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Global warming and its implication to emission reduction strategies for residential buildings

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ABSTRACT

Carbon emission reduction schemes by improving residential building energy performance are often developed and assessed upon the assumption of *current* or *stationary* climates. This study investigated the heating and cooling (H–C) energy requirements and corresponding carbon emissions of residential houses in different climatic conditions in relation to global warming. This included assessing and quantifying the efficacy of emission reduction schemes based on emission reduction capacity (ERC). ERC represents the percentage of projected carbon emission reduction under changing climate in a specific year compared to the expected reduction by a scheme at *current* or *stationary* climates. It is shown that in a heating-dominated region with a cold climate or temperate climate with cold winter, ERC is projected to increase (or the projected emission reduction is higher than the expected reduction under the emission reduction scheme) in the presence of global warming. In contrast, in a cooling-dominated region with a hot dry or hot humid climate or an H–C balanced temperate climate, ERC is projected to decline. This implies that emission reductions will be lower than those initially targeted by the emission reduction scheme without consideration of global warming. Additionally, to reflect the changing carbon emission over years due to climate change, the average emission reduction capacity (AERC) was also proposed for the assessment of reduction schemes. It was concluded that the design and assessment of carbon emission reduction schemes for residential buildings need to move beyond its assumptions of a current or stationary climate to take into account climate change impacts.

1. Introduction

The residential building sector contributed around 13% of the total Australia national greenhouse gas (GHG) emissions in 2005–2006 [1]. It is anticipated that the projected population growth, the trend of smaller family sizes, and the desire for more comfortable indoor environment and larger houses will increase the energy demands, and subsequent GHG emissions from the residential building sector. Consequently, residential building energy performance has been one of the major target areas of emission reduction schemes and regulations.

Building energy performance depends not only on building designs but also on local climate conditions including ambient temperature, humidity, solar radiation and wind. Changes in the local climate may alter building energy consumption. For example, a warming climate reduces the heating energy requirement in relatively cold climates [2–4]. However, a warming climate may increase the cooling energy requirement for buildings during a warm season [5]. The increase in cooling energy consumption may eventually offset or exceed the benefit from the saving of heating energy [6], especially in tropical and subtropical regions [7].

Local climate in Australia can vary considerably. The northern states of Australia are typically warm all the time, with the southern states experiencing cool winters but rarely sub-zero temperatures. In Australia [8], the average temperature has increased by 0.9 °C since 1950 with significant regional variations. The frequency of hot nights has also increased and the frequency of cool nights has declined. By 2030, the best estimation of annual average warming relative to the climate of 1990 is approximately 1.0 °C, with warming of around 0.7–0.9 °C in coastal areas and 1.0–1.2 °C inland. Climate change trends from 2050 will depend in part on greenhouse gas emission scenarios. For the high emission scenario (A1FI), the best estimation of the average annual temperature increase is 2.2 °C by 2050 and 3.4 °C by 2070. Consequently, changing climate may significantly alter the energy consumption of a building during its service life.

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