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UK policies and industrial stakeholder perspectives on building thermal performance

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Abstract

Improving building thermal performance is important if the UK is to meet the 80% emission reduction target by 2050. Aiming to provide insights into UK building thermal performances, relevant national policies were highlighted and a one-day workshop was run. Real-time responses of industrial stakeholders were collected using Poll Everywhere. The stakeholder perspectives on challenges, barriers, thermal performances and other concerns were reported. It showed that (i) a whole-house retrofit plan was necessary; (ii) improving thermal performances would be challenging but achievable; and (iii) industrial stakeholders were concerned about building performance, legislation, drivers, cost, professional development, technology alternatives and future vision. It was concluded that industrial consultation should be continued to assist thermal performances of buildings in the UK.

Keywords: Energy performance; thermal performance; building; stakeholder perspective; national policy

1. Introduction

In the UK, energy performances of buildings have been governed by Building Regulations [1–7] and British Standards [8–11]. In 2016, 30% of the total UK greenhouse gas (GHG) emissions was attributable to buildings [12].

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If the UK is to meet the 80% GHG emission reduction target by 2050 compared to the level in 1990 as outlined in the Climate Change Act [13], GHG emissions from buildings cannot be ignored. One possible mitigation strategy is thermal performance improvement, which is challenging. This is because Building Regulations have been reviewed numerously since enforcement, leading to variable performances in the UK. As such, retrofitting existing buildings is necessary. In addition, the UK government has recently introduced a few policies (see [14–16]) to enable *high quality housing and clean, affordable energy*. This study aims to provide insights on national policies and industrial stakeholder perspectives on thermal performance of buildings in the UK. In **Sections 2–5**, the UK policies, methodology, results and discussion, and conclusions are presented.

2. UK policies – a quick glance

The energy performance requirements of UK buildings are quantified by fabric energy efficiency and CO_2 emission rates i.e. energy demand in kWh and CO_2 in kg for 1 m^2 of floor area in a year respectively. The minimum energy performance requirements are governed by Building Regulations where builders are required to specify design features using the Standard Assessment Procedure (SAP2012) and determine Target Fabric Energy Efficiency (TFEE), Dwelling Fabric Energy Efficiency (DFEE) and the Dwelling CO_2 Emission Rate (DER) for new dwellings and Target CO_2 Emission Rate (TER) for all new building types. DER and DFEE of new dwellings which are built to the specifications will be lower than TFEE and TER, according to *L1A Conservation of Fuel and Power in New Dwellings* [1]. Monitoring thermal performances of commercial buildings (e.g. automatic meter reading and data collection) is highlighted in *L2A Conservation of Fuel and Power in New Buildings other than Dwellings* [2]. Considering high-efficient system alternatives such as cogeneration and renewable energy systems based on technical, environmental and economic analyses is required by both L1A and L2A. According to L1B *Conservation of Fuel and Power in New Dwellings* [3], such consideration is also recommended for building retrofit. Other regulations and guidelines have been made available by the UK government, as highlighted below:

- Building Regulations Part F *Ventilation* [5] which outlines ventilation levels that are acceptable for dwellings and non-dwellings buildings in reducing energy consumption whilst keeping up reasonable air quality;
- *Domestic* and *Non-Domestic Building Services Compliance Guides* [6–7] which presents installation guidance of conventional building service technologies i.e. (underfloor, community, solar water, space and water) heating, mechanical ventilation, heat pumps and micro-combined heat and power (CHP) systems for domestic buildings; and community heating, boilers, heaters, heat pumps and CHP systems for non-domestic buildings;
- British Standard EN 15316-1:2007 *Heating Systems in Buildings* [8–10] which explains the calculation of energy efficiencies and requirements of the heating systems; and
- British Standard EN 15232:2012 *Energy Performance of Buildings – Impact of Building Automation, Controls and Building Management* [11] which describes how control systems impact thermal performances.

