

URBAN FORM AND PASSIVE DESIGN FOR NET ZERO ENERGY BUILDINGS IN THE CHRISTCHURCH REBUILD

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“One of the most basic and fundamental questions in urban master planning and building regulations is ‘how to secure common access to sun, light and fresh air?’”¹

This paper investigates the urban form changes that would be required to deliver daylight and fresh air to ALL buildings in the rebuilt Christchurch City Centre (CCC). The aim is to identify strategies for achieving Net Zero Energy Buildings (NZEB's) in the CCC. The research questions town planning priorities, suggesting that if current densities only need to be reduced slightly (if at all) to deliver common access to sun and fresh-air, and achieve NZEB's, then why do traditional planning regulations allow, or even encourage, low performance buildings?

To identify critical urban form and building design parameters and combinations, this study employed a parametric optimization technique. Urban form parameters (building height, gap between buildings, etc.) were tested parametrically. Building design parameters (window to wall ratio, insulation levels, glazing transmittance, shading provision) were optimized by the program 'GenOpt' to find the optimal combination of variables (1,500 iterations per model). Each iteration was simulated in three programs. UrbaWind, a Computational Fluid Dynamics (CFD) program, determined wind pressure coefficients in various urban canyon scenarios that would then be used by EnergyPlus in its natural ventilation calculations. Daylight analysis program Daysim calculated the daylight distributions in each space; generating a daylight report that EnergyPlus used to calculate how often electric lights were needed to supplement the daylight. EnergyPlus was the primary energy consumption calculation tool. In total approximately 260,000 separate variations of urban form and building design were tested.

The findings demonstrate how far traditional Christchurch urban form, and fashionable urban design trends, affect the potential for individual buildings and the whole city to achieve NZE status. They identify strategies for creating the world-leading 'green' city that the citizens of Christchurch have identified as a collective goal.

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294 words

¹ Stromann-Andersen, J., Sattrup, P.A. The urban canyon and building energy use: Urban density versus daylight and passive solar gains. 2011. Pgs 2011-2020. Energy and Buildings. Elsevier.