Towards an integrated moisture-safe retrofit process for traditional buildings in policy and industry

IOP Conf. Series: Earth and Environmental Science **863** (2021) 012030 doi:10.1088/1755-1315/863/1/012030

Towards an integrated moisture-safe retrofit process for traditional buildings in policy and industry

V Marincioni[1,2,5], H Altamirano-Medina[1,2], P Rickaby[1,2], N Griffiths[3], Y D Aktas[1,4], C King[1]

[1] UK Centre for Moisture in Buildings (UKCMB), Here East, 8-9 East Bay Lane, Queen Elizabeth Olympic Park, London E15 2GW, United Kingdom
[2] UCL Institute for Environmental Design and Engineering, University College London, Central House, 14 Upper Woburn Place, London WC1H 0NN, United Kingdom
[3] Sustainable Traditional Buildings Alliance (STBA), The Foundry, 5 Baldwin Terrace, N1 7RU London, United Kingdom
[4] EPICentre, Department of Civil, Environmental and Geomatic Engineering, University College London, Gower Street, London WC1E 6BT, United Kingdom
[5] Corresponding author, v.marincioni@ucl.ac.uk

Abstract. Improving the energy efficiency of traditional buildings, which represent a large proportion of the building stock in the UK, is necessary to meet national targets on greenhouse gas emissions and alleviate fuel poverty. Traditional dwellings in the UK are defined as *hard-to-treat* homes because insulating them is not cost-effective or might lead to moisture-related issues. This has led to efforts from policy-makers and organisations towards minimizing moisture risk in the energy-efficient retrofit of traditional buildings. This paper presents an overview of the work done towards a moisture-safe retrofit in the UK in the past ten years, focusing on the Government's policies and the work and legacy of the late Neil May, one of the pioneers in sustainable traditional buildings in the UK.

Keywords – integrated retrofit; moisture risk; traditional buildings; policy; training.

1. Introduction

Traditionally constructed buildings account for a large proportion of the building stock in many countries; the United Kingdom has the oldest housing stock in Europe, where dwellings built prior to 1940 account for around 40% of its stock [1]. Improving the energy efficiency of such buildings is necessary to meet national targets on greenhouse gas emissions and alleviate fuel poverty. Most Traditional dwellings in the UK are defined as *hard-to-treat* homes, because – particularly due to their solid wall construction – insulating them is not cost-effective [2].

The current state of energy-efficient renovation of traditional buildings shows a discrepancy between ambitious carbon reduction targets and the actual rate of uptake of the retrofit. As of 2019, only 11% of dwellings with solid walls have insulation installed [3]. There is increasing evidence that the inappropriate retrofit of traditional buildings has led to unintended consequences, causing damage to the building fabric, heritage or health of building occupants [4].

Moisture plays an important role in this, as excess moisture accumulation is often associated with building damage. This paper presents the initiatives that have taken place in the UK towards an integrated approach to the moisture-safe retrofit of traditional buildings, focusing on policy and practice.

2. A recent history of moisture in the renovation of the UK building stock

2.1. Government schemes in the UK

Several policies were developed in the UK to address the reductions of greenhouse gas emissions. From 2002 to 2012, the UK Government ran a scheme, CERT (Carbon Emissions Reduction Target), an energy supplier obligation scheme aimed at rolling up a limited number of cost-effective measures (i.e., condensing boilers, loft insulation, cavity wall insulation, low energy lights, heating controls). The scheme had specific targets for each measure, with the most cost-effective measures deployed at the start, leading to good success. The fabric improvement subsidised by the scheme focused on measures that can be applied to the UK's post-1940 building stock, such as cavity wall insulation. However, from 2007, the Government shifted the focus towards lower cost-effectiveness measures, including solid wall insulation for traditional buildings. Government initiatives included a community-based scheme introduced in 2007, the Community Energy Saving Programme (CESP), followed by the Energy Company Obligation (ECO) scheme in 2010, and in 2012 the Pay As You Save (PAYS) scheme called the Green Deal. In this last period, the UK Department for Energy and Climate Change (DECC) became aware of moisture issues [5]. Moisture issues were prominent in a CESP-funded retrofit project in Preston, where nearly four hundred terraced houses built at the turn of the 20th century (1900) received external wall insulation. Shortly after, around 70% of those were affected by moisture issues [6]; similar issues were found across the country, especially in areas of high exposure to wind-driven rain [7] and drier areas of the country.

