Energy and Climate Change Committee
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Dear Sirs

ENERGY AND CLIMATE CHANGE COMMITTEE

INQUIRY ON ECCC PRIORITIES FOR HOLDING GOVERNMENT TO ACCOUNT

The Institute of Historic Building Conservation (IHBC) is the professional body for building conservation practitioners and historic environment experts working in England, Northern Ireland, Scotland and Wales, with connections to the Republic of Ireland. The Institute exists to establish, develop and maintain the highest standards of conservation practice, to support the effective protection and enhancement of the historic environment, and to promote heritage-led regeneration and access to the historic environment for all.

Thank you for inviting us to participate in this consultation.

1. The IHBC strongly supports the principle of national initiatives to promote reductions in CO_2 emissions, energy saving and the generation of energy from renewable sources.

2. However, we have been critical of specific programmes such as the Green Deal because of their top-down, one-size-fits-all approach which do not take proper account of:

   - local circumstances, such as the nature and condition of property being retrofitted with insulation.

   - variations in regional climatic conditions (for example The Lake District v. East Anglia).

   - the full whole life analysis of carbon emission savings rather than merely those of an installation when complete and running.

3. We are not surprised, therefore, that within government the Green Deal, with its many inherent problems, has been deemed a failure.

4. But we are surprised that the government has taken the difficulties encountered in specific climate change programmes as a signal to withdraw from them altogether.

5. As a matter of priority the IHBC considers that the ECCC should encourage the government to instigate more tailored programmes that will promote energy and climate change initiatives in a more targeted way.

6. We would like to see a replacement for the Green Deal that is properly sensitive to the particular circumstances of the 20% of the nation's housing stock that is built in traditional solid-wall construction techniques.

7. There is enormous potential for energy efficiency improvements in traditionally built properties, many of which do not require significant or costly interventions. When treated correctly such property could deliver a significant proportion of national energy reductions, while keeping the physical character that owners appreciate and wish to retain.

8. The major deficiencies of the Green Deal in respect of the traditional building stock were:

   - A failure to appreciate that traditionally constructed buildings rely for their performance on being able to "breathe". That is to say wetness from the weather has to be allowed to evaporate to the open air when the weather is dry. This ability to breathe is also needed to disperse moisture that is generated from within the building by occupants and the equipment they use. Solid wall insulation and other watertight forms of treatment only lead to the trapping of moisture in the wall structure causing dampness and mould growth that can sometimes lead to ill-health. Eventually excessive dampness can lead to failure of the structure altogether. Such defects often require further remediation so undermining the carbon savings that are purported to have been made; not to speak of giving rise to unnecessary additional cost.

   - SWI and other treatments cannot be successful if they are applied to buildings that are not already in good repair. Too often this aspect was being disregarded under the supposed imperatives that drove the Green Deal programme as a whole.

9. Such programmes are entirely inappropriate as one-size-fits-all techniques (research has shown) often increase energy use through "improvement"-driven dilapidations and other problems.

10. Proper energy efficiency in traditionally constructed buildings needs to be promoted in terms of the total energy savings (not just notional in-use savings) that can be made in the (new) design-life of the building as repaired, renovated, improved and maintained. There are sound methodologies for doing this but there has been an industry-wide reluctance to get to grips with them and there may also be vested interests in carrying out some work where it may not be necessary.

11. The IHBC would like to see a new approach which is bottom-up, based on the assessment, by knowledgeable independent assessors, of the capability of each building to be improved, rather than top-down with imposed solutions founded in centrally set unachievable numerical and financial targets.

12. If there are to be incentives for hard-to-reach groups (and we suggest these are needed) they must be properly evidence-based and funded in a way that ensures that assessments are made by properly qualified people and not by narrowly trained-up staff working for financially orientated delivery organizations driven entirely by profit.

13. We are certainly not alone in our views on this topic. We trust that the Committee's attention will have been drawn to the document *Solid wall heat losses and the potential for energy saving: Literature Review*[1] which was published on the DECC website earlier this year and which makes a very similar case to the one we have outlined above. To emphasize our submission we attach as an Appendix extracts of the Summary of this with what we consider to be the most salient points being highlighted by us.

14. We are aware that a companion document by BRE on Solid Wall Insulation has been with the DECC since October 2014 but remains unpublished. We suspect that this may have formed part of the case for the withdrawal of the Green Deal, and would urge that the government publishes it promptly. In any event we trust that the Committee will be able to consider it as part of its deliberations.

15. In summary, the IHBC does not think that the predictable failure of the Green Deal should result in a complete government withdrawal from energy saving programmes. We would like to see a programme that helps the large number of owners of traditionally constructed property improve the energy performance of their property in ways that are specifically right for the property, implemented properly and make properly evaluated and cost-effective energy savings over the whole life expectancy of the building.

