UCL ENERGY INSTITUTE

The impact of the CESP scheme on a set of case study households

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Contents

Summary of key findings

The overall finding was that the physical-works component of the CESP scheme was very effective, and that the educational component of the scheme was more necessary than originally anticipated and could thus benefit from being redesigned, to maximise effectiveness.

- In 8 out of the 10 properties whose occupants remained the same over the duration of the study, the internal temperature increased after the works. The occupants reported warmer homes and some of them were absolutely delighted with the effect of the works.

- In the same properties as above, the relative humidity decreased, often from a zone bordering-on-unhealthy (around 70%) by about 10-20%, which should result in less mould and less risk of dustmites. Therefore occupants with asthma and some allergies should experience better health after the retrofit.

- In many cases, occupants felt able to have the heating on less. Use of expensive secondary heating (gas fires, electric heaters) decreased as the central heating was normally able to make the property warm enough after the retrofit.

- The three sets of new tenants in the study, who did not experience their properties pre-retrofit, were all impressed and in some cases surprised with how warm their property had been during their first winter there.

- Since it transpired that many occupants do not know how to operate a heating system effectively, it is very important that they receive informed advice, perhaps in the form of a home visit, where the occupants are *shown* an efficient manner of operation. This visit should also cover ventilation and health aspects of a refurbished property.

- The advice visits would be most well-received and beneficial to the occupants if they were carried out by a party whose incentives were not selling energy, and if they were overseen or checked by [the RSL] in terms of their content.

- Some occupants would appreciate communication of how it was decided which works would be carried out, before the start, to feel part of the process. Similarly, since some occupants did not appear to understand the purpose of the works even though they had received letters and leaflets, perhaps there is room for thought on how this could be more effectively expressed.

- It may also be beneficial to communicate to tenants how they can anticipate changing their heating behaviour after the retrofit. This may aid their understanding and choice of how to take the benefit of the refurbishment.

Introduction

This report presents findings from a detailed study of 13 case study houses which were part of the CESP scheme, which may be of interest to [the RSL]. Firstly, the study methods are briefly described, after which the findings from monitored data in terms of temperature, relative humidity and occupant heating use before and after the works are presented. Following this, observations regarding how the occupants use their heating systems are discussed, then there is a section on the home energy advice visits. Finally, the topics of 'overcompensation' and new tenants' perceptions of the refurbished properties are raised. Recommendations are presented throughout the report and especially in the Conclusion section.

Please note that a small number of properties were studied; therefore the findings may not be typical of what happens in general. I may also have misinterpreted some of my reported findings due to either the limited number of case studies or limited access to information. I would welcome any feedback where you think this may be the case.

Finally, I am very grateful to [the RSL] for their permission to do monitoring in [the location], and for their cooperation and help where I needed information or to recruit households. I hope that this report will be helpful and am happy to answer any questions raised as it is read.

Research methods used

13 case study households were recruited for the study through letters and an open day. Three main methods were used to gather data.

Sensors:

In each room of each property, an air temperature/relative humidity sensor was placed at about waist height, a temperature sensor was placed on the radiator and the living room fire to discern when the central heating or fire was on, and an occupancy sensor was placed on the doorframe to discern how frequently the room was used. This was all carried out twice: the first monitoring period was the entire month of February, 2012 and the second was the entire month of February, 2013, such that a cold month before and after retrofit could be observed.

Interviews:

In-depth interviews of one member of each household were carried out at the same time as the sensors were taken down, at the start of March, 2012 and 2013. Questions were open-ended and covered life at home, how they dealt with the cold, how they used the heating, their financial situation, how they used the rooms, their perception of the retrofit, and other topics.

Shadowing:

An originally unplanned but eventually important part of the research came about when the opportunity presented itself to shadow a representative from [the energy company] charged with carrying out the 'Home Energy Advice' visits, for a day.

Findings 1: Change in temperature

The case study properties are numbered 1 to 13 below and throughout this report.

