kWh)</th>
<th>Electric Consumption (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA24</td>
<td>Pre: 2300, Post: 1800</td>
<td>Pre: 4500, Post: 3400</td>
</tr>
<tr>
<td>EA38</td>
<td>Pre: 1900, Post: 1500</td>
<td>Pre: 3200, Post: 2500</td>
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<tr>
<td>EA17</td>
<td>Pre: 2100, Post: 1700</td>
<td>Pre: 3400, Post: 2700</td>
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<tr>
<td>EA3</td>
<td>Pre: 2000, Post: 1600</td>
<td>Pre: 3100, Post: 2400</td>
</tr>
<tr>
<td>EA19</td>
<td>Pre: 2200, Post: 1800</td>
<td>Pre: 3300, Post: 2600</td>
</tr>
<tr>
<td>SA21</td>
<td>Pre: 2400, Post: 1900</td>
<td>Pre: 3600, Post: 2800</td>
</tr>
<tr>
<td>SA34</td>
<td>Pre: 2500, Post: 2000</td>
<td>Pre: 3700, Post: 2900</td>
</tr>
</tbody>
</table>
All of the households witnessed a reduction in energy consumption with the exception of SA24. This is the previously discussed property where an increase in fuel costs was also reported (p 22). For those where a reduction was observed, the relative decrease between pre and post energy consumption ranged between 11 and 42%, with an average decrease of 27%. This is slightly greater than the mean saving of 14.7% reported by DECC (2015) for gas heated properties\(^3\). It should be noted that properties EA19 and SA21 had some additional energy efficiency measures carried out after the insulation works. This may therefore explain why these 2 properties demonstrate greater reductions.

In comparing these results with comments obtained from the occupants during the interview regarding energy management, all of those who witnessed a decrease in consumption had also stated that they had either decreased their main thermostat temperature or decreased the number of heating hours. The reduction in energy consumption therefore correlates with the reports from the households. While it is difficult to make robust conclusions from this limited amount of data, it would appear that considerable reductions in energy consumption can be achieved with this type of intervention.

### 3.2.2. EPCs

As part of installation process, a pre and post-installation Energy Performance Certificate (EPC) is provided for each property. Each certificate requires an assessment of the property taking into account factors like property size, the thermal performance of the building envelope and the efficiency of the heating system. In Scotland these assessments are performed using the RdSAP methodology. This is used to generate a primary energy indicator value, measured in kWh/m\(^2\)/year, and an estimate of the annual CO\(_2\) emissions. These values are then converted into an Energy Efficiency Rating (EER) and Environmental Impact Rating (EIR), both of which are measured on a scale of 0 – 100 where a higher number indicates better performance. These values can also be converted to a performance band (A-G) where again A represents the highest level of energy-efficiency. Alongside these figures, the EPC also calculates the expected fuel costs for the property based on the modelled energy efficiency and a standard heating regime.

\(^3\) DECC (2015) – Based on properties in England and Wales only.

“Typical (median) annual percentage saving for solid wall insulation in 2012, when weighted to be representative of the housing stock, is 17.2 per cent, which represents around 2,200 kWh.”
A summary of all of the aforementioned figures is provided in Table 5 and Table 6, for South and East Ayrshire respectively. This illustrates the mean values for the pre-install and post-install EPCs as well as the resulting percentage increase or decrease. Three of the properties in South Ayrshire were excluded on the basis that additional energy-efficiency measurements (other than the EWI) had taken place between the pre and post-EPC assessments. There were also 5 properties in East Ayrshire where either one or both of the EPCs were not available. These have also been excluded from the analysis at this stage.

Table 5: South Ayrshire EPC Data

<table>
<thead>
<tr>
<th></th>
<th>Pre-install EPC</th>
<th>Post-install EPC</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Energy Indicator (kWh/m²/year)</td>
<td>341</td>
<td>273</td>
<td>-20%</td>
</tr>
<tr>
<td>Energy Efficiency Rating (EER)</td>
<td>50</td>
<td>63</td>
<td>24%</td>
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<tr>
<td>% with EER below national average (61)</td>
<td>71%</td>
<td>17%</td>
<td>-</td>
</tr>
<tr>
<td>Environmental Impact Rating (EIR)</td>
<td>46</td>
<td>58</td>
<td>27%</td>
</tr>
<tr>
<td>% with EIR below national average (59)</td>
<td>71%</td>
<td>50%</td>
<td>-</td>
</tr>
<tr>
<td>Annual Fuel Costs</td>
<td>£1,308</td>
<td>£944</td>
<td>-28%</td>
</tr>
<tr>
<td>Annual CO₂ Emissions (tonnes)</td>
<td>6.0</td>
<td>4.4</td>
<td>-28%</td>
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</table>

