

AI-Driven Predictive Maintenance for Sustainable Photovoltaic Systems and Environmental Protection

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Abstract

Maximizing the efficiency of photovoltaic (PV) systems is essential for ensuring clean energy production and reducing the environmental impact of energy generation. However, PV systems are prone to a range of faults due to environmental factors such as temperature variations, solar irradiance fluctuations, dust accumulation, and humidity. These faults can lead to reduced energy output, equipment degradation, and overall inefficiency. This paper explores the use of predictive maintenance driven by Artificial Intelligence (AI) to enhance the fault detection process in PV systems. The AI system integrates both environmental data (solar irradiance, temperature, humidity, and wind speed) and operational parameters (voltage, current, power output) to create a comprehensive predictive model. Using machine learning algorithms, the system can identify patterns in data that precede common PV faults such as module degradation, inverter failures, and cable issues. The AI-based approach predicts faults before they lead to significant performance degradation, allowing for timely interventions such as cleaning, repairs, or equipment replacement.

Keywords

Predictive Maintenance, AI, Sustainable Energy