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# Performance enhancement of photovoltaic module using finned phase change material panel: An experimental study under Iraq hot climate conditions

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**ABSTRACT**

The operational temperature highly influences the efficiency of the solar photovoltaic (PV) module, in which high temperature decreases the output power accordingly. In this work, a polycrystalline PV module is modified using a finned phase change material (PCM) panel attached to the rear as a thermal energy storage unit to decrease and regulate the operating temperature under hot weather conditions in southern Iraq. For this purpose, local Iraqi paraffin wax is used as a PCM loaded into a galvanized steel panel that has internal smooth wavy fins to improve the PCM poor thermal conductivity and accelerate its melting and solidification rates. Experimental results showed that the modified PV module temperature is decreased by up to 16°C compared with the reference PV module, resulting in maximum output power of up to 38.4% more than an identical reference PV module. Moreover, the electrical efficiency of the modified PV module is improved respectively by 34% and 37.2% on the first and second day of the experiment over the reference PV module, indicating remarkable electrical and thermal performance improvement.

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Photovoltaic module; phase change material; fins; PV thermal performance; passive cooling

## Introduction

Solar photovoltaic (PV) systems are one of the most growing technologies in recent years (International Renewable Energy Agency (IRENA) 2019). China and the USA have contributed to the PV industry in this regard, considering a global share of 35.9% and 11.7%, respectively (Pandey, Pandey, and Tumuluru 2022). Regardless of the rapid growth of this technology year after year, it still suffers from low electrical efficiency due to several challenges, including the increased operating temperature of PV modules. It has been reported that the PV module utilizes only 15%–20% of incident solar radiation to generate electricity, while the rest radiation converts to heat losses, reducing PV efficiency (Stropnik and Stritih 2016). Besides, the PV module efficiency further decreased as its temperature increased due to ambient temperature increment or adopting techniques to augment the PV output power using reflectors (Agrawal, Kumar, and Chowdhury 2021), sun-tracking systems (Alktranee, Al-Yasiri, and Sahib 2020), etc. For this purpose, researchers and responsible parties have adopted different successful techniques to handle this issue.

Among other techniques, the presence of nanofluids (NFs) as a cooling medium on the rear of the PV module is booming technology in the PV research domain (Elminshawy et al. 2021). In this technique, a circulated NF continuously removes the temperature from the PV panel, improving its performance. Recent studies showed that NFs, in this case, depend on several factors such as the PV configuration, nanomaterial type, nanoparticles size, base fluid type and weather conditions (Kumar,

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