Project Design Phase

Solution Architecture

Date	14 February 2026
Team ID	LTVIP2026TMIDS83348
Project Name	Weather Based Prediction Of Wind Turbine Energy Output - A Next Generation Approach To Renewable Energy Management
Maximum Marks	4 Marks

Overview

The solution architecture bridges business goals (supporting wind farm operators, grid managers, and renewable energy planners with accurate energy forecasting) and the technical implementation (EDA, ML models, and a Flask web application).The architecture defines system components, data flow, interfaces, and deployment considerations to ensure reliable and scalable renewable energy prediction.

Key Goals

- Provide a reliable, weather-driven wind energy prediction system
- Ensure modularity across preprocessing, modeling, and UI layers
- Enable scalability for multiple wind farms and real-time weather APIs
- Maintain reproducibility using saved artifacts (model, scaler, encoder)
- Support grid stability and renewable energy optimization

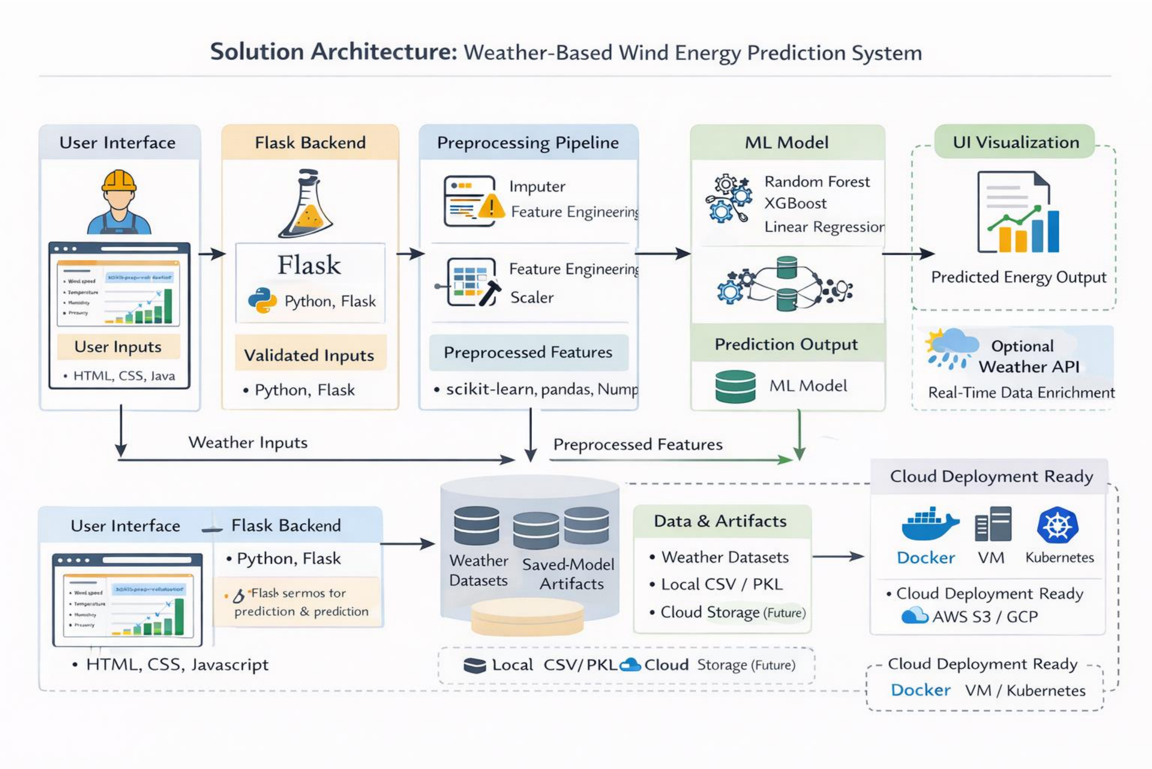
Architecture Components

Frontend (UI): HTML/CSS/JS forms for user inputs and result visualization.
Backend (API): Flask server exposing endpoints for prediction and serving templates.
Preprocessing Layer: Imputer, Encoder, Scaler to prepare inputs consistently.
ML Model Layer: Trained classifier/regressor (Random Forest/XGBoost).
Data & Artifacts: Historical rainfall datasets and serialized model files (.pkl).

Data Flow

1) User submits weather parameters through the web UI
2) Flask API receives the request and validates input values
3) Inputs pass through preprocessing (imputation, scaling, feature transformation).
4) Preprocessed features are sent to the trained ML model.
5) Predicted wind energy output is generated.

Solution Architecture Diagram



Non-Functional Considerations

- **Performance:** Low-latency inference (< 1 second) for real-time operational decisions
- **Reliability:** Consistent preprocessing using saved scaler/model artifacts
- **Security:** Input validation and secure model deserialization
- **Maintainability:** Modular layered design with clear separation of concerns
- **Scalability:** Supports additional turbines and geographic regions
- **Deployability:** Ready for cloud deployment (Docker / VM / Kubernetes) in future