Table 6: East Ayrshire EPC Data

<table>
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<tr>
<th></th>
<th>Pre-install EPC</th>
<th>Post-install EPC</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Energy Indicator (kWh/m²/year)</td>
<td>354</td>
<td>261</td>
<td>-26%</td>
</tr>
<tr>
<td>Energy Efficiency Rating (EER)</td>
<td>56</td>
<td>68</td>
<td>22%</td>
</tr>
<tr>
<td>% with EER below national average (61)</td>
<td>71%</td>
<td>11%</td>
<td>-</td>
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<tr>
<td>Environmental Impact Rating (EIR)</td>
<td>51</td>
<td>65</td>
<td>27%</td>
</tr>
<tr>
<td>% with EIR below national average (59)</td>
<td>76%</td>
<td>24%</td>
<td>-</td>
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<tr>
<td>Annual Fuel Costs</td>
<td>£1,087</td>
<td>£799</td>
<td>-26%</td>
</tr>
<tr>
<td>Annual CO₂ Emissions (tonnes)</td>
<td>4.8</td>
<td>3.5</td>
<td>-29%</td>
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</table>
In looking firstly at the energy-efficiency of the properties, as shown in Figure 42 and Figure 43, there is considerable variation amongst the EERs with pre-install ratings ranging between 11 (Band G) and 71 (Band C). The majority of properties were however below the national average prior to the insulation works. The mean EER was also found to be slightly lower in South Ayrshire than in East Ayrshire. For the post-installation EPCs the average EER ratings had increased to 63 and 68 (Band D) for South and East Ayrshire, respectively. In total 42 properties were lifted above the national average following the works. The properties gained an additional 13 points on average, with the differences in the pre and post ratings ranging from 3 to 26 points.

For the EIRs, the baseline values varied between 6 (Band G) and 72 (Band C) with mean values of 46 and 51 (Band E) for South and East Ayrshire. Following the insulation work, the scores increased on average by 13 points. This equated to an average CO₂ saving of 1.6 tonnes per property on an annual basis.
Modelled Fuel Costs

As discussed previously, the EPCs also provide an estimate of the predicted fuel costs. In comparing the figures from Table 5 and Table 6, the mean annual fuel cost was indeed higher prior to the intervention (approximately £1300 for South Ayrshire and £1090 for East Ayrshire) compared to the post-intervention costs (approximately £940 for South Ayrshire and £800 for East Ayrshire). Pre and post-intervention costs for each property are shown in Figure 46 and Figure 47. In all cases the post-intervention value was lower than the pre-intervention value although in 10 cases the reduction was found to be less than 10%. For South Ayrshire the estimated annual reductions ranged between £20 and £1250 with an average saving of £360 per year. For East Ayrshire the savings were between £18 and £432 with an average of £290.
While the results from EPCs do appear to demonstrate significant costs savings, there are a number of limitations to the RdSAP calculation method that must be acknowledged. Firstly, the EPC fuel costs relate only to space heating, hot water heating and lighting. They do not include aspects like cooking and the use of appliances which could add a further 1,000 to 2,000 kWh to the annual energy consumption (Menon, 2010), although these figures can vary depending on the property size, occupancy and type of appliances used. Depending on the tariff and unit costs, this could increase the annual fuel costs reported on the EPC by several hundred pounds. On this basis alone it would be expected that both the pre and post EPC figures would be lower than the actual costs. The unit prices used in the RdSAP calculations are also based on the prices available at the time of EPC assessment which may differ slightly from the actual unit prices on the customers’ energy bills. Furthermore the use of standard unit rates does not account for slight

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4 Assuming standard tariff rate of £0.15 per kWh (BRE, 2015)

www.bre.co.uk/filelibrary/SAP/2012/SAP-fuel-prices-January-2015.xls
differences for different locations and payment methods as well as discounts for dual fuel rates, paperless billing.