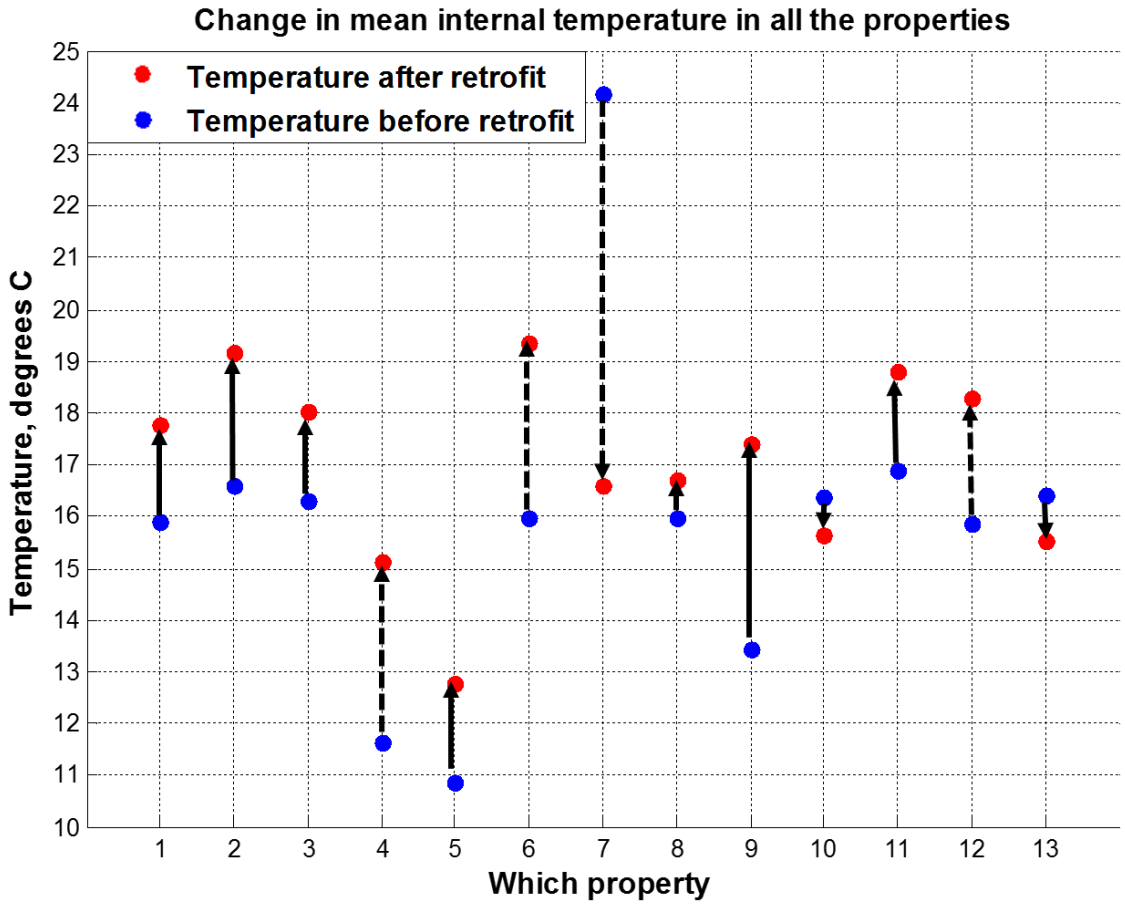

Figure 1: Temperature change.

Figure 1 shows initial (pre-retrofit), and final (post-retrofit) temperatures, with arrows so that the direction of change can be easily seen. Those arrows which are dashed instead of solid represent properties in which something significant happened as well as the retrofit: such as a change in occupant (properties 4,7,12) or a broken heating system being mended (property 6), in which case it is difficult to know the effect of the retrofit exactly. The effect of variation within and between monitoring periods has been taken into account here and in all other graphs in this report.

It can be seen that most properties increased in temperature after the retrofit. It was shown in separate analysis (not shown here) that this increase was mostly due to the properties keeping heat in better when the heating was switched off. In this way, the retrofit was a success.

In two of the properties (10 and 13), the temperature decreased, since the occupants turned down the heating so much after retrofit that it actually got colder, from already being fairly cold. This will be treated later in the report as it is potentially quite important.

