# WIND ENERGY POTENTIAL ASSESSMENT BASED ON WIND DIRECTION MODELLING AND MACHINE LEARNING

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**Abstract:** Precise wind energy potential assessment is vital for wind energy generation and planning and development of new wind power plants. This work proposes and evaluates a novel two-stage method for location-specific wind energy potential assessment. It combines accurate statistical modelling of annual wind direction distribution in a given location with supervised machine learning of efficient estimators that can approximate energy efficiency coefficients from the parameters of optimized statistical wind direction models. The statistical models are optimized using differential evolution and energy efficiency is approximated by evolutionary fuzzy rules.

Key words: *differential evolution, wind direction modelling, evolutionary fuzzy rules, wind energy potential assessment, estimation, optimization*

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## 1. Introduction

The knowledge of wind speed and direction is very important for wind energy generation, integration, and management. Predicting the amount of generated wind energy is essential for the safe and effective operation of stochastic renewable energy sources such as wind turbines and wind farms. The estimation of wind energy potential [28] is essential for the growth of green, renewable energy applications.

In the recent years, the construction of large wind power plants has stagnated, partly because of the exceeded transmission capacity of overhead power lines. However, small power plants with nominal power in the order of tens to hundreds of kilowatts are getting into the forefront of interest. This interest is given by the development of new technologies for off-grid systems. The Off-Grid systems are understood as systems independent of the supply of electric or heat energy from an external power grid and as systems using mainly renewable source [36]. Although

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