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Performance Monitoring and Environmental Impact Analysis of a Photovoltaic Power Plant: A Numerical Modeling Approach

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Abstract : The widespread adoption of photovoltaic panel systems for global electricity generation is a prominent trend. Algeria, demonstrating steadfast commitment to strategic development and innovative projects for harnessing solar energy, emerges as a pioneering force in the field. Heat and radiation, being fundamental factors in any solar system, are currently subject to comprehensive studies aiming to discern their genuine impact on crucial elements within photovoltaic systems. This endeavor is particularly pertinent given that solar module performance is exclusively assessed under meticulously defined Standard Test Conditions (STC). Nevertheless, when deployed outdoors, solar modules exhibit efficiencies distinct from those observed under STC due to the influence of diverse environmental factors. This discrepancy introduces ambiguity in performance determination, especially when surpassing test conditions. This article centers on the performance monitoring of an Algerian photovoltaic project, specifically the Oued El Keberite power (OKP) plant boasting a 15 megawatt capacity, situated in the town of Souk Ahras in eastern Algeria. The study elucidates the behavior of a subfield within this facility throughout the year, encompassing various conditions beyond the STC framework. To ensure the optimal efficiency of solar panels, this study integrates crucial factors, drawing on an authentic technical sheet from the measurement station of the OKP photovoltaic plant. Numerical modeling and simulation of a sub-field of the photovoltaic station were conducted using MATLAB Simulink. The findings underscore how radiation intensity and temperature, whether low or high, impact the short-circuit current, open-circuit voltage; fill factor, and overall efficiency of the photovoltaic system.

Keywords : performance monitoring, photovoltaic system, numerical modeling, radiation intensity
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