Note that dwelling 7's initial temperature was exceptionally high since the occupants (who have since moved out) had the heating on continuously. They had learning difficulties and had not had a bill through yet, and thus seemed unaware of the implications of 24/7 heating at a high temperature on gas cost.

Findings 2: Changes in relative humidity

Relative humidity (RH) is important since mould is known to grow best if RH is greater than 70%, potentially aggravating asthma. House dustmites also proliferate in high-RH conditions. If retrofit helps increase internal temperature, relative humidity should decrease. This theory was tested in the case study properties.

The outcomes fell into two groups: those whose temperatures increased and whose RH decreased, and those whose temperatures decreased and whose RH remained about the same but became less variable.

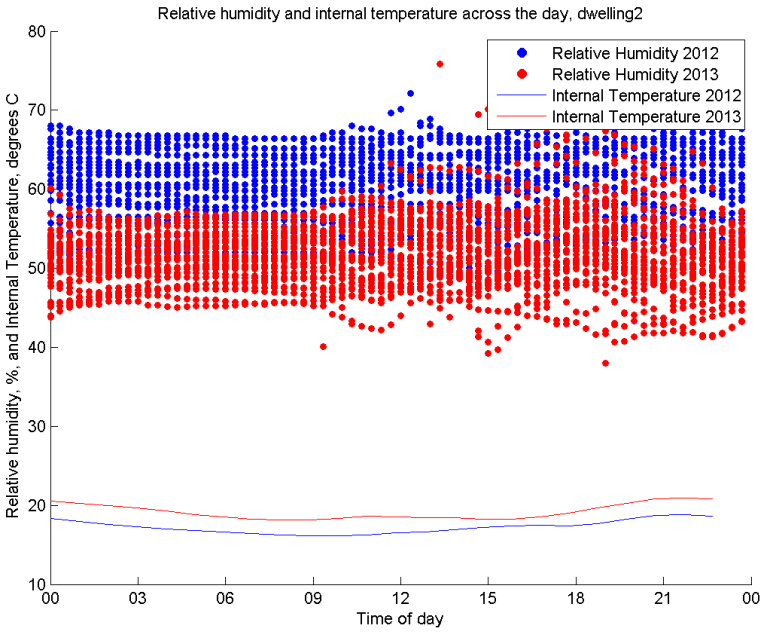

Figure 2: Relative humidity, first type of outcome.

An example of the first outcome is shown in Figure 2. It can be seen that the RH lowers, from a fairly high level (in fact, this house had a lot of mould problems) to a more reasonable range.

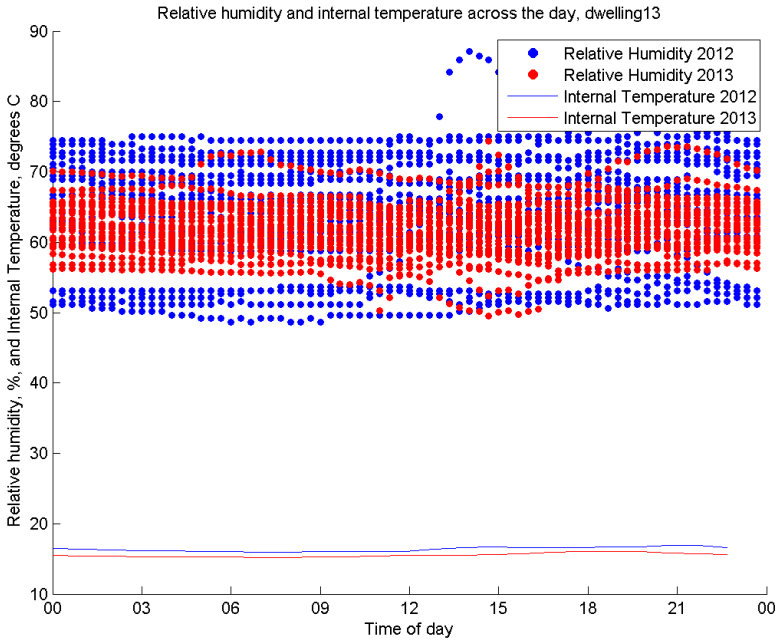

Figure 3: Relative humidity, second type of outcome.

