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Title: Machine Learning for Solar Power Prediction: Leveraging Large Scale Real Solar Generation Data and Weather Inputs in Saudi Arabia

Abstract
This study evaluates machine learning and deep learning methods for short-term solar power forecasting using two years of real-world data from a large solar farm in Saudi Arabia. Sixteen engineered feature sets were developed, combining lagged generation values and meteorological variables such as irradiance, clearness index, and temperature. Support Vector Regression (SVR), Long Short-Term Memory (LSTM), Bidirectional LSTM (BiLSTM), and Convolutional Neural Network-LSTM (CNN-LSTM) were compared. Results showed that SVR with lagged irradiance features achieved the lowest mean absolute error (MAE = 7.77, RMSE = 19.07), while CNN-LSTM achieved the highest R^2 (0.969), reflecting its ability to capture temporal dynamics. The findings underline that the most suitable model depends on the forecasting objective: minimising error versus reproducing temporal patterns. This work contributes novel insights for forecasting in arid climates and supports more reliable integration of renewable energy into power systems.

Abdulaziz Alhayd is a PhD student in Urban Energy Planning and AI at King's College London. His research focuses on balancing energy supply and demand in cities, using machine learning and deep learning to improve renewable energy forecasting and integration, particularly in solar dominated and arid regions. Prior to his PhD, worked at King Abdulaziz City for Science and Technology (KACST), contributing to national energy and innovation projects under Saudi Arabia's Vision 2030. Also founded a civic-tech startup supported by major accelerator programmes. Abdulaziz holds an MSc in Engineering Management from Temple University and a BSc in Mechanical Engineering from Pittsburg State University.