There are also various factors which may further under-estimate or indeed overestimate the predicted costs and hence have an impact on the potential savings. For instance the modelling methods incorporate assumptions regarding occupancy and usage patterns. For RdSAP, the occupancy of the property is based on the floor area of the building rather than the actual number of occupants. If the occupancy is greater than that of the estimate then the calculated hot water and electricity use would also be greater. Within this study it was found that there were 11 cases where the EPC overestimated the number of occupants and 4 cases where there were more occupants living in the property than estimated by the EPC calculation. The RdSAP method also assumes that the occupants are heating their home for 9 hours per weekday and 16 hours at the weekend. Referring back to the heating patterns of the households included in this study (Figure 23), this standard is seldom achieved. The model also assumes that temperatures of 21°C and 18°C are achieved in the living room and other rooms respectively. Without environmental monitoring it is unclear whether these targets are being met. However based on the reported heating patterns and thermostat settings, there were at least 16 households which were still being under-heated following the insulation works. In these cases the EPC would give an overestimate of the fuel costs, and potential savings. There were also 4 cases of over-heating where the property was heated for over 10 hours per day, both prior to and after the works. In all of these cases the reported savings were less than those predicted by the EPC. This is expected given that the consumption for space heating would have remained relatively consistent.

Other issues relating to occupant behaviour can also contribute to the performance gap. The EPCs for example do not take into account whether the occupants have changed their energy-use behaviours following the works, including the previously discussed rebound effects. Given that 18 of the households had experienced an increase in the temperature of their home, the improved comfort levels may have at least partially reduced the potential cost savings. Other issues such as changes to ventilation patterns and the use of electrical appliances were also reported following the insulation work but these behavioural changes are again not recognised in the EPC assessment.

Other possible explanations for the performance gap include errors with the actual install. As previously mentioned in Section 3.1.7, poor quality workmanship can mean that upgraded property may not be as thermally efficient as expected. Furthermore the condition of the existing fabric may not be taken into account. In
some cases this could lead to the use of inaccurate baseline u-values which would in turn over-estimate the predicted efficiency of the building fabric.

The EPC fuel cost data was also compared with the reported figures from Section 3.1.3. There were 26 properties where sufficient information was available to make this comparison. It was found that 23 out of the 26 households reported higher pre-intervention costs than those predicted in the EPC. This is also true for 24 of the post-intervention costs. Assuming that the main elements omitted from the EPCs (cooking, appliances etc) remain consistent between the pre- and post-assessment, we can instead look at the relative savings in order to identify other discrepancies between the modelled and reported values. As shown in Figure 48 there were 8 properties where the percentage decrease between the pre and post costs were actually fairly similar (±10%). There were then 11 properties where the relative savings were less than the reported savings. For 7 of these households, this discrepancy can be at least partially explained by rebound effect given that increased temperatures and comfort were also reported in these cases. For the remaining 4 households where the reported savings were less than expected but where no temperature improvements had been experienced, the limited costs reductions were attributed to a combination of factors. In 3 cases the properties were considerably under-heated (i.e. heated for only 1-3 hours per day) and this pattern did not change following the insulation works. It is therefore expected that limited fuel savings would be experienced. For the remaining household, the EPC model resulted in a significant underestimate of occupancy (2.4 rather than 6 occupants) and did not account for the addition of a new occupant between the pre- and post-assessment.

![Figure 48: Annual Fuel Savings (Comparison)](image-url)

For the 7 properties where the reported savings were in fact higher than those in the EPCs some further observations can be made. Firstly, there were 2 instances
where supplementary heating appliances in the form of portable electric radiators were used prior to the installation but were now no longer required. Since only fixed room heaters are included as part of the RdSAP calculations, this results in an additional saving in electricity which is not taken into account in the EPC. Depending on the type of heater and tariff, this could lead to additional annual savings of £20 to £90, assuming the heater is used for 3 hours per day over the 3 coldest months of the year\(^5\). It should also be noted that there were 6 cases in this group where the households reported a change in their heating patterns such as a reduction in the number of heating hours or number of room heated as well as turning down the main thermostat and/or TRV temperature. Turning down the thermostat from 19°C to 18°C can reportedly lead to a relative saving of 13\% in space heating energy, equivalent to approximately 1,530\text{kWh} (DECC, 2012). This change in behaviour may have led to a reduction of consumption beyond that predicted by the EPC. In the remaining household the larger reported reduction was attributed to a change in tariff/supplier.

3.2.3. Fuel poverty (modelled)

Self-reported income data and modelled energy use, obtained from the EPCs, was also used to investigate the number of households likely to be in fuel poverty. For these calculations estimated costs for cooking and household appliances were added to the EPC figure based on the number of occupants and total floor area of each property (BRE, 2014b). Again this information was obtained from a limited sample given that both income data and EPC data were available for only 37 properties. The calculations also rely on self-reported income data from the participants. For properties where sufficient data was available, it was found that prior to the insulation upgrades 20 households were estimated to be in fuel poverty. This gave an overall fuel poverty rate of 54\% within the study group. This baseline rate of fuel poverty was higher than the rate of 31\% for Scotland as a whole (Scottish Government, 2016) which is expected given that properties are selected for the ABS programme on the basis of being \textquote{hard to treat} and located in an area which is at high risk of fuel poverty.