An example of the second outcome is shown in Figure 3. Here, the RH is still quite high, partly because the temperature maintained is low – it decreased from the pre-retrofit level. However, the range has become less, so it does not exceed 70% as often as before. This is therefore still a positive outcome, even though it is still possible that the property will have mould problems in the future.

Findings 3: Change in heating use after retrofit

How did people's daily heating schedules change after retrofit? The results of interviewing people about this will be presented later on, but an overview of the sensor data is given in Figure 4, which shows for most properties[1] the change in number of hours the heating was on per day after retrofit:

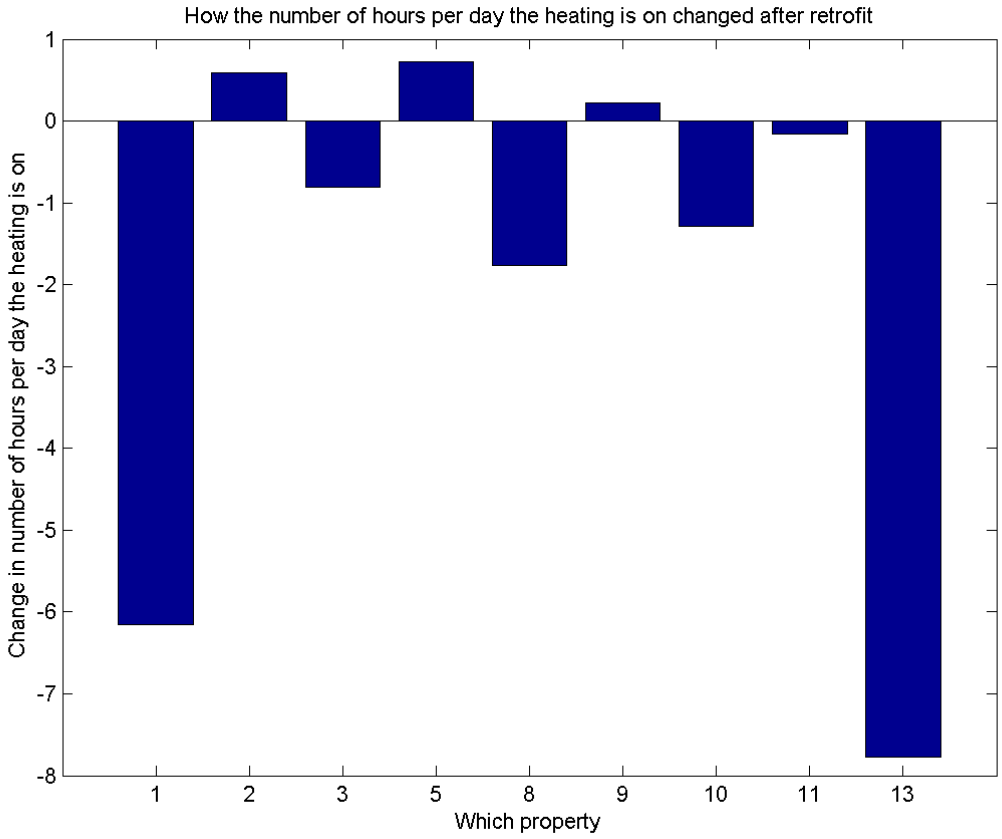

Figure 2: change in heating use.

It can be seen that in most properties, the occupants have been able to have the heating on fewer hours per day after retrofit, which is a positive result in terms of saving them energy.

It is worth describing what happened in those properties whose daily heating hours increased, as it was due to three different reasons.

In property 2, the occupants (a couple) still felt fairly cold after the retrofit. In property 5, the occupant had received an increase in income around the same time as the retrofit and was consciously having the heating on more because he could afford it. In property 9, the occupant was enjoying the extra warmth compared to the previous year (he now kept his flat very warm, one reason being that he did not use the thermostat to control the temperature!)

[1] Properties with a change of occupant between the two monitoring period, and property 6 in which the heating had been broken in 2012, are excluded here and in Figure 5.

