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Feasibility of Two Positive-Energy Schools in a Hot-Humid Tropical Climate: A Methodological Approach

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Abstract : Achieving zero-energy targets in existing buildings is known to be a difficult task, hence targets are addressed at new buildings almost exclusively. Although these ultra-efficient case-studies remain essential to develop future technologies and drive the concepts of Zero-energy, the immediate need to cut the consumption of the existing building stock remains unaddressed. This work aims to present a reliable and straightforward methodology for assessing the potential of energy-efficient upgrading in existing buildings. Public Singaporean school buildings, characterized by low energy use intensity and large roof areas, were identified as potential objects for conversion to highly-efficient buildings with a positive energy balance. A first study phase included the development of a detailed energy model for two case studies (a primary and a secondary school), based on the architectural drawings provided, site-visits and calibrated using measured end-use power consumption of different spaces. The energy model was used to demonstrate compliances or predict energy consumption of proposed changes in the two buildings. As complete energy monitoring is difficult and substantially time-consuming, short-term energy data was collected in the schools by taking spot measurements of power, voltage, and current for all the blocks of school. The figures revealed that the bulk of the consumption is attributed in decreasing order of magnitude to air-conditioning, plug loads, and lighting. In a second study-phase, a number of energy-efficient technologies and strategies were evaluated through energy-modeling to identify the alternatives giving the highest energy saving potential, achieving a reduction in energy use intensity down to 19.71 kWh/m²/y and 28.46 kWh/m²/y for the primary and the secondary schools respectively. This exercise of field evaluation and computer simulation of energy saving potential aims at a preliminary assessment of the positive-energy feasibility enabling future implementation of the technologies on the buildings studied, in anticipation of a broader and more widespread adoption in Singaporean schools.

Keywords : energy simulation, school building, tropical climate, zero energy buildings, positive energy
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