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Towards net zero energy for older apartment buildings in Brisbane

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Abstract

Between 1961 and 1981 the number of Australian apartments more than tripled in response to booming post WW2 immigration, growing local manufacturing industries and the new construction skills of migrants. The Australian Bureau of Statistics records more than 500,000 brick multi-residential dwellings constructed in this period. This cohort is very consistent in construction method, with cavity brickwork external walls, rendered brick internal walls, concrete slab floors, and roofs typically made of an uninsulated low pitch metal sheet. These buildings were built in an age where there were no energy or water efficiency regulations and many remain close to original condition. They are now around 40 years old and are facing the need for replacement of substantial parts of their building envelopes. The uniformity of this building type and the number of dwellings involved make it worth investigating what renovation strategies could be implemented to improve their energy efficiency and indoor comfort conditions. International examples show that substantial energy demand reduction is possible, and net zero energy is an achievable and cost effective target for similar apartment buildings.

This paper presents initial results of ongoing research into the current condition and future value of 1960s and 1970s apartment buildings in Brisbane. Modeling tools are employed to assess hygro-thermal behaviour and energy consumption of a typical building, comparing its current and post energy retrofit performance. The feasibility of the most effective retrofit strategies is then evaluated in light of socio economic factors, and conclusions are drawn about the best future for these buildings and their inhabitants.

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Keywords: Apartment buildings; energy retrofit; hygro-thermal computer modelling, cavity brickwork wall

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1. Introduction

Australia's per capita greenhouse gas emissions are the second highest in the OECD and in the top ten in the world[1], mainly as the result of the reliance on coal for electricity generation[2]. Under the 21st Conference of the Parties (COP21) agreement, Australia has undertaken to reduce its emission to 26% below 2005 levels by 2030 – meaning a greater than 50% reduction in emissions per capita and a 65% reduction in the emission intensity of the economy[3]. The National Construction Code (NCC), acknowledging the negative impact of residential energy use, requires a degree of energy efficiency in all new dwellings[4]. Yet, even if each of the 140,000 new dwellings constructed each year[5] were designed to the highest standard and were able to generate enough energy on site to completely account for the energy used in their materials, construction and occupation over their entire lifespan, they would only "make a very small dent in the emissions of the building stock as a whole"[6]. There are more than 1.2 million dwellings built since energy efficiency rules came into effect in 2003 but there are around 7.8 million older buildings likely to have poor or very poor energy efficiency[7, 8]: on average they require more than four times the energy of a similar sized 6 star rated house[9] - which is the current minimum energy rating requirement under the NCC[4]. If Australia is to meet its COP21 greenhouse gas reduction targets then the energy retrofitting of existing buildings becomes an urgent task.

Pre-2003 detached housing represents nearly 60% of the residential stock[5, 7], and its energy upgrade is comparatively well understood considering the abundant literature on the subject[10-13]. In comparison the energy retrofitting of Australian multi-residential buildings is a relatively unexplored field, even though more Australians live in apartments than in any dwelling type other than detached houses[5]. To address the gap, this paper presents on-going research into energy retrofitting of older multi-residential buildings in Brisbane. It examines a typical 1970s multi-residential tower, assesses its current energy use and investigates possible improvements of its energy efficiency. Comparisons are also made to the current and expected NCC energy efficiency requirements.

2. Post WW2 Apartments in Brisbane

Before 1920 there were no recorded multi residential buildings in Brisbane, i.e. buildings specifically designed for multiple households to live independently in the same building. Instead, increased density was often achieved via multiple families occupying a single house, splitting large homes into flats, and tenement buildings with shared cooking and bathing facilities. Multi-residential construction commenced in the inner suburbs of Brisbane in the 1920s, reaching an early peak in the 1930s[14]. Economic constraints in the late 1930s and material rationing in the 1940s and 1950s limited construction of any type, creating a pent up demand for new dwellings, exacerbated by the high levels of immigration in that period. When material rationing was eased in the early 1960s, the conditions were set for an explosion in flat construction that continued well into the 1970s[15, 16]. By 1981 there were more than 65,000 multi-residential dwellings, nearly 17% of all dwellings in South East Queensland, [17-19]. 75% of these dwellings are of masonry construction and share a core of common characteristics – whether they are low-rise 6 packs by a small builder or larger, luxurious mid- and high-rise towers by prominent developers and builders. They are almost entirely masonry structures: external walls are cavity brickwork while internal walls are double or single leaf brickwork, and floors are suspended concrete slabs. Internally the brickwork is usually plastered and the underside of the concrete slab floor above is exposed as the ceiling of the unit. Roofs are predominantly low-pitched profiled metal sheeting over timber framing with minimal insulation.

The multi-residential towers of the 1960s and 70s are concentrated on riverfront locations and hills, with views back into the CBD or out to the surrounding mountains. They are usually serviced by a central lift and stairwell with an internal lobby space on each level providing considerable privacy to each apartment. Their plans are often generous and many have ensuites, internal laundries and large kitchen. Apartments often face out in all directions to capture the best available views and breezes. In contrast, the low-rise multi-residential buildings of this period are spread throughout the city – often close to train stations and other public transport. Access is usually via a walkway along one side of the building at each level, undermining the privacy of each flat and forcing the living spaces to the opposite edge of the building. Typically all living spaces are oriented in the same direction towards one of the side boundaries of the site regardless of view, breeze or sun exposure.