Findings 4: Overall outcomes

An 'ideal' outcome, it could be argued, is if the occupants' heating use reduced after retrofit and also those who were too cold before could maintain a higher temperature in their home.[2]

Figure 5 shows the combined results of the sections named 'Findings 1' and 'Findings 3'; that is, what happened to internal temperatures and heating use, after retrofit.

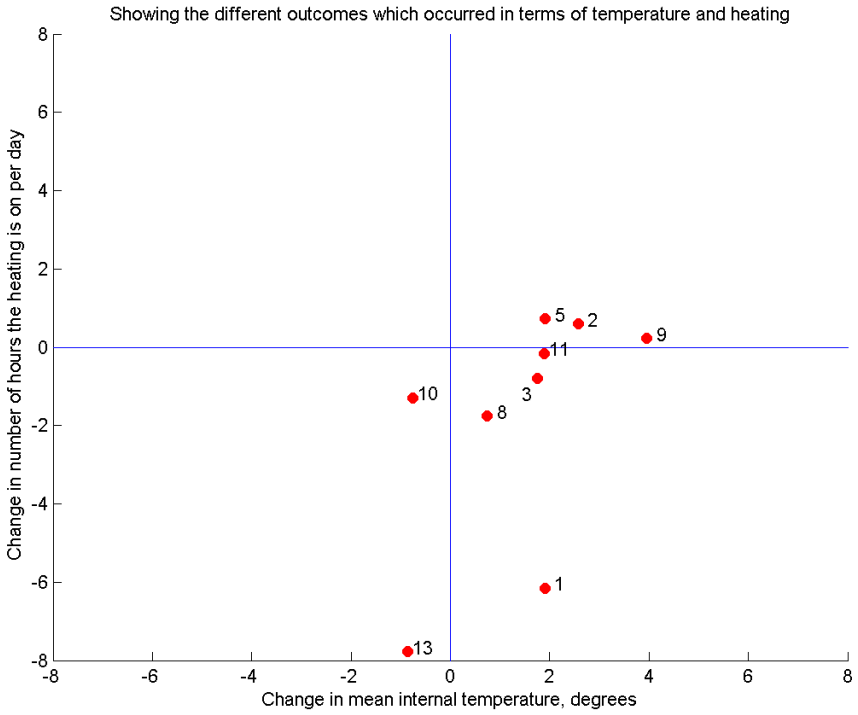

Figure 3: overall outcomes.

The bottom right hand quarter of Figure 5 represents the 'ideal outcome' described above: that is, after retrofit, temperature increased and heating was on less. Four properties fell into this category.

The top right hand corner represents the properties whose temperatures increased and who also used more heating after retrofit. None of them used much more heating so it is not a 'bad' outcome, but they are not saving money on their bills after retrofit.

The bottom left hand corner represents the properties whose temperatures decreased and whose use of heating also decreased. In the case of property 13, the heating use decreased dramatically, whereas in dwelling 10, a smaller reduction was enough to decrease the temperature despite the retrofit. This was for a few reasons, one being the low thermostat setting which kept a tight rein on the temperature after retrofit, unlike in some other properties. Figure 5 is shown because it illustrates the diversity in outcomes that even only 9 properties exhibit. This diversity is largely due to a combination of occupant choice/financial constraint and level of knowledge about how a heating system works.

[2] This may be different from the ideal outcome in the CESP calculator, which may be all in terms of fuel saved without allowing temperature to increase – I am not sure if allowance for temperature increase was made in the CESP calculator.

Findings 5: How the occupants actually used their heating systems

Many people, including myself before I went into the case study houses, assume that the way people operate heating is as follows: leaving the thermostat at a reasonable setting (e.g. 20°C) to control temperature, then turning the heating on and off either using a timer or manually. However, this assumption turned out to be quite wrong in many of the case study properties, and had some implications for energy use and for the effect of the retrofit.