The comparative pre and post-installation Fuel Poverty Index (FPI) values are shown in Figure 49. Following the insulation upgrades, only 13 properties were found to be in fuel poverty giving a revised rate of 35\%. While this indicates a reduction, it again highlights that insulation measures alone may not be sufficient to

\(^5\) Assuming rates of £0.08 to £0.36 per hour

https://www.cse.org.uk/advice/advice-and-support/room-heaters
lift some of the properties in our sample out of fuel poverty. Indeed 4 of the households would still be classed as being in ‘extreme fuel poverty’ following the insulation upgrades.

![Figure 49: Fuel Poverty Index (Estimated)](image)

Given the aforementioned differences between the modelled cost savings and the actual cost savings reported by the householders, there is also a resulting discrepancy between the estimated fuel poverty rates calculated using the modelled and reported figures. For properties where both modelled fuel costs and reported fuel costs were available, the comparative post-intervention FPI values are shown in Figure 50. There were 4 cases where based on EPC data, the household would not be classed as fuel poor but where the reported fuel expenditure would place the household in the fuel poverty category. There were also 2 cases where the opposite scenario was true. The modelled and reported figures may therefore paint very different pictures with regards to fuel poverty at the individual household level.

![Figure 50: Fuel Poverty Index (Modelled vs Reported)](image)
3.3. Cost Analysis

A basic cost analysis has been performed in order to compare the previously discussed savings in fuel costs (both modelled and reported) against the initial capital costs of the works. The installation costs can vary greatly depending on the size of the property. The Energy Saving Trust\(^6\) give typical cost estimates of between £8,000 and £22,000 for external wall insulation works. For the properties included in this study, installation costs were found to range between £3,600 and £12,900 with an average value of £8,100. These lower costs are partly attributed to the area based approach which allows for greater efficiencies in relation to travel times, distance between jobs, high workloads and bulk purchasing of materials (Butterworth et al., 2011). A further breakdown of the typical costs by property type is shown in Figure 51.

![Figure 51: Average Capital Costs by Property Type](image)

Only 3 detached properties were included in the study. These had floor areas ranging between 76 and 110 m\(^2\) which may explain the high variation for this group. The semi-detached/end-terraced properties appear to have the highest overall cost however this can partly be explained by that fact that 27% of this group are Weir Timber houses which require a slightly different, and more expensive, system than for the other construction types. Indeed the average installation cost for this group alone is £10,800 compared to a cost of £8,300 for an end-terrace with a solid-wall construction. As expected, the cost for a mid-terrace property is even lower due to the reduced external wall area and increased efficiencies offered by working on an entire block. Costs for the remaining property types were broadly similar with average values of between £6,500 and £7,500. For the 2014/15 ABS

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\(^6\) [http://www.energysavingtrust.org.uk/home-insulation/solid-wall](http://www.energysavingtrust.org.uk/home-insulation/solid-wall)
In comparing these capital costs with savings in fuel expenditure, the average payback period for each of the property types is shown in Figure 52. Calculations have been performed using both the modelled fuel savings, as obtained from the EPCs, and the actual savings reported by the householders. With the exception of the detached houses and mid-terraces where the modelled and actual figures are relatively similar, the modelled payback periods are lower than those based on the reported savings. A particularly lengthy period of 40 years has been calculated using data collected from those living in ground floor flats. This is partly due to the fact that only 5 of these properties were able to provide sufficient data on fuel expenditure. Furthermore, 2 of these properties had not made any savings on their bills and one had experience a slight increase. Similarly, only 2 properties were included for the detached group. A larger sample of these properties would therefore be preferred in order to make more robust conclusions.

EWI systems typically come with 25 year performance guarantee from SWIGA (Solid Wall Insulation Guarantee Agency) although the manufacturers also state...
that the system should remain effective for at least 30 years if properly maintained. Ideally the proposed payback period would be less than the product lifespan. Even using the more onerous 25 year benchmark, with the exception of the detached properties, the EPC figures predict that the cost of the installation would be recouped during the guarantee period. However this is not the case for many of the reported figures. Again these reported savings should however be treated with caution due to the limited sample sizes.

