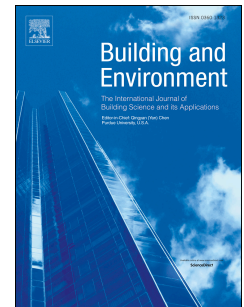


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Climate change and building ageing impact on building energy performance and mitigation measures application: a case study in Turin, northern Italy

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Abstract

This study uses a building energy performance simulation to investigate the impact of predicted climate warming and the additional issue of building ageing on the energy performance for a library in Turin, Italy. The climate and ageing factors were modelled individually and then integrated together for several decades. Results from the climate-only simulation showed a decrease in the building heating energy usage which outweighed the increase in the on-site cooling energy demand occurring in a warming scenario. The study revealed a high sensitivity of energy performance to building ageing, in particular due to HVAC (Heating, Ventilation and Air Conditioning) equipment efficiency degradation. Building ageing was seen to negatively affect the energy performance as it induced a further increase of the cooling energy usage in a warming climate, while it also counteracted the reduction of the heating energy usage resulting from warming. Simulations on the combination of mitigation techniques showed a number of potentially retrofit measures that would be beneficial for buildings to avoid an increase in the cooling energy usage due to climate warming. The combination of these retrofit techniques showed a potential decrease of 87.3% in the final cooling energy usage for the considered building.

Keywords: Building modelling, Climate change, Energy performance, Efficiency, Building ageing, Degradation, Mitigation, IDA ICE simulations

1. Introduction

Climate change will have an increasing impact on our modern society and how we live, work, build and generate energy. Significant research has focused on constructing new more energy efficient buildings that use the latest in construction materials and methods to reduce envelope heat loss/gain, and equipment inefficiency - resulting in the so-called zero energy design. However, a major problem still remains, due to the fact that most people live and work, and will continue to reside, over the next 50 years, in buildings constructed before stringent building regulations were enforced. This leaves building designers and engineers with the problem of retrofitting old buildings to meet the demands of a more extreme climate in the future. Climate plays a unique and primary role as it directly affects the thermal load and thus energy performance of the building. In general, buildings have life spans surpassing 50 years and are therefore expected to encounter climate change in the coming years.

In addition, building components, from the materials used in its construction to energy components such as the HVAC systems (heating, ventilation and air conditioning), are subject to degradation with time. These changes can occur gradually with slow spontaneous natural ageing and weathering or even

through mismanagement and poor maintenance. The general accumulation of component flaws results in a reduction in energy efficiency of buildings over time. To make a full forecast of the future energy profile of a building in a warmer climate, it would be necessary to also take into account the variation of the building state in time. This is an area that is often ignored in building energy simulations that analyse the influence of climate warming and future energy forecasts.

1.1. The impact of climate change on building energy usage in Europe

With the predicted increase in global mean temperatures and the increase in extreme events, there will be an unavoidable impact on most of human activity and life, including buildings and their occupation patterns. The Intergovernmental Panel on Climate Change [IPCC] report temperature rises of between 1 °C and 6 °C from the year 1990 to 2100 due to critical weather variability and extreme events [1, 2]. As a result of global warming, there is also predicted to be a rise in the mean sea level, as well as increased frequency of extreme events of greater intensity and duration, such as heat waves, droughts, heavy precipitation and flooding, together with a general reduction in the global frequency of cold days.

A wide range of future climate change scenarios and their potential implications for the built environment have been investigated. Frequently, there is found to be significant reduction in the heating load of buildings due to climate warming

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