Non-linear regression model for wind turbine power curve

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Abstract

In this article, a study of wind turbine power curve modelling is presented with application to a particular wind turbine of Seirijai wind farm in Lithuania. A non-linear regression model for wind turbine power curve approximation was proposed, which stands out with several advantages, such as fitting physical properties of wind turbine (i.e., power curve does not exceed the highest value of generated power as it is maximum physically possible), lower number of parameters to be estimated, dependency on only one factor. MAPE was used as a measure of approximation method accuracy. Mode approach was introduced as an alternative to typical techniques for modelling power curves of wind turbines with the aim to avoid elimination of the outliers from initial data and the impact of varying concentration of observations in the full range of wind speed. Performed cross-validation analysis demonstrated that the developed power curve model is appropriate for the prediction of wind power and is not directly dependent on the initial data set.

Keywords: wind energy, wind power curve, non-linear regression, cross-validation.

ABBREVIATIONS

CI Credible interval
CV Cross-validation
MAPE Mean absolute percentage error
MHTan Modified hyperbolic tangent
RES Renewable energy sources
SSE Sum of squares error
WTPC Wind turbine power curve

1 Introduction

Transition from conventional to low carbon energy system requires increasing share of renewable energy sources. Wind energy is the most rapidly developing renewable energy sector in the world. However, wind power dependence on the wind volatility is one of the most important issues compared to the traditional means of power generation as it complicates the task of grid balancing. This situation requires a short-term (48 hours) wind speed and power prediction systems which are already used in a number of wind power developing countries to facilitate the balancing of the system. With increasing wind power share more precise wind power prediction methods are becoming necessary for the successful integration of wind power.

There are plenty of models used in the world for short-term wind power prediction and the truth is that there is no single best model for all cases, because wind speed variations are
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