It should also be acknowledged that this cost-analysis does not take into account various other factors which would likely increase the cost-effectiveness. First of all, these calculations assume that energy costs would remain static in the coming years. This is highly unlikely given that most studies predict an increase in energy costs in future decades. According to DECC (2013), energy prices are expected to increase by 10% to 38%, compared to 2013 prices by 2030. In modelling the impacts of these scenarios, the cumulative savings up to 2030 (16-17 years after the intervention) have been calculated based on average pre- and post- annual fuel costs of £1,212 and £873, as obtained from the EPCs. As shown in Figure 53, based on a 10% increase in energy prices, by 2030 up to 75% of the initial install costs (based on an average install cost of £7,605) would have been redeemed through energy savings. If energy price increases are as high as 38% then this figure would increase to 84% (Figure 54). By comparison, if energy prices were to remain consistent, the payback by 2030 would be 70%.

Figure 53: Cumulative Savings (10% increase by 2030)
There is a further argument that installing external wall insulation will also help to reduce the maintenance costs of the properties. For example, the Weir timber properties included in this study would otherwise require preservative coatings and even replacement panels during the proposed 25 years life-span of the EWI. Typically re-applications of coatings are required every 6 years (Davies et al., 2002), therefore a minimum of 4 maintenance cycles would likely be required. For a standard 2-storey semi-detached property an additional saving of £1200-1400 could be expected over 25 years. For properties with an existing roughcast finishing, savings in maintenance costs are more difficult to quantify. A lifespan of 50 years could be expected for this type of finish however this is very dependent on the quality of the original work. Even assuming that one maintenance cycle was required, the EWI could save the thousands of pounds that would typically be required to renew the roughcast.

Another financial saving, which has been discussed in other studies is the saving resulting from avoided CO$_2$ emissions (Butterworth et al., 2011). Attempts have been made to quantify this so-called ‘social cost of carbon’ however there is much uncertainty regarding the most appropriate figures with reported values ranging between £0/t Carbon and £1000/t Carbon (Watkiss and Downing, 2008). The lower UK benchmark of £35/t C has been used in this study to give a conservative estimate of the potential monetary savings based on the modelled CO$_2$ savings. As shown in Table 7, based on the average CO$_2$ saving per property, this results in an average saving of £400 over 25 years.
Table 7: Monetised CO₂ Saving

<table>
<thead>
<tr>
<th></th>
<th>Tonnes CO₂</th>
<th>Social Cost of Carbon</th>
<th>Average monetised CO₂ savings per property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average CO₂ savings per property (Annual)</td>
<td>1.6</td>
<td>1t C = 3.6t CO₂</td>
<td>£16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>£35/t C = £10/t CO₂</td>
<td></td>
</tr>
<tr>
<td>Average CO₂ savings per property (over 25 years)</td>
<td>40</td>
<td></td>
<td>£400</td>
</tr>
</tbody>
</table>

There is also evidence to suggest that energy-efficiency improvements can increase the value of a property. A recent study of the English property market found that increasing the EPC rating of a home from a band G to a Band A or B led to an increase in value of 14% (Fuerst et al., 2013). Even improving a G rated property to a Band F resulted in an average increase of 6%. While the properties within the ABS programme were only raised to a maximum of a Band C, the EWI offers further aesthetic improvements which could also be expected to increase property values.

In reviewing some individual cases of properties within the ABS scheme which have been sold following the intervention, there do appear to be some cases where the property value has increased. It should be noted that these properties are not necessarily those who were interviewed. Analysis has instead been performed on any ABS property for which a recent sale history could be obtained. For example, one 3 bedroomed property in Tarbolton was purchased for £49,000 in October 2013. It was then sold following the insulation works in October 2015 for £65,000 representing an increase of 32%. This is greater than the value increases for Tarbolton as whole, where average property prices increased by only 10% during this same period.

In looking more broadly, data was compiled for pre and post-installation property sales for the areas of Tarbolton and Annbank. As shown in Figure 55, the average selling price of properties within ABS streets increased following the insulation works. In the case of the 3 bedroom properties, these increases were greater than the predicted increases based on trends for the relevant area. While this cannot be attributed directly attributed to the insulation, it certainly indicates some positive trends regarding property values within the area.
Another element which has not been included in the cost-analysis is the potential savings for the health service. Although the reported health benefits discussed in 3.1.8 have not been quantified at this stage, it is possible than the types of improvements described would also have financial benefits in the form of reduced GP /hospital visits, decreases in medication use and fewer absences from work or school. Such savings have been reported in various other studies regarding domestic energy-efficiency improvements (Chapman et al., 2004; Grimes et al., 2012; Liddell, 2011; Mason and Roys, 2011; Nicol et al., 2015). A more detailed analysis of these potential savings will therefore be incorporated into a separate prospective study which aims to capture more quantitative health data for ABS recipients.