We hope these comments are helpful.

Yours faithfully

James Caird
Consultant Consultations Co-ordinator

1 Building Research Establishment: *Solid wall heat losses and the potential for energy saving: Literature Review,* 29 May 2014

APPENDIX

Building Research Establishment: *Solid wall heat losses and the potential for energy saving: Literature Review,* 29 May 2014

Extracts from the Summary with emphases by IHBC

Overview of the review findings

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How much energy is saved as a result of insulating solid walled properties?

Quantifying the savings that can be attributed to the installation of solid wall insulation (SWI) can be difficult. The majority of recent studies have tended to investigate the aggregated consequences of a combination of retrofit strategies, one of which could be insulation of walls, and most have not looked at solid walled properties. However, **the research available consistently shows that the actual savings achieved are far less than those predicted.**

How can the gap between predicted and actual savings be explained?

The primary reasons for the gap between the predicted and actual savings, identified by the review are:

1. Inaccurate assumptions regarding the baseline performance of the building envelope and the temperatures the homes are heated to prior to installation;
2. Errors in the installation of the insulation and poor workmanship;
3. Changes in occupant energy use behaviour once the insulation has been installed.

Calculation tools may include **erroneous assumptions about occupant behaviour**, assuming that all homes are heated to a standard temperature, regardless of occupancy or income. In addition, changes in occupant behaviour following the energy efficiency improvement have been estimated to typically be account for between 30% and 60% of the reduction in the predicted space heating savings.

The review has found that simulation-based and calculation methodologies tend to be based on a standard approach that may not be appropriate for materials with variable properties. **Steady-state methodologies may fail to represent the thermal performance of some materials accurately because of the limitations in the assumptions made, misrepresenting the construction quality and the energy consumption prior to the retrofit.** The use of in situ measurements and surveys to collect input data should improve the quality of the baseline scenarios.

What are the potential unintended consequences of installing solid wall insulation?

The main unintended consequences identified from the review can be categorised into two areas:

1) the risk of overheating in buildings with SWI and
2) changes to the distribution of moisture in a building following an intervention.

Both of these can have severe effects on occupants' health, as well as the building itself. The research suggests installing external rather than internal insulation can help to moderate the excesses of internal temperature swings. However, poor installation of either can lead to problems with water ingress, condensation, and mould growth. **The majority of the unintended consequences observed, have been linked to shortfalls in the quality of the workmanship, as well as mistakes in the initial assessment of the buildings when assessing their suitability for the application of wall insulation.**

What additional considerations need to be taken when insulating heritage buildings?

Heritage buildings are considered to be complex systems that exhibit a delicate equilibrium between thermal mass, air leakage, building envelope properties and heating regime. **Many traditional buildings were built to be 'breathable' and so installing impermeable insulation materials and vapour barriers increases the likelihood of moisture problems.** Natural insulation materials (such as cellulose or sheep's wool) may prove more suitable. Both external and internal wall insulation may be unsuitable for heritage buildings due to the loss of historic detail.

Chapter summaries

More detailed summaries of the key findings, conclusions and recommendations from each review chapter, are given below.

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Predicted performance compared to actual savings

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The literature review for this topic has found that the majority of previous studies have investigated the aggregated consequences of a combination of retrofit strategies, one of which could be insulation of walls and that **few have monitored a sufficiently large sample for a sufficient length of time for statistically robust comparisons to be made.**

The baseline performance of the building envelope could be determined by laboratory-based studies and in situ measurements. **The weakness of laboratory-based studies is that they often fail to capture the complexities of hygrothermal and maybe other behaviours of the materials in real settings. This is particularly relevant for pre-1919 dwellings and traditional materials where the lack of accurate data about the properties of the materials and the variety of materials used reduces the certainty of baseline U- values that are not based on in situ measurements. For example, the uneven distribution of moisture in a wall could lead to increased scatter in comparisons of measured and calculated U-values. Analysis for this project should consider this.**

Studies have suggested that:

- **the behaviour of walls in existing dwellings could differ from the standard performance of materials;**
- **methodologies used for determining the U-value of materials may not be able to accurately represent**
- **the baseline performance of materials of pre-1919 dwellings and traditional buildings;**

- **datasets of materials obtained under laboratory conditions may fail to consider the influence of moisture content on the baseline performance; and**
- **common industry standards used for the appraisal of moisture content of building elements may be limited in representing the dynamics of moisture transport within and across the wall build-up which is particularly relevant for the performance of pre-1919 solid walls.**

