

## **Project Development Phase**

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

#### **1. Problem Definition & Requirement Analysis**

This phase identifies the need for accurate wind energy prediction using weather parameters. Key weather variables such as wind speed, wind direction, temperature, pressure, and humidity are selected. The expected output is the predicted wind turbine energy output, evaluated using metrics like MAE and RMSE.

#### **2. System Architecture & Design**

The system architecture includes input layers for weather data, a processing layer for preprocessing and prediction, and an output layer for visualization. Suitable machine learning or deep learning techniques are selected.

#### **3. Data Collection**

Historical weather data and wind turbine operational data are collected from reliable sources and aligned based on timestamps.

#### **4. Data Preprocessing**

The collected data is cleaned, normalized, and processed to remove missing values and outliers. The dataset is then split into training, validation, and testing sets.

#### **5. Model Development**

Next-generation predictive models such as Machine Learning and Deep Learning algorithms (ANN, LSTM) are implemented and trained using historical weather data.

#### **6. Model Testing & Validation**

The trained model is tested using unseen data. Predicted outputs are compared with actual turbine outputs to evaluate performance.

#### **7. Performance Evaluation & Analysis**

Performance metrics such as MAE and RMSE are calculated. Results are compared with traditional prediction methods.

#### **8. Visualization & Result Presentation**

Graphs, charts, and tables are used to present actual vs predicted energy output and error distribution.

#### **9. Deployment & Application**

The system can be deployed for real-time energy forecasting and smart grid integration.

#### **10. Documentation & Future Enhancements**

Complete project documentation is prepared. Future enhancements include real-time IoT integration and advanced AI models.