For example, about half of the case study households had their thermostats set on maximum (30°C). Some of them did not know what the thermostat was (one occupant thought that since it made a clicking sound when she moved it, it indicated that it was broken). Others had the idea that the thermostat needs to be set higher on colder days outside, since they thought it was a kind of valve which controlled the power of the heating system. Others thought it was an on-off switch, so turned it to max (30°C) to switch the heating on, and back to zero to turn the heating off.

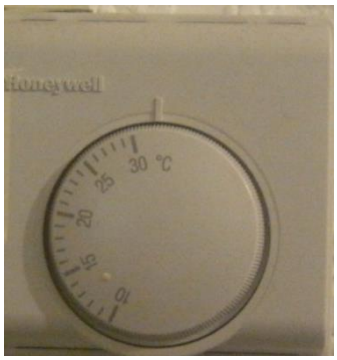

Figure 4: what a typical thermostat in the case study properties was set at.

Most of the occupants did not use the timer on their programmer; they turned it on and off manually. In most cases this seemed reasonable; they often had more control this way. However in one case, not knowing about the existence of a timer led to quite a lot of energy waste: an occupant who worked night shifts arrived home mid-morning, and turned on the heating so that the house would be warm when the children came back from school, before she then went to sleep. A timer set to switch the heating on when she was asleep, one hour before the children came home, instead of about 5 hours, would save a lot of energy.

There were many misunderstandings about energy use caused by heating. For example, many of the tenants thought that leaving the heat on whilst they went out for a few hours uses less heat than turning it off and then on again later. Also, some of them living in larger properties thought that turning down the radiators in unused rooms used the same amount of energy as keeping them on full, as the unused room would get cooler and suck out heat from other spaces, whereas in fact they could have saved some energy by keeping unused rooms cooler and closing the doors.

There were also misunderstandings about the necessary level of ventilation in a property. One household used air freshener instead of letting fresh air in, to avoid heat loss. Another household closed all the trickle vents and occasionally opened to windows instead, hence confusing continuous background ventilation and purge ventilation, both of which are necessary but especially background ventilation. In another household the conflict between letting in fresh air and keeping in warmth led to arguably the wrong outcome: even though one occupant needed fresh air to keep down the mould as she was asthmatic, her partner would go around and close all the trickle vents.

Findings 6: Home energy advice visits

Given that, as explained in the previous section, many occupants did not understand the components of a central heating system or ventilation techniques such as trickle vents, the home energy advice could provide an opportunity to educate occupants about the most effective way to operate the newly refurbished building and its systems.

In the CESP scheme, the visits were carried out not by [the RSL] but by [the energy company], with one consequence of this being that (as far as I am aware) communication between [the RSL] and [the energy company] on the content of the advice given to householders was minimal.

As far as I was aware (but may be wrong on this), each property undergoing retrofit was supposed to receive a home energy advice visit. Since, however, none of the case study households received such a visit, I made an arrangement to join the individual carrying out the visits for a day.

The [energy company] representative I was told was supervising the home energy advice packs and thus shadowed was an extremely helpful and kind individual who wanted to help the occupants save money on their bills and gave them good advice. He made a great deal of effort in the face of frequent rejection by occupants.

However, giving advice was not what he had specifically been told to do by [the energy company], who had given him a pre-existing tool developed possibly for another purpose.[3] The tool seemed more about data gathering than communicating personalised advice to the occupants. He had tried to ask [the energy company] what they do with the information he input, but they had not given him a response.

Even though he was very polite to the tenants, they often did not want to let him in since he was from an energy company. Indeed, in the interviews of the case study households many of them expressed resentment at companies such as [the energy company] for raising prices and simultaneously making a lot of profit. This raises a question of whether the proportion of homes accessed could be increased if such visits were carried out by a more neutral party whose incentives aligned with those of the occupants.

Some recommendations therefore for future home energy visits are as follows:

1) It is very important that tenants receive informed advice on how to use a heating system optimally given the evidence found of their misconceptions; it is even better if they are *shown* how to use their system. Given that many of them did not really read various letters about the purpose of the works, it is unlikely that the will read a paper document on the optimal use of their heating system.
2) It is also important that broader issues than just heating systems are covered, since certain occupant actions following retrofit such as extreme turning down of heating may have health implications (see the following section). Perhaps the visits could be branded as, for instance, “Getting the most out of your refurbished home”, and cover ventilation, heating, humidity and health.
3) It could be beneficial for the occupants if [the RSL] in future could either help design the advice given, or cross-check the advice being given with an independent authority to validate its content, or at least join the home energy advice visitor for a couple of visits to check how the visits are proceeding.

