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MACHINE LEARNING TECHNIQUES FOR THE ENERGY GENERATION ANALYSIS AND PREDICTION

Abstract: The global energy landscape is rapidly shifting towards renewable sources, notably photovoltaic (PV) installations. However, the PV reliance on meteorological conditions poses challenges to grid stability. Leveraging machine learning (ML) models offers a promising solution by accurately predicting energy generation. ML's ability to tackle complex patterns and continuously learn from historical data enables the development of adaptive forecasting models, enhancing the efficiency of PV installations and advancing sustainable energy practices.

Keywords: forecasting, renewable generation, photovoltaic installations, machine learning

Over the past few years, there has been a rapid transformation in the global energy landscape, characterized by a significant shift towards the widespread adoption of renewable energy sources. Leading this transition are photovoltaic (PV) installations, which have emerged as key contributors to the global power generation mix. This shift towards renewable energy sources is in line with efforts to combat climate change, achieve Net Zero emissions, and promote sustainable energy practices. In 2022, solar PV generation experienced remarkable growth, increasing by 270 TWh, marking a 26% rise and reaching an impressive total of almost 1 300 TWh [1]. This surge in solar PV generation surpassed that of wind power for the first time in history, solidifying its position as a frontrunner in the renewable energy sector.

At the same time, renewable energy sources, particularly solar power, present challenges to the reliability and efficiency of existing power grids. PV installations heavily rely on meteorological conditions, making accurate prediction of energy generation a complex and dynamic task. Given the direct correlation between solar power production and weather patterns, precise forecasting becomes essential for ensuring grid stability, optimizing resource utilization, and effectively managing energy distribution.

To address these challenges, leveraging machine learning (ML) models for predicting distributed generation from photovoltaic installations presents a viable solution [2]. By harnessing the capabilities of ML, the aim is to enhance the accuracy and reliability of generation forecasts, considering the intricate

relationships between solar energy output and meteorological parameters. ML's capacity to discern complex patterns and dependencies within vast datasets positions it as a promising tool for handling the volatile patterns of renewable energy generation behaviour.

In general, ML techniques offer powerful tools for forecasting, particularly in the context of renewable energy generation, by providing sophisticated approaches to uncover patterns and relationships within complex datasets. Another advantage of ML models is their ability to continuously learn from historical data, enabling the development of accurate and adaptive forecasting models. This iterative learning process allows for the incorporation of new data, thereby potentially increasing the accuracy of forecasts [3].

When applied to PV installation generation, ML demonstrates superior performance in capturing the interplay between environmental factors and solar power output. Unlike traditional methods, ML algorithms autonomously learn from historical data, facilitating the development of accurate and adaptive forecasting models. By identifying the most influential weather variables, ML algorithms empower generation operators, researchers, and stakeholders to make informed decisions regarding installation optimization and its impact on solar energy production. This insight contributes to the formulation of targeted strategies aimed at enhancing PV installation efficiency.

The rapid global transition towards renewable energy, notably PV, necessitates accurate forecasting for stability and resource management. Leveraging machine learning (ML) for PV generation prediction offers a promising solution, with ML's capacity to discern intricate patterns and continuously learn from data enhancing forecast accuracy. Integrating ML techniques into PV generation forecasting is thus pivotal for navigating renewable energy complexities and achieving resilient, efficient energy systems for a cleaner, sustainable future.

References

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