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

Bachelor Thesis / Master Thesis:

AI-Driven Wind Energy Forecasting

The increasing integration of renewable energy sources into modern power grids presents significant challenges and opportunities. Wind energy is characterized by variability and non-linear behavior, complicating grid management and energy planning. Accurately forecasting wind energy generation is essential for optimizing grid operations, reducing energy costs, and ensuring system reliability. This thesis will explore innovative approaches to predict the generated wind energy over a 24-hour horizon by leveraging physical models (such as turbine power curves) and data-driven machine-learning techniques.

Project Description:

The primary objectives of the thesis are to:

1. **Literature Review:** Survey existing methods in wind energy forecasting, including physics-based models, statistical regression, and machine learning techniques.
2. **Data Acquisition and Preprocessing:** Gather historical weather and turbine performance data. Address data quality issues, such as missing or noisy data, and perform feature engineering.
3. **Develop a Predictive Model:** Create a robust model that forecasts wind energy generation for the next 24 hours using historical and forecasted meteorological data combined with turbine-specific information.
4. **Integrate Hybrid Approaches:** Investigate the benefits of combining physics-based models with advanced machine learning techniques, including deep learning (e.g., LSTM, GRU) and ensemble methods.
5. **Quantify Uncertainty:** Incorporate uncertainty quantification methods to provide probabilistic forecasts and assess the reliability of the predictions.
6. **Benchmark and Evaluate:** Compare various modeling techniques (e.g., regression, time series forecasting, and deep learning) to identify the most effective strategies under different conditions.
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.

Contact:

Lingga Aksara Putra, M.Sc.

Professorship of Regenerative Energy Systems

Schulgasse 16, 94315 Straubing, Room 0.A10

Telephone: +49 (0) 9421 187-118

E-Mail: lingga_aksara.putra[at]tum.de