Journal of Building Engineering 94 (2024) 109948

Contents lists available at ScienceDirect

Journal of Building Engineering

journal homepage: www.elsevier.com/locate/jobe

Short-term forecasting of rooftop retrofitted photovoltaic power generation using machine learning

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ARTICLE INFO

Keywords:
Rooftop retrofitted photovoltaic (PV)
Machine learning
Short-term forecasting
Photovoltaic power generation
Solar energy

ABSTRACT

This paper explores short-term forecasting of rooftop retrofitted photovoltaic (PV) power generation using a Neural Networks (NN) model, highlighting its importance for energy management and grid integration. The study used data from the Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA) of the Faculty of Electrical & Electronics Engineering Technology (FTKEE), capturing a 570.4 kWp rooftop PV system. The data, collected at 15-min intervals from January 29 to February 4, 2024, included thirty-three input features such as ambient temperature, horizontal irradiation, AC voltages, AC currents, and Maximum Power Point Trackers (MPPTs). The target was the total active power in kilowatts. The methodology involved partitioning the data into a training set covering the first five days and a testing set for the last two days. The NN model was compared with other machine learning approaches, including Long Short-Term Memory Networks (LSTM), Gated Recurrent Units (GRU), Random Forest (RF), and k-Nearest Neighbors (k-NN). Performance metrics: Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Maximum Error, and Standard Deviation were used to evaluate the models. The results showed that the NN model outperformed all other models, achieving an RMSE of 0.7098, an MAE of 0.3629, a Maximum Error of 3.901, and a Standard Deviation of 0.7076. These findings suggest that NN effectively capture complex patterns in rooftop PV system data, contributing to enhanced reliability and efficiency in short-term solar power forecasting. The study's implications extend to improved grid management and energy efficiency, underlining the significance of advanced machine learning techniques in renewable energy forecasting.

1. Introduction

The growing integration of renewable energy sources, particularly solar photovoltaic (PV) systems, plays a pivotal role in the global transition towards sustainable energy practices. Recognizing the urgency, the International Energy Agency reports a surge in the demand for clean energy, driven by heightened environmental concerns and the imperative to mitigate climate change [1]. Solar technologies, including rooftop retrofitted PV systems, have emerged as crucial contributors to this transformative journey, ushering in

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https://doi.org/10.1016/j.jobe.2024.109948
Received 7 March 2024; Received in revised form 22 May 2024; Accepted 13 June 2024
Available online 14 June 2024