Performance Analysis

Weather-Based Prediction of Wind Turbine Energy Output: A Next-Generation Approach

Prediction Accuracy

The proposed weather-based prediction framework demonstrates improved accuracy compared to traditional

statistical and power-curve-based methods. By incorporating weather parameters such as wind speed,

air density, temperature, and turbulence intensity, the model captures non-linear relationships

between environmental conditions and turbine output. Mean Absolute Error (MAE) and Root Mean Square

Error (RMSE) values are significantly reduced across multiple forecasting horizons.

Temporal Performance

Time-series evaluation shows that the system adapts effectively to rapid fluctuations in wind

conditions. Sequential learning enables real-time responsiveness, reducing deviation between

predicted and actual power output during sudden weather changes.

Robustness to Weather Variability

The framework maintains stable performance under low-wind, high-wind, and turbulent conditions.

Seasonal evaluation confirms consistent accuracy across varying climatic patterns, ensuring

reliable real-world deployment.

Model Efficiency

Optimized feature selection and model tuning reduce computational overhead, enabling near real-time

prediction. The framework is suitable for edge and hybrid cloud-edge deployment scenarios.

Comparative Performance

Compared to baseline regression and static power-curve models, the proposed approach achieves

superior forecasting accuracy, particularly during extreme and rapidly changing weather conditions.

Operational Impact

Accurate energy output prediction improves grid stability, energy trading, and predictive

maintenance planning, leading to enhanced wind farm efficiency and revenue generation.

Conclusion

The performance results confirm that next-generation, weather-aware AI-based prediction systems

offer a robust and scalable solution for modern wind energy forecasting.