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Zero Energy Buildings in Hot-Humid Tropical Climates: Boundaries of the Energy Optimization Grey Zone

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Abstract : Achieving zero-energy targets in existing buildings is known to be a difficult task requiring important cuts in the building energy consumption, which in many cases clash with the functional necessities of the building wherever the on-site energy generation is unable to match the overall energy consumption. Between the building's consumption optimization limit and the energy, target stretches a case-specific optimization grey zone, which requires tailored intervention and enhanced user's commitment. In the view of the future adoption of more stringent energy-efficiency targets in the context of hot-humid tropical climates, this study aims to define the energy optimization grey zone by assessing the energy-efficiency limit in the state-of-the-art typical mid- and high-rise full AC office buildings, through the integration of currently available technologies. Energy models of two code-compliant generic office-building typologies were developed as a baseline, a 20-storey 'high-rise' and a 7-storey 'mid-rise'. Design iterations carried out on the energy models with advanced market ready technologies in lighting, envelope, plug load management and ACMV systems and controls, lead to a representative energy model of the current maximum technical potential. The simulations showed that ZEB targets could be achieved in fully AC buildings under an average of seven floors only by compromising on energy-intense facilities (as full AC, unlimited power-supply, standard user behaviour, etc.). This paper argues that drastic changes must be made in tropical buildings to span the energy optimization grey zone and achieve zero energy. Fully air-conditioned areas must be rethought, while smart technologies must be integrated with an aggressive involvement and motivation of the users to synchronize with the new system's energy savings goal.

Keywords : energy simulation, office building, tropical climate, zero energy buildings
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