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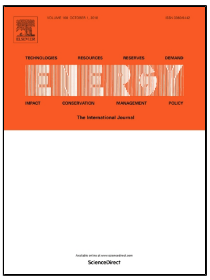

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SPATIAL PREDICTION OF RENEWABLE ENERGY RESOURCES FOR REINFORCING AND EXPANDING POWER GRIDS

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ABSTRACT

Due to intermittency of wind and solar generating resources, it is very hard to manage renewable energy resources in system operation and planning. In order to incorporate higher wind and solar power penetrations into power systems maintaining a secure and economic power system operation, the accurate estimation of wind and solar power outputs is needed. As wind and solar farm outputs depend on natural resources that vary over space and time, spatial analysis is also needed. Predictions about suitability for locating new wind and solar generating resources can be performed by optimal spatial modelling. In this paper, we propose a new spatial prediction of renewable energy resources for reinforcing and expanding power grids. Potential capacity factors of renewable energy resources for long-term power grid planning are estimated by optimal spatial modelling based on Kriging techniques. The proposed method is verified by empirical data from industrial wind and solar farms in South Korea.

Keywords: spatial modelling, kriging techniques, spatial prediction, potential capacity factor, slope estimation, grid integration analysis

List of abbreviations

OK	Ordinary Kriging	PSD	Power Spectral Density
CF	Capacity Factor	s/s	Substation
NWP	Numerical Weather Prediction	HVDC	High Voltage Direct Current
SVM	Support Vector Machine	ANN	Artificial Neural Network
ARMA	Auto Regression Moving Average		

1 INTRODUCTION

As global economic recession is persistent and oil prices are increased, the installed capacity of renewable energy is rapidly increasing around the world. The expansion of renewable energy has increased an important boost in recent years. In case of wind power generation, total accumulated wind power capacity reached 319 GW in 2013. The worldwide total of wind power capacity was 432.9 GW in 2015 [1] and is expected to consistently increase. The Global Wind Energy Council (GWEC) predicts that wind power capacity will reach 2,000 GW capacity in 2030. In case of solar power generation, total accumulated solar power capacity reached 210 GW in 2015 and will be reached 1,760 GW capacity in 2030 [2]. For these reason, the integration of renewable generators into power system is growing at a significant rate in many countries [3-5]. These countries have been announced for expanding renewable energy and transmission system through long term system-planning [6].

High penetration of renewable energy into grids can lead to large variabilities and uncertainties so it is challenging to maintain power-system stability. As the supply of renewable energy expands, we need accurate prediction of renewable energy outputs to mitigate the variability and uncertainty of variable generation resources [7,8].

The capacity factor is the ratio of an actual electrical energy output to the maximum possible electrical energy output. The capacity factor is defined for any electricity-producing installation, such as a fuel-