[3] From what I can tell, the assessment was an ‘in-home energy assessment’, described for example here: [link removed]; however no personalised report for the occupants was mentioned by the [energy company] representative. Perhaps [the energy company] posted one to each property later but the type of information one can give on paper is limited compared to actually showing the occupants how to use their system, in the context of their own needs.

4) An organisation with incentives to help the occupants reduce their energy use, and of whom the occupants do not have a prior negative opinion, carrying out the visits may make the proportion of accessible homes higher and the occupants more trusting of the advice given.

Findings 7: Some specific phenomena to raise

Overcompensation

As was mentioned previously, there were two properties where the temperature decreased following retrofit. Obviously it is the occupants' choice how much to use their heating, both before and after retrofit works are carried out. However, if the properties are already cold and become even colder after retrofit, there could be health consequences. If the occupants are in difficult financial situations as these were, and are looking for ways to save money, it is possible that they 'overcompensate' on reducing their heating use after retrofit, and with the resulting temperature drop could come a relative humidity increase and thus mould and dustmite growth. The relative humidity did not increase in any of the case study properties, but it could have done if the temperature decreased enough. Perhaps, then, as part of the home energy visits, as well as energy saving advice, separate advice on *minimum* recommended temperatures could be given.

New tenants' perceptions of the retrofitted properties

Three of the case study properties had a change of occupant between the two monitoring periods. It is worth mentioning that all three of the new households were impressed and in some cases surprised by how warm their new property was.

Conclusion

Positive outcomes of the scheme

- In 8 out of the 10 properties whose occupants remained the same over the duration of the study, the internal temperature increased after the works. The occupants reported warmer homes and some of them were absolutely delighted with the effect of the works.

- In the same properties as above, the relative humidity decreased, often from a zone bordering-on-unhealthy (around 70%) by about 10-20%, which should result in less mould and less house dustmites. Therefore occupants with asthma and some allergies should experience better health.

- In many cases, occupants felt able to have the heating on less. Use of expensive secondary heating (gas fires, electric heaters) decreased as the central heating was normally able to make the property warm enough after the retrofit.

- The three sets of new tenants, who did not experience their properties pre-retrofit, were all impressed and in some cases surprised with how warm their property had been during their first winter there.

What could be done for the residents whose properties were refurbished, to further increase the effectiveness of the current scheme

- It would be beneficial to know how many of the occupants with newly refurbished properties had not had an energy advice visit. Since the individual carrying them out was very good, I do not think these properties need a further visit, but I would recommend that those who did not receive a visit should get one, in which they are shown how to use their heating system in an efficient way.

- In terms of the above, it is not just advice about saving energy which is needed, but identifying those households whose buildings may be unhealthy, due to phenomenon such as overcompensation, and giving advice on ventilation and minimum recommended temperature (it may be useful to provide a thermometer).

- The advice visits would be most well-received and beneficial to the occupants if they were carried out by a party whose incentives were not selling energy, and if they were overseen or checked by [the RSL] in terms of their content.

What could be done in future retrofit schemes

- Some occupants would appreciate communication of how it was decided which works would be carried out, before the start, to feel part of the process.

- Even though letters and leaflets had been sent, some tenants still did not seem to know the purpose of the works. I am aware that this type of communication is difficult and this is not the only CESP scheme where this happened. Since [the RSL] best knows the tenants, perhaps your experience can help devise a communication strategy which might enable more tenants to understand the purpose of the works.

- It may be beneficial to communicate to tenants how they can anticipate changing their heating behaviour after the retrofit – i.e. the more they turn down the heating after retrofit, the less their house will get warmer – or conversely, if they use the heating in the same way after as before, they will have a warmer home but might not save energy. Giving them these options up front may aid their understanding and choice of how to take the benefit of the refurbishment.