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Review

Review of sustainability in buildings

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ABSTRACT

At present, it is estimated that the building sector contributes up to 45% of annual greenhouse gas emissions primarily through the use of fossil fuels during their operational phase and consumes up to 40% of all energy in UK. Given the massive growth in new construction in economies in transition, and the inefficiencies of existing building stock, if nothing is done, greenhouse gas emissions from buildings will be more than double in the next 20 years. This is a review paper describe the extent and nature of sustainable buildings in UK, either within new or refurbishing old ones, in order to move away from traditional methods of construction and to look at multi-disciplinary and integrated approaches, as well as end-user perspectives.

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1. Introduction

Today, it is widely accepted that human activities are contributing to climate change. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) estimated that between 1970 and 2004, global greenhouse gas emissions due to human activities rose by 70% (IPCC, 2007).

The Fourth Assessment Report of the IPCC estimated building-related GHG emissions to be around 8.6 million metric tonnes CO_2 equiv. in 2004 (Levine et al., 2007). What is particularly worrying is the rate of growth of emissions: between 1971 and 2004, carbon dioxide emissions, including through the use of electricity in buildings is estimated to have grown at a rate of 2.5% per year for commercial buildings and at 1.7% per year for residential buildings (Levine et al., 2007). So a large fraction of the energy delivered to buildings is wasted because of inefficient building technologies. Building of future have to take into account the challenges and the opportunities brought about by technological, environmental and societal changes. Energy savings can be made not by reducing the standard of living, but by utilising more efficient technologies to provide the same, or higher, levels of comfort and convenience we have come to enjoy and appreciate (Granqvist, 2014). Today significant energy can be saved by making cost-effective efficiency improvements in buildings and their equipment – which will reduce our nation's energy consumption and GHG emissions and provide significant economic savings to consumers.

The world's governments can successfully tackle climate change by harnessing the capacity of the building sector to significantly reduce GHG emissions. Doing so can create jobs, save money – and most importantly, shape a built environment that is a net positive environmental influence – not simply a 'less-bad' version of what we currently have (UNEP, 2009a, b). Investing in achieving such

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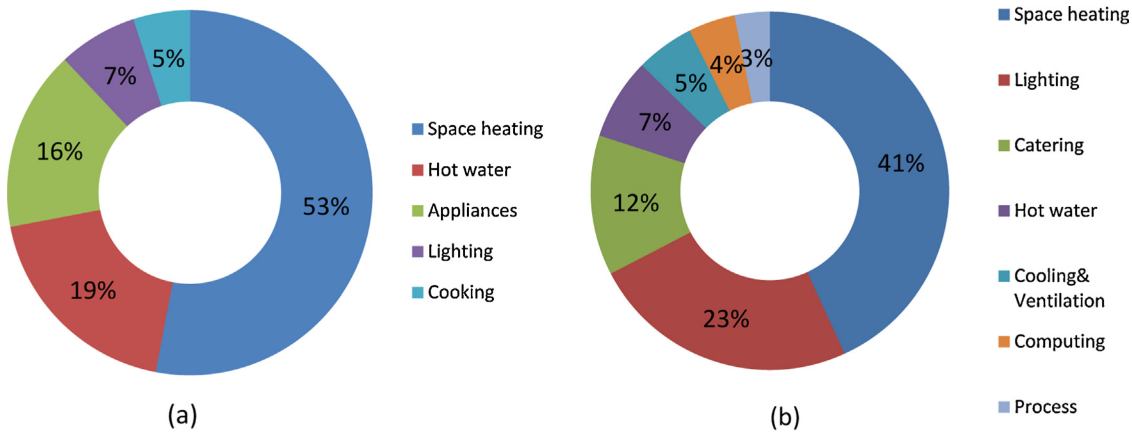

Fig. 1. Source of carbon emissions by end use for (a) domestic and (b) non-buildings.

results in the building sector also has the potential to boost the local economy and improve living conditions.

