

Integration of Solar Photovoltaic/Thermal (PV/T) Systems, Heat Pumps, and Energy Storage Technologies Enhanced with Nanomaterials

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Abstract:

The conversion and utilization of high-efficiency energy as a practice enables optimal usability of energy output from an energy source while ensuring energy loss and waste are minimized during the conversion process and subsequent utilization. To realize high efficiency energy conversion and utilization, this study explores the integration of solar photovoltaic/thermal (PV/T) systems, heat pumps, and energy storage technologies enhanced with nanomaterials. The study investigates the effects of synergy of system coupling and the function of nanomaterials for the improvement of electrical efficiency, thermal conductivity, and storage capacity. The simulation and experimental results demonstrate the capability of working fluids and phase change materials (PCMs) enhanced with nanomaterials in improving the efficiency of PV/T by approximately 20% and enhancing the Coefficient of Performance (COP) of heat pump by 15-25%. The findings in this study indicate the potential of nanomaterials in developing future integrated energy systems that would not only support renewable energy reliably but also sustainably.