The construction quality of the retrofit work can also affect the performance achieved after the retrofit as can the quality and suitability of the design. **Studies have found the following errors in the construction process: poor workmanship, poor standards on site, gaps in the insulation, changes in the specifications, poor execution of details at junctions and poor site care to reduce thermal bridges. The quality and suitability of the specification at the design stage will also have a major impact on performance achieved after the retrofit. Poor design and errors in installation are likely to undermine the post-retrofit performance and jeopardise the achievement of the anticipated savings.** This project should pay particular attention to the process of any installations of solid wall insulation. **It is not enough to assume that achieved performance matches the designed performance in situ.**

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In summary, this survey of the literature has highlighted that the gap between predicted and actual performance is affected by three main elements. The first; baseline estimates, occurs because of what could be summarised as **overly simplistic assumptions about the thermal performance of the walls.** More information about the wall, coupled with more resolution in the sources of information about standard performance assumptions, can lead to better baseline estimates. Related to this is how walls are represented in simulation tools. **More information needs to be collected in order to allow more sophisticated assumptions to be made within the software.** Other explanations are that the **insulation system does not perform as expected because of its installation and the behaviour of the occupants may not (or is unlikely to) match the standard assumptions used in most models.** The literature has shown that **the occupant factors are likely to be misrepresented before and after the retrofit.**

The main findings of specific relevance for this project are:

- It is important to collect detailed data on internal temperatures alongside U-value measurements (i.e. in several rooms, not just at the point of the U-value measurement). This will be particularly useful if obtained both before and after solid wall insulation.
- Data on moisture content of the wall is likely to be important for some construction types, so this should be routinely collected as part of this and future studies of U-values.
- Occupant behaviour, especially with regard to the control and use of heating systems, gives rise to significant modelling uncertainty, so by survey or otherwise, it is important to capture data about this during the remainder of the study.
- **If possible, attempts should be made to determine whether design and construction errors have been made during the application of solid wall insulation and the consequences of those defects evaluated.**

Future directions of research include **the calibration of simulation-based methodologies and standards on the basis of in situ U-value measurements and the creation of a comprehensive database of traditional materials to improve the quality of U-value baseline performance.** Both aspects **could be embedded in the tools to estimate the baseline performance of existing dwellings for retrofit programmes such as the Green Deal.** Combining user profiles and heating patterns in relation to the energy efficiency of the dwelling may improve the occupancy assumptions embedded in simulation-based methodologies. **A clearer understanding of construction defects and common sources of on-site error could lead to the creation of confidence or safety factors to account for the construction quality likely to be delivered during retrofit work.**

Occupant behaviour

The idea that energy efficiency improvements might increase rather than decrease energy use is not new, as it was proposed as far back as 1865. There is an agreement in the research literature about the existence of the rebound effects; however, there is not a consensus on the size of the effects or a definitive definition. Rebound effects can be classified into three main categories: direct, indirect and economy-wide. It is recommended that this project should focus on direct rebound effects which occur when energy efficiency improvement in one type of energy or energy service increases the consumption of the same energy or energy service.

The review suggests that there are an insufficient number of suitably monitored and analysed projects to thoroughly assess rebound effects. In addition, the methodological quality of most research using before and after measurements is relatively poor.

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For space heating, the rebound effect is estimated to be around 30% on average (30% of the potential savings are taken back through increased consumption). However, others estimate the percentage to be as high as 60%.

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Currently, the lack of suitable research studies conducted at a large enough scale hampers the development of the sophisticated understanding likely to be necessary to inform the design of successful retrofit programmes.

As well as rebound effects, prebound effect and behavioural spillover are also factors which are likely to contribute to the difference between the predicted and actual energy savings achieved, but research is needed to explore this further. The prebound effect is found when the actual energy use in the homes, prior to the installation of insulation, is actually lower than modelled or predicted. Energy efficiency improvements cannot save energy that is not being consumed in the first place; therefore the expected savings are overestimated. Research suggests that the worse a home is thermally, the more economically the occupants tend to behave with respect to their space heating. Low efficiency and low consumption go hand in hand, as do high efficiency and high consumption. Therefore this overestimation of the consumption prior to insulation is likely to be greater for more inefficient homes.

It is suggested that energy efficiency policies need to work collaboratively with policies aimed at eradicating fuel poverty, since it can be argued that the causes of the prebound effect should not be isolated from the energy efficiency policies. We recommend that the field trial proposed under this project should look at the differences between the predicted energy consumption prior to the installation of the wall insulation as well as after, so that any prebound effect can be quantified reliably.

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Unintended consequences of solid wall insulation

Two main unintended consequences were identified from the review: **1) the risk of overheating in buildings with SWI; and 2) changes to the distribution of moisture in a building following an intervention and the damage this may cause to the building and its occupants. More research is required to address the gaps in existing knowledge. <u>Future research needs to be rigorous and based on the assessment of actual properties</u>.** Many of the existing studies are based on modelling using computer software rather than careful studies of actual buildings in sufficient numbers.