This sparked two reviews on quality standards for the construction industry that focused on solid wall insulation [8] and protecting consumers' rights when installing energy efficiency and renewable energy measures in their homes [9]. The latter, called the 'Bonfield review' (later renamed Each Home Counts) recommended establishing a Retrofit Standards Task Group to address the UK's need for technical standards in the retrofit sector. It also recommended taking "a holistic approach and adequately considers the home, its local environment, heritage, occupancy, and the householders' improvement objectives when determining suitable measures" [9].

As part of the efforts to improve quality standards, the Government worked with BSI to raise awareness of the risks associated with moisture in buildings following the installation of solid wall insulation, which resulted in the development of a White Paper on *Moisture in buildings: an integrated approach to risk assessment and guidance* [10].

2.2. (Some of) the work of Neil May

2.2.1. Traditional buildings

Interest around solid wall insulation gained traction in the 2010s. Before then, solid wall insulation was not very common (in 2008, only 2% of solid-walled dwellings had wall insulation [11]), because it was neither cost-effective nor subsidised.

Neil May, a sustainability expert with a background in history and anthropology and years of experience in the building trade (as builder and founder of one of the first companies distributing natural building materials in the UK), saw the challenges associated with the blanket roll out of insulation measures in the energy-efficient retrofit of traditional buildings. In his own company, he embarked on developing a moisture-safe insulation system for the UK market [12]. At the same time, fusing his experience setting up several organisations on sustainability, he co-founded the Sustainable Traditional Buildings Alliance (STBA) in 2012. The STBA is an umbrella group of historic building groups and environmental and professional building organisations, seeking to improve understanding of traditional buildings, their impact on environment and society and the construction industry's impact on buildings.

One of his first endeavours at the STBA was the preparation of a gap analysis on guidance and research to support the responsible retrofit of traditional buildings [13], a literature review highlighting the knowledge gaps that hindered the uptake of retrofit measures for the improvement of traditional building performance.

The work was commissioned by DECC, arising from "concerns raised with the application of certain potential Green Deal retrofit measures to traditional buildings including possible failures of financial

and energy payback, fabric and human health issues, the possible damage to heritage as well as missed opportunities for the improvement of traditional building performance" [14]. The document highlighted several areas where research was lacking, some of which are now being explored, although there is still more to be done [14].

Neil's work at the STBA led him to formalise and develop the principles of responsible retrofit of historic buildings [15]: an integration among energy (and environment), health and heritage; a whole building approach and a joined-up process. The integration and balance of energy, health and heritage in practice were explored in more detail in the STBA Guidance wheel [16], a tool conceived by Neil to deliver a complex message in a clear way for professionals. The guidance wheel was based on principles and literature, without providing prescriptive guidance; Neil was firm in advocating for a principle-based approach to complex issues. He knew that more prescriptive guidance could only be developed if put in context; to this end, he developed practical guidance for the solid wall insulation of traditional homes in Bristol, with some prescriptions (e.g., prescribing a maximum insulation thickness) based on research [17].

He also worked for the heritage sector to be part of the sustainability discourse in a positive way: "*Old buildings have a lot to offer to the sustainability of our country and planet both practically and culturally: practically, in term of how traditional buildings can contribute to mainstream sustainability targets in energy and carbon, as well as regards economic value and occupant health; and culturally in terms of how heritage thinking and practice, as well as the presence of old buildings, can (re-)connect people with nature, beauty and the past in a way which is essential for the long term survival and flourishing of humankind; they can also challenge our modern ways of thinking and being through their real enduring witness to different ways of life"*[18].

The STBA is now representing its organisations in the development of the retrofit standards born out of the Government reviews referred to in 2.1.

2.2.2. Moisture

From a technical perspective, Neil saw moisture at the heart of the problems besetting housing in the UK: from health issues such as asthma [19] to issues associated with structural damage.

He believed that a healthy built environment cannot be separated out from a healthy society and a healthy economic system. He argued in favour of developing a research epistemology and methodology that grapples with non-physical and physical health, with complex system interactions, with context and uncertainty [19]. A new approach to moisture and health in buildings was needed, focusing on the notion of balance; not only a balance between too dry and too wet conditions but also between occupants and building context.

