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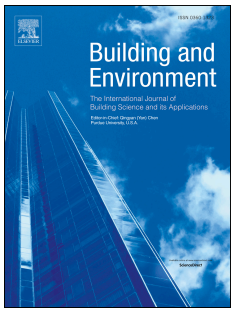

Transitioning to low-carbon suburbs in hot-arid regions: A case-study of Emirati villas in Abu Dhabi

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Title: Transitioning to Low-Carbon Suburbs in Hot-Arid Regions: A case-study of Emirati villas in Abu Dhabi

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Abstract

The continued and global popularity of single-family homes indicates that a scalable, yet regionally appropriate strategy for achieving zero-carbon suburban development is needed in the coming decades. This need is especially critical in the hyper-arid region around the Arabian Gulf where per-person carbon emissions are among the highest in the world. Using geometrically sensitive simulation models for a household's building energy, water, and automobile use this paper uses Emirati neighborhoods in Abu Dhabi, UAE as a case study to estimate a baseline and set of future possible scenarios towards transitioning single-family households in the region to low, and eventually near-zero operational carbon emissions. An analysis of the combined impact of energy efficiency gains through (1) technology adoption and better design, (2) carbon intensity reduction from renewable energy transitions, and (3) carbon sequestration from parcel scale tree planting is presented. From a baseline CO_2 emissions of 64 tons per household per year, the study finds future emissions potential reduction of 98.1% from electrification, and 99.4% from electrification and improved house design. This study also finds that if the water-energy nexus in Abu Dhabi were to transition to solar-powered, reverse-osmosis desalination trees would become net carbon sinks. As a result, in the future, low-density neighborhoods with significant areas of dense tree planting may become the more sustainable housing typology when measured by net operational emissions. This fact would upend multiple current assumptions by Western planners about sustainable transitions for arid regions.

Keywords: Arid region; Single-family housing; Household metabolism, Energy modelling; Low-carbon transition; Afforestation

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