In the *UK Industrial Strategy* [14], innovation, highly skilled personnel and modern infrastructure are 3 of the 5 keys to continuously attracting international business investment whilst clean growth is one of the grand challenges to enable the UK to lead the development, manufacturing and commercial application of low-carbon technologies, systems and services, which include fuel switch, advanced construction, improved energy efficiency and smart energy systems. Improving energy efficiency and rolling out low-carbon heating are the focus of the *Clean Growth Strategy* [15] where budgets are planned to be spent on the development of new energy efficiency and heating technologies (£184 million) as well as early stage clean technologies (£20 million), home upgrade using new boilers with improved control devices (£3.6 billion) and low-carbon heat technology installation in homes and businesses (£4.5 billion). Also as part of the *Clean Growth Strategy*, voluntary building standards will be explored for commercial buildings. To make the UK a world leader with green finance capacities and encourage more energy-efficient properties nationwide, green mortgage products with attractive repayment schemes will be offered by mortgage lenders. The White Paper *Fixing Our Broken Housing Market* [16] describes policies to diversify the building market and support more small to medium innovative building developers. The strategies include (i) investigating how effective planning can enhance modern construction methods; (ii) developing a stronger measurement approach to evaluate technology performance and provide mortgages available for the approved construction methods; and (iii) enabling modern construction approaches and support energy-efficient homes through an *Accelerated Construction Programme* and the *Home Building Fund*.

3. Methodology

The UK policies, as presented in Section 2, were reviewed. Focus areas (i.e. challenges in retrofitting energy-efficient measures, barriers to energy performance improvement and thermal performance of buildings) were identified via email communication and Skype meetings prior to a one-day workshop. More than 600 experienced engineers, consultants, managers and directors working across the UK were approached. During the workshop at the BRE facility, 3 keynotes were presented to cover the gap between actual and achieved performance, the critical need to consider ventilation and approaches to retrofitting. The participants (33 in total) formed 11 groups randomly and took part in the interactive sessions. To understand how industrial stakeholders perceived the prominence of barriers to energy performance improvement in the UK context, the participants were asked to organise the list previously identified by Building Performance Institute Europe [17]. Real-time responses of the participants were captured by using Poll Everywhere. After the workshop, the participants were asked to review and clarify their feedback, as summarised in **Sections 4.1–4.4**.

4. Results and discussion

A few key points were stimulated from the keynotes, as summarised in Table 1.

Table 1. Key points extracted from the keynote speeches.

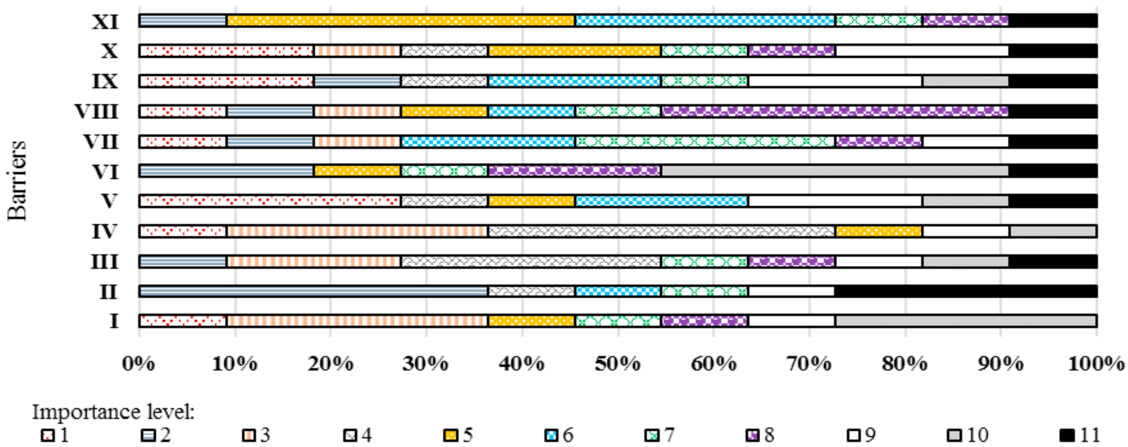
Topics	Key points
The performance gap between predicted and actual energy performance of buildings	• *Whilst buildings rarely performed as well as predicted by building developers, building operators should understand both predicted and actual building energy use.* • *Energy performance gap occurred due to management factors (e.g. degradation over time, imperfect installation and hand over) and lack of (i) knowledge about what was buildable and how components and design strategies would perform in reality; (ii) communication among building designers, constructors and operators; (iii) consequences for designers, contractors and suppliers when actual building energy consumption exceeded predictions.*
New approaches to energy efficient building retrofitting	• *Investment support must be based on evidence instead of intuition.* • *A new model might emerge in the near future covering (i) flexible eligibility – customised to local needs and leveraged local activities; (ii) fuel poor outreach – provided support to vulnerable household services; (iii) targeting, marketing and leading generation – channelling money into high quality activities; and (iv) private landlords – raised awareness and uptake e.g. landlord licensing.*
No insulation without ventilation	• *As ventilation was critical to avoid condensation and mould as well as ensure air quality, fabric strategy i.e. good air-tightness must be given attention in retrofitting existing dwellings.* • *Ventilation options e.g. intermittent extract fans, heat recovery room ventilators and mechanical ventilation with heat recovery must be chosen based on demand control.*