This led him to establish the UK Centre for Moisture in Buildings (UKCMB) in 2016, to bring together academia, industry and government towards advancing the knowledge around moisture in buildings and towards a safer built environment.

The writing of the BSI paper *Moisture in buildings: an integrated approach to risk assessment and guidance* [10], in collaboration with Dr Christopher Sanders, allowed Neil to distil his thinking around moisture issues. The paper, which constituted part of the Government effort to raise awareness of the risks associated with moisture in buildings (see section 2.1), was conceived to offer a new framework for the development of future moisture standards. Part of the framework set out in this paper has now been included in the upcoming edition of the main UK standard on moisture in buildings, *BS 5250:2021 Management of moisture in buildings – Code of practice* [20]; also, moisture is now at the heart of the overarching standard for retrofit, PAS 2035:2019 on *Retrofitting dwellings for improved energy efficiency – Specification and guidance* [21].

Since Neil's passing away in 2018, the BSI paper continues to be the blueprint for much of the work being done at the UKCMB and elsewhere, in the field of moisture in buildings in the UK.

3. The future of moisture: moisture within an integrated framework

The future challenge now lies in the integration of moisture into the broader construction industry. One change that is happening in historic buildings and beyond is the move away from operational carbon (i.e. energy efficiency) towards the wider notion of carbon reduction [22], considering carbon emissions

that arise from the manufacture of materials and products, and the processes of construction or retrofit, operation and maintenance.

Decarbonisation and moisture safety should be the drivers for a healthy, robust and low-impact built environment in a climate emergency. So far, the work presented in this paper has led to an increased awareness on moisture issues in buildings, demonstrated by the development of research initiatives by the UK department of Business, Energy and Industrial Strategy [5] and by industry with the aim of reducing moisture-related unintended consequences in the retrofit of existing buildings. At the same time, the STBA and UKCMB are establishing a dialogue with international partners on the issues around the sustainable retrofit of traditional buildings and its moisture-related unintended consequences, by contributing to international initiatives such as the IEA SHC Task 59 on renovating historic buildings towards zero energy [23].

Finding the balance between carbon reduction and moisture risk is the next challenge; so far these fields have been developed separately, so the development of a linked up process that recognizes the interaction is needed. Four principles were set out in the BSI paper on Moisture in Buildings (shown in Table 1) [10]; these principles were developed with the complexity of retrofit in mind, but are equally valid for new buildings. To properly assess moisture risk in the retrofit process, it is important to understand the context and complexity of the issues and risks that can affect the performance of traditional buildings.

Table 1. The four principles (or four C's) of moisture management [10]

Principle	Sub-principle
Compatibility with context	Geography Form Materials and construction method Condition Use
Coherence	Coherence of moisture approach Thermal coherence Airtightness Weathering / waterproofing Ventilation, heating and insulation
Capacity	Design Process
Caution	Usability Maintenance Monitoring Feedback

These principles are necessary for the successful integration of disciplines. The principles and sub-principles are not just valid for moisture, but can be extended other areas such as heritage, resources and energy use. To this end, it was considered that an approach based on risk management, guided by the four C's, would provide integration across disciplines to improve the quality of construction industry outputs. After developing an initial risk management framework, the focus went on creating a training course *Understanding and managing moisture risks in buildings.* The course aims to provide practical guidance for the application of recently developed standards in moisture-safe construction and retrofit practice.

The training course has four main objectives:

- Disseminating evidence on the current context within which moisture issues are found;

- Explaining the theory behind moisture physics in buildings, both looking at moisture in the air and within the building fabric;
- Sharing the principles behind a moisture risk management framework that supports decision-making;
- Proving the value of moisture risk management by showing practical examples.

The course is now part of the training offer of two of the leading national organisations in the UK construction sector. Although the training is not solely focused on historic buildings, it recognizes the increasingly important fields of retrofit and the renovation of existing buildings, especially older, solid-wall buildings, where issues of moisture movement and risk are of a different nature from those found in new construction. An online version of the course is now being developed by the UKCMB.

4. Conclusions

This paper aimed to present the UK's efforts towards improving the quality of the sustainable retrofit of traditional buildings, focusing on the work and legacy of the late Neil May. The UK construction industry is still fragmented, and an integrated approach is still difficult to adopt in practice. However, momentum has developed from the Government's drive for improved quality in construction, as well as from concerted efforts of various organisations, acting on multiple fronts - from training to policy-making.