Unintended consequences of installing insulation on solid walls identified by the review include; thermal bridges (leading to heat loss and mould growth), various moisture problems resulting from greater airtightness and inadequate ventilation, interstitial condensation, overheating during hot weather, and a less durable wall surface. As well as the health problems associated with damp and mould, overheating in bedrooms could be a risk to health, particularly given the urban heat island (UHI) effect and climate change projections.

The review found that the influence of thermal mass on post-insulated buildings is not well understood and needs to be studied in greater detail. It also needs to be considered alongside orientation and fenestration to assess the risk of overheating. There is conflicting evidence on the role of thermal mass and particularly on the best place to put insulation to avoid overheating. However, there is a clear preference for external insulation so that the existing mass of the external walls can moderate the excesses of internal temperature swings.

<u>A thorough and extensive review of buildings that have been insulated with EWI is suggested, to endeavour to identify causes of unintended consequences.</u> The current arguments are based on limitations in different numerical models (Glaser / Wufi). **<u>Although Wufi encompasses more parameters (wind-driven rain, water ingress, and local climate data) than Glaser, it is still a numerical model, with serious limitations on the materials and climate data bases within the tool. Much support is given to undertaking this type of modelling, but it is both costly and impractical on a mass roll-out of supported / funded insulation schemes.</u>**

Although at an early stage in this project, there are already indications that the areas of weakness in the EWI process could be categorised into three main causes of unintended consequences: **the initial assessment of buildings, systematic problems, and factors relating to occupancy.** There is already a growing list of these that need to be considered, and ranking these by risk and effect will help focus the minds of the people involved in making the decision whether to insulate or not.

The literature examined as part of this review points to several factors which can lead to the unintended problems often observed. These factors include:

- **Inadequate assessment of the condition of the building before improvement is considered,**
- **The limitations in assessing realistic climatic conditions,**
- **Incorrect installation methods being used.**

All of these factors have the potential for considerable risk in the implementation of large-scale external wall insulation projects such as the Green Deal or ECO, and in particular when external or internal insulation is applied to walls that are of solid construction. Many factors are influential in this early deterioration but poor detailing on junctions and penetrations in buildings appear to be major factors.

Heritage and conservation

Heritage buildings are complex systems that exhibit a delicate equilibrium between thermal mass, air leakage, building envelope properties and heating regime. **The literature review reveals many unknowns and uncertainties about the interconnections between these aspects and their individual and combined effect on the performance of the buildings.** Some of the knowledge gaps identified by the review include:

- **limited validity of many current standards and models—specifically, BS 5250, BS EN 13788, and the Glaser method—to assess the hygothermal performance;**
- **uncertain and varying values of thermal conductivity for traditional materials (the discrepancies between the U-values measured in situ and values embedded in the databases of traditional materials used by models to determine the building performance);**
- **air permeability and ventilation rates in heritage buildings and how the pre-existing ventilation conditions are related to the specific hygrothermal characteristics of the envelope (U-values, breathability, moisture transport within and throughout wall build-ups);**
- **the role of occupants in the creation of internal moisture and the effect on the overall moisture balance in heritage buildings; and the relation between heating regime and energy consumption have not been explored in depth;**
- **uncertainties about the medium and long-term consequences of applying insulation to solid walls made of traditional materials—the change in the performance of the envelope could lead to changes in the whole building performance (balance of moisture, hygrothermal performance), in the indoor environment conditions and in the overall building condition (decay and damage).**

The guidance and the research presented here highlights the need to **understand the pre-existing conditions and characteristics of heritage buildings when proposing energy efficiency retrofits to ensure compatibility between the existing and the new and to prevent damage and deterioration. This is particularly relevant for the implementation of insulation on solid walls due to the complexity of moisture transport within and across the wall, the hygrothermal performance of traditional materials, the breathability of the envelope and the relation to the overall performance and physics of heritage buildings.**

There is a need to consider how the knowledge gained about the in situ performance and post-retrofit monitoring studies could inform and improve the standards, performance models, methods and guidelines used by the building industry for determining the performance of the building and building elements; and, enhance the data about traditional materials embedded in databases. **From the few detailed in situ studies that exist, the review finds that there are enough warning signs to suggest that insulating external walls either externally or internally can lead to undesirable consequences. Further studies are needed before a large scale roll-out of wall insulation for heritage buildings can be recommended.**

Finally, the review finds that retrofit work should balance the different aspects concerning heritage buildings. These include: conservation principles, an improvement in energy performance and the indoor environment, the role of occupants in energy consumption reduction, and a reduction of existing decay and damage. Therefore, research on the performance of heritage buildings should be disseminated to the building industry, planning and building control authorities to increase their knowledge about the considerations and risks associated with retrofit works.