Given the UK's commitment to cut GHG emissions by at least 80% by 2050 relative to 1990 levels, the government recently updated the details of its strategy and milestones for the next five years in its Carbon Plan. Energy efficiency measures in the UK have historically been primarily delivered by government-backed schemes and supplier obligation programmes (which set targets for energy suppliers) (Mallaburn & Eyre, 2014; Rosenow, 2012). However, to deliver projected energy efficiency measures in the future, the UK government has proposed a combination of market-based and government-regulated interventions, under the 'Green Deal', the 'Energy Company Obligation' (DECC, 2012a) and 'Renewable Heat Incentive (RHI)'. These schemes are designed to help people make energy efficiency improvements to buildings by allowing them to pay the costs through their energy bills rather than upfront.

2. Research problem and method

This study takes a brief look at the concept of sustainability in existing UK building through the review of relevant literature. It is aiming to present sustainable measures and to investigate how these measures would contribute to energy saving in UK. It is considering the history for sustainability in the built environment and also argues that energy efficiency in building need to take account of some factors such as people attitude and constraints for these measures.

The authors developed a hierarchical pathway incorporating categorised techniques in a sequential process. A goal of this a hierarchical pathway is to minimise energy demand and match energy demand with local Low/Zero Carbon energy supply. It can offer a clear vision and choices of sustainable techniques for relevant stakeholders involved in building sectors and policy analysis domain.

The review paper contributes to the ongoing information exchange helping to remove barriers to energy efficiency improvements, and to increase the transparency of policy and measures.

3. Carbon emission from UK buildings

The building sector is the largest contributor in terms of GHG emissions, therefore requires specific attention in order to save energy and CO_2 (Koch, Girard, & McKoen, 2012). Residential emissions account for 66% of buildings emissions, with commercial and public sector emissions accounting for 26% and 8%, respectively (Parliament Committee, 2013). Fig. 1 shows delivered carbon emissions in the UK buildings broken down by end-user. Domestic buildings (Fig. 1a) heating accounts for over half of all emissions (53%) and hot water has a significant use also (19%). Other sources such as appliance, lighting and cooking come after that 16%, 7%, and 5%, respectively. For non-domestic buildings (Fig. 1b), heating accounts for 41% of total related carbon emissions (8.9 $MtCO_2$). Lighting is the next largest emission source produces 23% of the total emissions due to electricity having a higher emission factor compared to fossil fuels. Similarly computing and cooling produce 4% and 5% of the carbon emissions, respectively, with 5% from other sources (Pout, MacKenzie, & Bettle, 2002). As more and more electrical items are used within the non-domestic sector it is likely that the proportion of emissions that are attributed to heating will fall, although this does not mean that absolute carbon emissions from heating will fall. It is also worth noting that a 1% drop in total energy consumption caused by savings in lighting will lead to a 1.6% drop in total carbon emissions.

Between 2003 and 2008, buildings CO_2 emissions fell by 3%, mainly due to improved energy efficiency. Since 2008, buildings emissions have fallen by 8% but have shown year-to-year fluctuations due to economic and temperature effects; while in 2009, emissions dropped 10% due to rising fuel prices and the recession, the emission also increased by 7% in 2010 due to cold weather, but fell again (by 14%) in 2011 due to warmer winter months and rising fuel prices (Parliament Committee, 2013). In 2012, preliminary data suggests that both direct and indirect emissions rose across all buildings sectors by 11% to 202 $MtCO_2$ (Fig. 2). Indirect emissions rose by 11 $MtCO_2$ (11%), largely due to an increase of highly carbon-intensive coal generation at the expense of gas in the power sector (Parliament Committee, 2013). This was driven by a low global whole sale price of coal and a low carbon price, which increased the carbon intensity of electricity by 10%. Although temperatures in 2012 were not colder than the long-term average, direct emissions nonetheless rose by 10% due to the colder

Fig. 2. Change in direct and indirect buildings CO_2 emissions.
Source: Parliament Committee (2013).