"I am not saying that these aims (such as reducing carbon emissions) are not good, but that they are incomplete.[...]The deeper and more profound values found in heritage thinking and practice, such as the importance of craft, beauty, spirit of place, memory, connection to nature, and the relation of the part (such as building, person, community, activity or feeling) to the whole (in many forms, but including the whole of creation and that beyond), which relationship is radically different in traditional society compared with modernity, are still largely missing and unexamined within the mainstream sustainability discourse."

Neil May [18]

5. Acknowledgments

This paper is dedicated to the memory of the late Neil May MBE. Neil was a visionary and has dedicated the last years of his life to working towards improving housing conditions, and placing old buildings at the heart of the sustainability discourse, both in policy-making and in the industry. Although aware of the wider issues impacting UK housing (e.g. the housing crisis and inequality issues), he believed that consideration of moisture issues could be a vehicle for improving the quality of the UK housing stock, in a fragmented construction sector.

6. References

[1] HM Department for Communities and Local Government, "English Housing Survey. Headline report.," 2017.
[2] BRE Housing, "Energy Analysis Focus Report: A study of Hard to Treat Homes using the English House Condition Survey," 2008.
[3] Ministry of Housing Communities and Local Government, "English Housing Survey 2019 to 2020: headline report," 2020.
[4] C. King and C. Weeks, *Designing out unintended consequences when applying solid wall insulation*. IHS BRE Press, 2016.
[5] H. Danskin, "A BEIS perspective on moisture in buildings," 2020. [Online]. Available: https://ukcmb.org/members/. [Accessed: 01-Feb-2021].
[6] K. de Selincourt, "Disastrous Preston retrofit scheme remains unresolved," *Passive House Plus*, 2018.
[7] Building Research Esthablishment, "Post Installation Performance of Cavity Wall and External Wall Insulation," 2016.
[8] P. Hansford, *Solid wall insulation: unlocking demand and driving up standards*. London: Department for Business Innovation and Skills, 2015.
[9] P. Bonfield, *Each Home Counts*. London: Department of Business, Energy and Industrial

Strategy, and Department for Communities and Local Government, 2016.
[10] N. May and C. Sanders, *Moisture in buildings : an integrated approach to risk assessment and guidance*. BSI, 2017.
[11] Department for Communities and Local Government, *English Housing Survey. Household report 2008-09.* 2010.
[12] V. Marincioni, H. Altamirano-Medina, and I. Ridley, "Performance of internal wall insulation systems - experimental test for the validation of a hygrothermal simulation tool," in *10th Nordic Symposium on Building Physics*, 2014.
[13] N. May and C. Rye, *Responsible Retrofit of Traditional Buildings*. Sustainable Traditional Buildings Alliance, 2012.
[14] N. Griffiths and P. Draper, *Performance and Energy Efficiency of Traditional Buildings: Gap Analysis Study*. Historic England, 2020.
[15] N. May and N. Griffiths, *Planning responsible retrofit of traditional buildings*. Sustainable Traditional Buildings Alliance, 2015.
[16] STBA, "Guidance Wheel," 2012. [Online]. Available: www.responsible-retrofit.org/wheel. [Accessed: 29-Dec-2020].
[17] STBA, *A Bristolian's guide to Solid Wall Insulation. A guide to the responsible retrofit of traditional homes in Bristol*, no. March. 2014.
[18] N. May, "The future of the past," 2017. [Online]. Available: https://stbauk.org/neil-may-obe/. [Accessed: 01-Feb-2021].
[19] N. May, M. Ucci, and C. McGilligan, *Health and Moisture in Buildings - A Report from the UK Centre for Moisture in Buildings*. 2017.
[20] BSI, *BS 5250:2021 Management of moisture in buildings – Code of practice*. 2021.
[21] BSI, *PAS 2035:2019 Retrofitting dwellings for improved energy efficiency – Specification and guidance*. 2019.
[22] Historic England, "There's no place like old homes: re-use and recycle to reduce carbon," in *Heritage Counts*, Historic Environment Forum, 2019, p. 68.
[23] "IEA-SHC Task 59 / ECB Annex 76. Deep renovation of historic buildings towards lowest possible energy demand and CO2 emissions (nZEB)." [Online]. Available: https://task59.iea-shc.org/. [Accessed: 15-Mar-2020].