4.1. Challenges in retrofitting energy-efficient measures

Whilst some industrial stakeholders felt that retrofitting existing buildings with renewable energy systems and low-cost heat pumps could offer solutions to meet the national GHG emission reduction target, others were uncertain about it due to technical challenges associated with the integration of energy efficient systems. For instance, determining strategic location and the right size would be necessary prior to installing heat pumps. As retrofitting energy-efficient measures could cover up poor building energy efficiency, some industrial stakeholders were in favour of the "fabric-first" approach i.e. choosing the most ideal building fabric (i.e. materials and components) for optimal thermal performances. Overall, the industrial stakeholders agreed that a medium-term, whole-house retrofit plan would be required and should be reviewed regularly. The industrial stakeholders were also concerned about cost as integrating energy efficient measures was not cheap whilst tax breaks, subsidies and incentives were unavailable in the UK.

4.2. Barriers to energy performance improvement

The barriers to building energy performance improvement which were previously identified by Building Performance Institute Europe and a Likert scale based on 11 prominence levels (from 1 representing the least important barrier) were adopted. As illustrated in Fig. 1, the results showed some interesting patterns. With the exception of awareness of potential/benefit and information barrier (labelled as I and VI in Fig. 1), all barriers were perceived by at least 9.09% of the workshop attendees as the most important obstacle to overcome. Also, 9.09% of the workshop felt that potential/benefit and information barrier together with structural issue and payback expectation were the least important barriers (labelled as I, VI, VII and VIII in Fig. 1). Meanwhile, access to finance, financial incentives and institutional bias were also recognised by 18.18–36.36% of the workshop attendees as the least important barriers. Provided the barriers were classified into "less important" and "more important" categories based on prominence levels of 1–5 and 7–11 respectively (where the prominence level of 6 was the borderline), more than half of the workshop attendees felt that (i) competing investment priority, institutional bias and financial incentive (labelled as III, IV and X in Fig. 1) were less important i.e. 54.54%, 81.81% and 54.54% respectively; and (ii) awareness of potential/benefit, multi-stakeholder issue, structural issue and payback expectation (labelled as I and VI–VIII in Fig. 1) were more important i.e. 54.54%, 72.72%, 54.54% and 54.54% respectively. The patterns were disparate, which implied no unshakeable views among the UK industrial stakeholders. As such, improving the energy performance of buildings in the UK would be challenging but possible before any negative perception instilled deeply among the stakeholders.



Barriers:
(I) Awareness of potential/benefit – insufficient knowledge about energy, cost and carbon savings from different measures; (II) Professional skill shortage – lack of skilful contractors (for effective installation) and architects (who are familiar with low energy renovation design); (III) Competing investment priority – staff and equipment versus energy costs; (IV) Information barrier – do not fully comprehend the effectiveness of technologies; (V) Institutional bias – more familiar with supply-side investments than demand-side projects; (VI) Multi-stakeholder issue – difficult to reach a decision for multi-owner buildings; (VII) Structural issue – aging buildings and the landlord-tenant dilemma; (VIII) Payback expectation – against proposals that required more than 5 years to pay back the investments; (IX) Access to finance – required for investing energy efficiency measures; (X) Financial incentive – to undertake energy retrofit investments; and (XI) Regulatory and planning – fragmentation, delay and gaps in the regulatory action of public planning.

Fig. 1: The relative importance of barriers to energy performance improvement for buildings in the UK.

