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# A Theoretical and Experimental Evaluation of a Solar-Powered Off-Grid Air Conditioning System for Residential Buildings

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**Abstract :** Residential air-conditioning units are essential for quality indoor comfort in hot climate countries. Nevertheless, because of their non-renewable energy sources and the contribution of ecologically unfriendly working fluids, these units are a major source of CO2 emissions in these countries. The utilisation of sustainable technologies nowadays is essential to reduce the adverse effects of CO2 emissions by replacing conventional technologies. This paper investigates the feasibility of running an off-grid solar-powered air-conditioning bed unit using three low GWP refrigerants (R32, R290, and R600a) to supersede conventional refrigerants.A prototype air conditioning unit was built to supply cold air to a canopy that was connected to it. The assembled unit was designed to distribute cold air to a canopy connected to it. This system is powered by two 400 W photovoltaic panels, with battery storage supplying power to the unit at night-time. Engineering Equation Solver (EES) software is used to mathematically model the vapor compression cycle (VCC) and predict the unit's energetic and exergetic performance. The TRNSYS software was used to simulate the electricity storage performance of the batteries, whereas the IES-VE was used to determine the amount of solar energy required to power the unit. The article provides an analytical design guideline, as well as a comprehensible process system. Combining a renewable energy source to power an AC based-VCC provides an excellent solution to the real problems of high-energy consumption in warm-climate countries.

**Keywords :** air-conditioning, refrigerants, PV panel, energy storages, VCC, exergy
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