

Title:

Increasing building energy efficiency through artificial turf and rooftop photovoltaic systems

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Abstract:

Introduction: Increasing building energy efficiency is a primary objective for achieving energy independence and environmental sustainability. While there have been significant advances in energy modelling of individual buildings, improved understanding of how the interaction between buildings and their surroundings modifies the energy savings obtained through green engineering measures is needed.

Methods: Modelling and experimental results will be presented. TUF3D is a model that simulates urban temperatures and associated heat fluxes for neighbourhoods with different building densities, geometries, materials, and weather conditions. Of particular interest are the effects of artificial turf (AT), and rooftop solar photovoltaic panels which have applications as urban heat island mitigation, water conservation, and/or renewable energy generation measures. Thermal infrared camera measurements of a building partially covered by solar PV panels are also presented.

Results: In a coastal suburban area in Southern California, the low albedo of AT results in a reduction in shortwave radiation incident on nearby building walls and an approximately equal increase in longwave radiation. Consequently, building walls remain at similar relatively cool temperature as those that are adjacent to irrigated grass surfaces.

From the measurements, we found that in daytime the ceiling temperature under the PV arrays was up to 2.5°C cooler than under the exposed roof. Conversely at night, the ceiling temperature under the PV arrays was warmer.

Discussion: In temperate climates the slight increase in building heat conduction and infiltration loads near AT are small compared to the reduction in radiative cooling load through windows and embodied energy savings through irrigation water conservation. Locally, this study points to a win-win situation for AT use for urban landscaping as it results in water and energy conservation. However, 2.3 kWh m⁻² day⁻¹ of heat are added to the urban boundary layer increasing urban air temperatures.

Photovoltaic panels act as effective insulators of buildings roofs and can dramatically decrease roof cooling load.