The impact of flipped-layout design on energy efficiency of town-houses

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INTRODUCTION: Recent changes to planning policy in Greater Adelaide have resulted in the large-scale replacement of traditional one-storey detached dwellings with townhouses or blocks of flats. The new townhouses often rely on default layouts and construction methods that have already led to unhealthy levels of overheating, forecasted to increase further over the next decades. In this push for higher-density living, however, little consideration seems to be given to the climate-specific design of these new townhouses. This study investigates the benefits of rearranging the interior layout of the new townhouses, in particular so-called ‘flipped’ layouts.

METHODS: We used field measurements and building simulation data for a monitored case study house in Lochiel Park, the study analyses and compares common townhouse typologies and alternative layout configurations in Adelaide. Four house layout configurations were modelled including: original, flipped-rough, flipped-functional and flipped-redesign layouts. The simulations were performed by using the software Rhinoceros with the plugins Honeybee and Ladybug tools for Grasshopper. The townhouse model is validated against the measured performance from 1st to 14th January 2012 with coefficient of variation of RMSE = 4.3% for living area and 3% for bedrooms.

RESULTS: Overall, the interior space in all layouts performs in a much narrower range than the outdoors (max 8.5C indoors compared to 22.9 outdoors), which also reflects the energy efficient construction of the existing house. The differences between flipped and original point to point values, range between 0.1 and -1.4C in both bedrooms and -0.1 to -1.1C in the living room (average -0.7C in Bedroom 1, Bedroom 2 and the Living area). Temperature differences in flipped and original layouts indicate 8-9% variation in bedrooms and 8% variation in the living area.

Bedrooms where people sleep at nights are substantially cooler (1.4C) in the flipped version. Bedrooms may get slightly hot during the day (average 0.7C) but that is the time they are not usually occupied. This suggests that the flipped layout can provide a level of passive protection during summer heat waves in Adelaide. The temperature in the living areas are up to 1.1C higher in the flipped version in the afternoon and during the night (average 0.7C) but these are easier to cope through adaptive behaviour such as natural ventilation, fans or clothing during the day, and the living area may not be occupied throughout the night.

CONCLUSIONS: The original house is designed to achieve a high level of energy efficiency and has a NatHERS energy rating of a minimum 7.5 stars. However, the flipped layouts have lower overall energy load (17-29%). The change in occupancy patterns resulted from layout changes has a significant impact on energy load thus potentially increasing the energy rating. The flipped-redesign layout has the lowest energy load (29% lower than original; 9% lower than flipped-functional and 12% lower than flipped-rough layouts). More consideration and guidance for housing layouts and room arrangements not only in planning and design, but also in building regulation and policy will provide significant benefits for reducing heating and cooling loads and ultimately for creating more resilient cities.