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Empirical metric for uncertainty assessment of wind forecasting models in terms of power production and economic efficiency

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As made for most of renewable energy sources, wind energy is driven by highly uncertain and thus unpredictable meteorological processes. In the context of wind power scheduling and control, reliable wind predictions across scales is a challenging problem. However, since the generation of wind energy is, in fact, a nonlinear transformation of wind velocity through the power curve of each specific turbine, the errors in meteorological predictions have different impacts on wind power forecasts. It is well-known that for quite a large range of wind velocity values, the wind power production is either zero or constant, thus independent of the individual wind velocity value. This interesting feature allows for ensuring better predictions of the output, i.e. the energy production, with respect to input, i.e. wind velocity. Taking advantage of this, we present a hybrid stochastic framework for multi-step ahead wind velocity predictions and their evaluation by means of power production and economic efficiency. The methodology is tested for different wind regimes and different layouts of wind turbine systems, emphasizing to mixing of different turbine types, which allows for minimizing uncertainties. Finally, we investigate the use of this index in the technical and operational optimization of wind energy systems.