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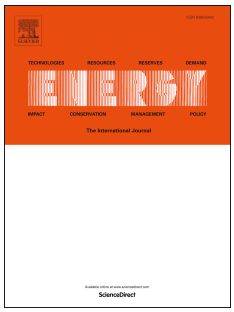


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# SHORT-TERM PROBABILISTIC FORECASTING OF WIND ENERGY RESOURCES USING THE ENHANCED ENSEMBLE METHOD

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## Abstract

Unlike other traditional energy resources, wind power outputs depend on natural wind resources that vary over space and time. Accurate wind power forecasting can reduce the burden of balancing energy equilibrium in electrical power systems. In this paper, we propose the short-term probabilistic forecasting of wind energy resources using the enhanced ensemble method. The enhanced ensemble forecasting methods are grouped into two main categories: temporal ensemble and spatial ensemble forecasting. The temporal ensemble forecasting is implemented by autoregressive integrated moving average with explanatory variable model, polynomial regression with time-series data, and analog ensemble for a probabilistic approach. The spatial ensemble forecasting is implemented by geostatistical model and interpolation with geographical property data. In addition, the stochastic approach, analog ensemble is applied to reduce the uncertainty in wind power forecasting and use of Numerical Weather Prediction models for accurate wind power forecasting is considered. We conduct stochastic wind power forecasting using practical data of Jeju power system and evaluate the system reliability on wind power generation variations. As a result, the proposed model shows better performances than single models, while at the same time providing probabilistic forecasts. Based on these forecasts, the grid operators can identify critical operating time points to prepare for problems that can occur in the system due to wind power variations in advance.

*Keywords*: probabilistic wind power forecasting, short-term forecasting, ensemble method, temporal ensemble, spatial ensemble.

## List of abbreviations

| | | | |
|---|---|---|---|
| **GWEC** | Global Wind Energy Council | **AnEn** | Analog Ensemble |
| **NREL** | National Renewable Energy Laboratory | **NWP** | Numerical Weather Prediction |
| **NEISO** | New England Independent System Operator | **MAPE** | Mean Absolute Percentage Error |
| **EWEA** | European Wind Energy Association | **ARIMAX** | Auto Regressive Integrated Moving Average with Exogenous variable |
| **VGR** | Variable Generation Resources | **SVM** | Support Vector Machine |
| **ANN** | Artificial Neural Network | **SVR** | Support Vector Regression |
| **PSR** | Phase Space Reconstruction | **AR** | Auto-regressive |
| **ARMA** | Auto-regressive Moving Average | **PSO** | Particle Swarm Optimization |
| **MA** | Moving Average | **EEM** | Enhanced Ensemble Method |
| **NMAE** | Normalized Mean Absolute Error | **BIC** | Bayesian Information Criterion |
| **MAE** | Mean Absolute Error | | |