Title: Design and Development of a Novel Hybrid Radiative Sky Cooling System: Harnessing the Night Sky for Low Carbon Cooling (FIR 040301)

Abstract:

Renewable energy is currently necessary for the development of low-carbon cooling technologies to mitigate the effects of climate change. A potential new technology dubbed "radiative sky cooling" (RSC) provides broad and efficient cooling by reflecting heat into space through the atmospheric window. The goal of this research project is to create a novel hybrid radiative sky-cooling system by integrating renewable energy sources into energy systems and using the night sky for low-carbon cooling. By providing more flexibility for matching energy supply with demand, the technology will increase the stability, adaptability, and cost-effectiveness of energy systems. This technology is accessible and useful for low-carbon and zero-energy buildings since the radiation law makes it possible to compute or monitor radiative and non-radiative heat transfer and cooling performances. In order to collect and store coolness throughout the night for usage during the day, this integrates Nocturnal Radiative Cooling (NRC) with Thermal Energy Storage (TES). Daily temperature fluctuations are resolved, and sustainable and energy-efficient building cooling is guaranteed. A comprehensive literature review, the development of a mathematical model, the selection and testing of materials, the design and construction of a system prototype, performance testing under various environmental conditions, result analysis, and an evaluation of the project's economic viability are all necessary to finish the project. This innovative approach offers a compelling strategy for developing a more environmentally friendly and sustainable future while meeting the growing need for energy-efficient and sustainable building technology.

Objectives: The primary objectives of this project are as follows:

- Developing a hybrid radiative sky-cooling system that harnesses the night sky for low-carbon cooling while incorporating renewable energy sources into energy systems.
- Integrating Nocturnal Radiative Cooling (NRC) with a Thermal Energy Storage (TES) system to capture and store coolness during nighttime for use during daytime hours.
- Implement a smart control system using environmental sensors to modulate heat transfer rates.
- Addressing the challenge of daytime temperature fluctuations while ensuring sustainable and energy-efficient building cooling.
- Conduct a comprehensive analysis of the environmental benefits, including the potential reduction in carbon emissions and energy consumption, associated with the widespread adoption of Nocturnal Radiative Cooling Systems.

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