Other potential financial benefits include more general contributions to the wider economy. For example a study by Butterworth et al. (2011) investigated various direct and indirect economic impacts of a cavity wall and loft insulation scheme concluding that the project facilitated the creation of new full time employment positions which in turn had a positive impact on the local economy. Other modelling studies also highlight the macro-economic benefits of improving energy-efficiency in housing, citing job creation and GDP increases as potential outcomes (Cambridge Econometrics and Verco, 2012; Platt and Rosenow, 2014). Although these types of benefits are beyond the scope of this study, they re-iterate the fact that the impacts of the ABS scheme stretch beyond the individual households.
4. CONCLUSIONS

This report has summarised the findings from a retrospective study involving 79 households in South and East Ayrshire who had received external wall insulation as part of the HEEPS: ABS scheme. The recruited households had generally low incomes with high rates of relative poverty. The majority of households included either a child (under 16) or an elderly occupant.

A range of different property types were included allowing a broad assessment of factors which may have influenced the extent of improvement following the insulation. Despite the fact that all of the properties were targeted based on the assumed poor energy-efficiency, analysis of the pre-intervention EPC data in combination with reports from the householders revealed that there was considerable variation in terms of the baseline energy-efficiency. Nonetheless the majority of households (71%) had a below average EPC rating prior to the insulation works. Following the insulation works, this figure was reduced to 17% for South Ayrshire and 11% for East Ayrshire. The modelled fuel savings predicted by the EPCs also equated to approximately £360 and £290 per year.

A comparison of the predicted improvements in performance and reports from the householders did however reveal various inconsistencies. This included both under-estimates and over-estimates of performance, most of which could be explained by the differences in the assumptions made by the EPC assessment and the realities of occupant behaviour. For example it was apparent from the household questionnaires that few of the properties were heated to the standard assumed in the EPC modelling. There was also evidence of the rebound effect whereby a proportion of the predicted savings were likely absorbed through increased consumption. Difficulties were also experienced in obtaining historic energy bills from the participants thereby limiting the number of properties for which the modelled and actual usage could be compared directly. The results from the interviews have therefore highlighted the complexity in determining the true impact of an intervention like wall insulation on fuel expenditure.

Additional benefits to the householders, beyond those relating to fuel costs, were also investigated. It was found that the majority had experienced an increase in the temperature of their home following the insulation upgrades. There was also a reduction in the need for coping strategies such as supplementary heating appliances. These are aspects that are not acknowledged in the EPC assessment. Furthermore, there were positive reports relating to the improved appearance of the property and general neighbourhood as well as a few reports of reduced noise. There was also some anecdotal evidence of improved health outcomes particularly
in relation to respiratory conditions, mobility issues and mental well-being. Although these are not the primary aim of the scheme, they represent important secondary benefits.

In relation to any unintended consequences of the insulation, there was little evidence of any negative impacts with only one report of over-heating and one issue with mould which was related to an existing defect in the wall. It is however acknowledged even where there are no visible moisture problems, indoor air quality may still be comprised. Additional monitoring of relative humidity and CO₂ would therefore be useful in confirming that there are no negative impacts on the environmental conditions.

For the actual installation process, although there were some mixed reports in relation to the contractors, the majority of participants were happy with the end results and stated that they would recommend the scheme to others. With regards to possible defects in the installations, tools such as thermographic surveys may be useful in identifying any hidden thermal bridges or areas of poor workmanship, particular in households where the fuel savings or increases in temperature were lower than expected.

Finally, a basic cost analysis revealed that, based on the predicted reductions in energy consumption, for the majority of properties the initial costs of the works would be recouped through savings in fuel expenditure within the lifespan of the insulation. The payback periods were however much higher in some cases when the actual savings experienced by the householders were taken into account although these calculations were limited by the small sample size. There are however other financial benefits which, although not quantified at this stage, may contribute further to the cost-effectiveness of such a scheme.

Overall while the results presented here suggest a range of potential benefits resulting from the ABS scheme, the study is limited somewhat in its retrospective nature. The study will therefore be complimented with an ongoing prospective study and more detailed environmental monitoring, both of which are due for completion in Spring 2017.
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