Professur für Regenerative Energiesysteme
Campus Straubing für Biotechnologie und Nachhaltigkeit
Technische Universität München

Bachelor Thesis / Master Thesis:

AI-Driven Photovoltaic Energy Forecasting

The rapid expansion of solar photovoltaic (PV) installations worldwide has created a significant need for accurate energy forecasting to support grid stability and energy management. Predicting PV energy generation over a 24-hour period is challenging due to the dynamic nature of solar irradiance and weather conditions. This thesis aims to develop innovative approaches that combine physical modeling of PV system performance with advanced machine learning techniques to generate accurate short-term forecasts.

Project Description:

The primary objectives of the thesis are to:

1. **Literature Review:** Review current methods in PV energy forecasting, focusing on both physical models (based on irradiance and system characteristics) and data-driven machine learning approaches.
2. **Data Acquisition and Preprocessing:** Gather historical PV generation data, meteorological forecasts, and detailed system information (panel efficiency, orientation). Address data quality issues, such as missing or noisy data, and perform feature engineering.
3. **Develop a Predictive Model:** Create a robust model to forecast PV energy generation for the next 24 hours using historical PV output data, meteorological forecasts, and system-specific parameters.
4. **Integrate Hybrid Approaches:** Combine physics-based models (e.g., PV performance models based on irradiance and temperature) with data-driven methods (such as machine learning algorithms) to enhance prediction accuracy.
5. **Incorporate Uncertainty Quantification:** Develop methods to assess and communicate the uncertainty inherent in solar forecasting.
6. **Benchmark Multiple Methods:** Compare different predictive techniques, including regression models, time series forecasting, and deep learning architectures (e.g., LSTMs), to evaluate their strengths and limitations in various scenarios.
7. **Documentation:** Compile results in a well-structured thesis document.

Key Requirements:

- Strong background in renewable energy and data science.
- Experience with machine learning and statistical modeling (proficiency in Python or a similar programming language is preferred)
- Familiarity with time series analysis and deep learning architectures is a plus.
- Interest in interdisciplinary research that spans both physical systems and data analytics.

Start date: April/May 2025.

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