4.3. Thermal performance of buildings

The industrial stakeholders believed that effective design, monitoring and control could enhance thermal performances of buildings in the UK. Constructability should be the focus of building design. More large-sample, real-time data measured by advanced tools with rapid measurement and feedback loops were crucial for effective monitoring. Analysing such data would (i) enable material comparison; (ii) allow for retrofit plans to be quickly tailored; and (iii) offer insights into the behaviour of occupants for better energy performance control. Implementing industry-led projects with technical input from research and development, identifying skill gaps as well as barriers, and providing training were perceived as necessary from a social-technical perspective. The industrial stakeholders asked the UK government to prevent any stick-on solutions installed by inexperienced contractors, if energy efficient measures were to be initiated in future.

4.4. Other concerns

When the workshop participants were asked whether they had any concern over any issues, the following questions were submitted:

i Building design and monitoring
- *Should new builds be designed as future-proof instead of meeting current standards only?*
- *How to ensure sufficient time is given to designers to do their job?*
- *Can design engineers spend more time working alongside the building during the commissioning phase?*
- *Why are systems still not being monitored to show the facts not theory and spin?*

ii Energy performance and building occupancy
- *Should a comparison/scale of energy performance be carried out?*
- *How to make energy performance more user friendly and understandable for building users?*
- *How does energy performance vary across building types and with common occupancy patterns?*
- *What do real occupancy patterns look like and can any generic ones be discerned?*

iii Legislation and standards
- *Should the building regulations be updated and reviewed?*
- *Is there legislation that can be amended or introduced?*
- *What are the agreed standard set of metrics to compare innovative technologies e.g. capital, operational cost, size per output, energy and carbon efficiency?*

iv Drivers
- *How to measure decision makers' drivers?*
- *What drivers are important to different people in terms of building design and use?*

v Professional practice, development and communication
- *Should education and training be provided to improve the knowledge of building stakeholders?*
- *How can ethics, communication and training be improved?*
- *Is there sufficient work force which is trained to a required level in respect to energy efficiency?*

vi Technology alternatives
- *How to incentivise people to use alternative technology?*
- *How to educate people about the new technologies?*
- *Why is alternative technology not being employed yet?*
- *Taking account of transition and technology, is disruptive new technology appropriate for energy supply?*
- *Is carbon capture feasible or a waste of time?*
- *Can technology/manufacture of community generation/utilisation systems improve network efficiency?*

vii Future vision
- *How can the UK Climate Impacts Programme predictions and scenarios for future climate be integrated into the performance prediction procedures in order to take account of likely performance over the whole life of the building in a warming climate?*
- *How will future distribution networks connect to buildings to deliver power for electric or hydrogen cars and what are the storage possibilities that should be looked at for energy?*

Whilst the questions offered insights into stakeholder perspectives in the matter, two of the questions above were further investigated but not reported here. Overall, the feedback showed that the UK industrial stakeholders were concerned about the topics and there was no objection to national policies, although no close reflection was received as well. New techniques such as Building Information Modelling (BIM) should be analysed and compared but this was not reported because of word count limit.

5. Conclusions

The UK policies on thermal performances of buildings and the industrial stakeholders' perceptions on challenges, barriers and thermal performance itself were investigated. Whilst minimum energy performance requirements have been continuously governed by Building Regulations as well as British Standards, the government has proposed new strategies, for instance (i) enabling innovation, modern infrastructure and highly skilled personnel; (ii) leading development, manufacturing and commercial application of low-carbon technologies, systems and services; (iii) improving energy efficiency and rolling out low-carbon heating; and (iv) diversifying building market and support small to medium innovative building developers. The feedback from the industrial stakeholders shows (i) the need of a whole-house retrofit plan; (ii) the achievability of thermal performance improvement in the UK buildings via effective design, monitoring and control; and (iii) the concerns about building energy performance, legislation, drivers, cost, professional practice and development, technology alternatives and future vision. The study is important and beneficial as it provides insights into the UK industry stakeholders' perspectives, which allows better understanding among all building stakeholders including industrial practitioners, policy makers, researchers and the public. Through continuous engagement with industrial stakeholders, the study shall be expanded to cover wider scope such as environmental and economic analyses on a regional or global scale.

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