PO.002

Analysis and benchmark-oriented evaluation of energy yields with focus on the performance assessment of wind turbines

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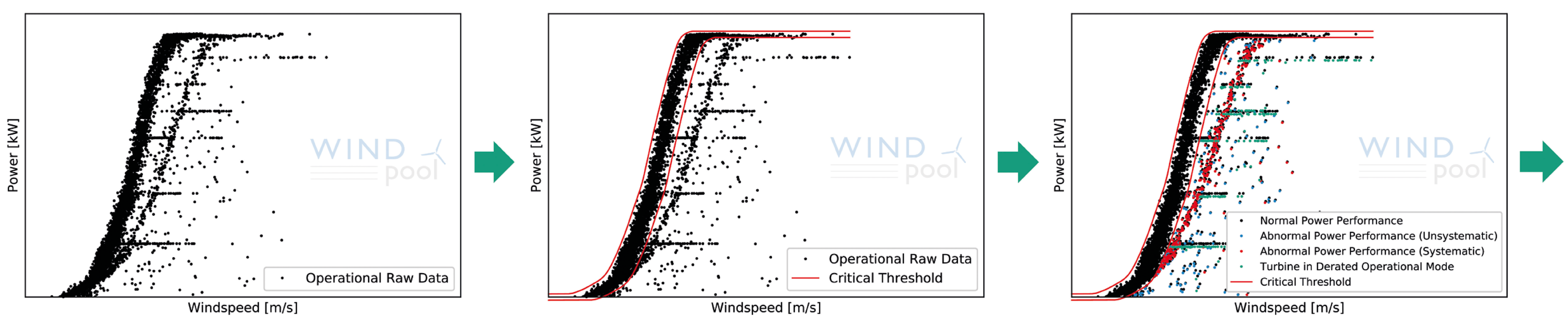
Abstract

The “Renewable Energy Sources Act” introduced in 2017 includes a new tendering model for on- and offshore turbines in Germany, which leads to high uncertainties in the German wind industry sector and associated optimization pressure for wind farm operators. The energetic yield of a wind turbine is essential for its economical operation and is influenced by three different factors:

While the **wind conditions** are not controllable, the **turbines availability** and **power performance behaviour** often offer great optimization potential. Hence, these parameters should undergo a continuous and detailed investigation. In this context, various industrial services were launched to identify and assess the causes for low energetic yields.

Approach

If a structured data basis for fault and maintenance data is available (e.g. ZEUS & RDS-PP©), the causes for turbine shutdowns can be identified and evaluated with relatively little effort. This situation changes with the identification of **performance anomalies** since not all performance influencing factors lead to an entry in the machine log. Therefore a **functional, statistic based and easy to implement approach** was created and evaluated, which analyses the turbines power performance behaviour and determines if the turbines power output should be considered as “normal” or “abnormal” for a given timeframe. This information is then recorded in a newly defined **key performance indicator (KPI)**:

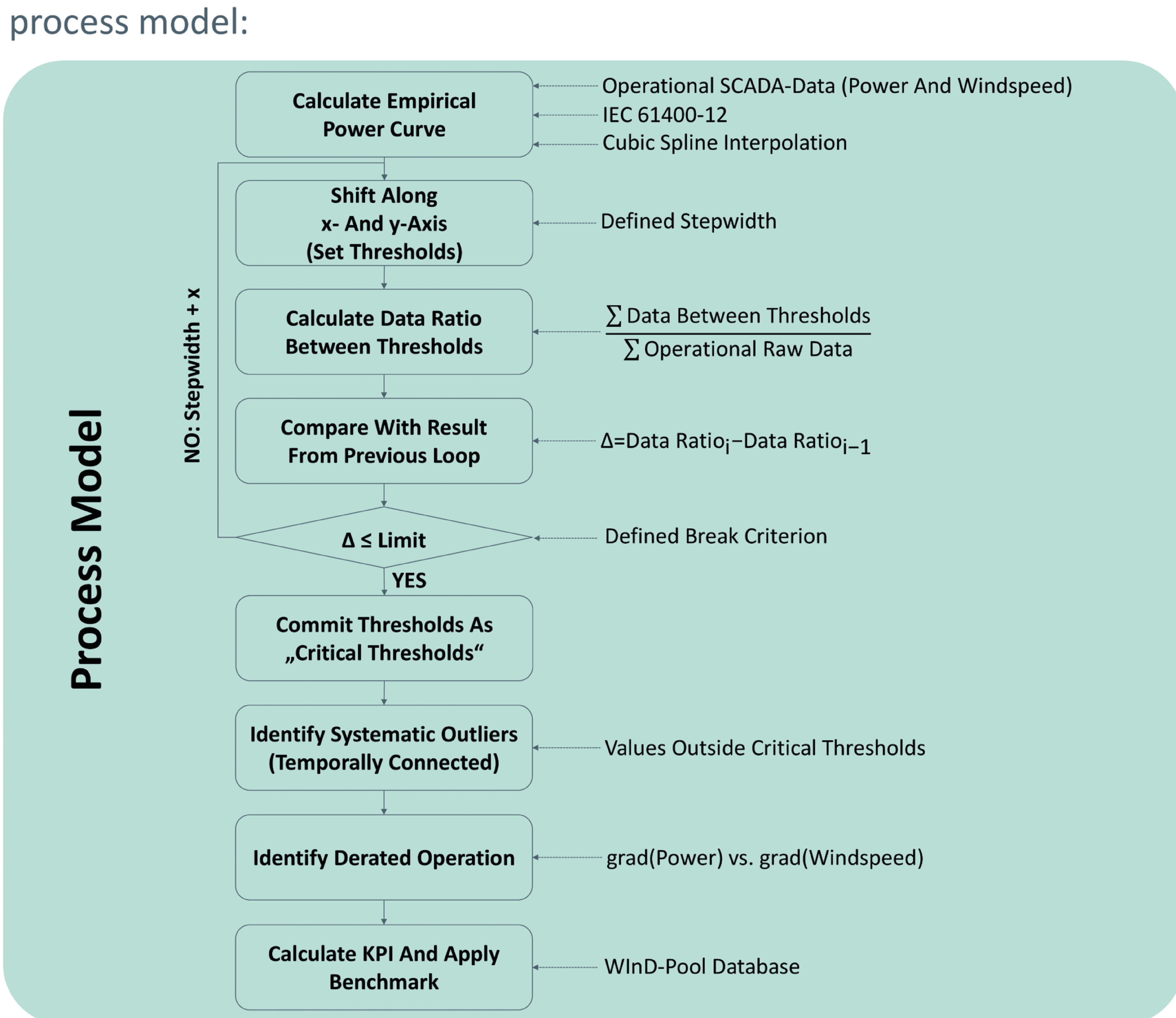


$$KPI = 100\% \times \left[1 - \frac{\sum \text{Abnormal Power Performance Values (Systematic)}}{\sum \text{Operational Raw Data Values}}\right]$$

In order to evaluate the magnitude of calculated KPIs for specific turbines, a benchmark with other turbines was implemented. For this purpose the **W**indenergy-**In**formation-**D**ata-Pool (**WInD-Pool**) developed by the Fraunhofer IEE was used. This common knowledge base of the wind industry aggregates operational data from more than 900 wind turbines and provides a reliable data basis for statistical analysis.

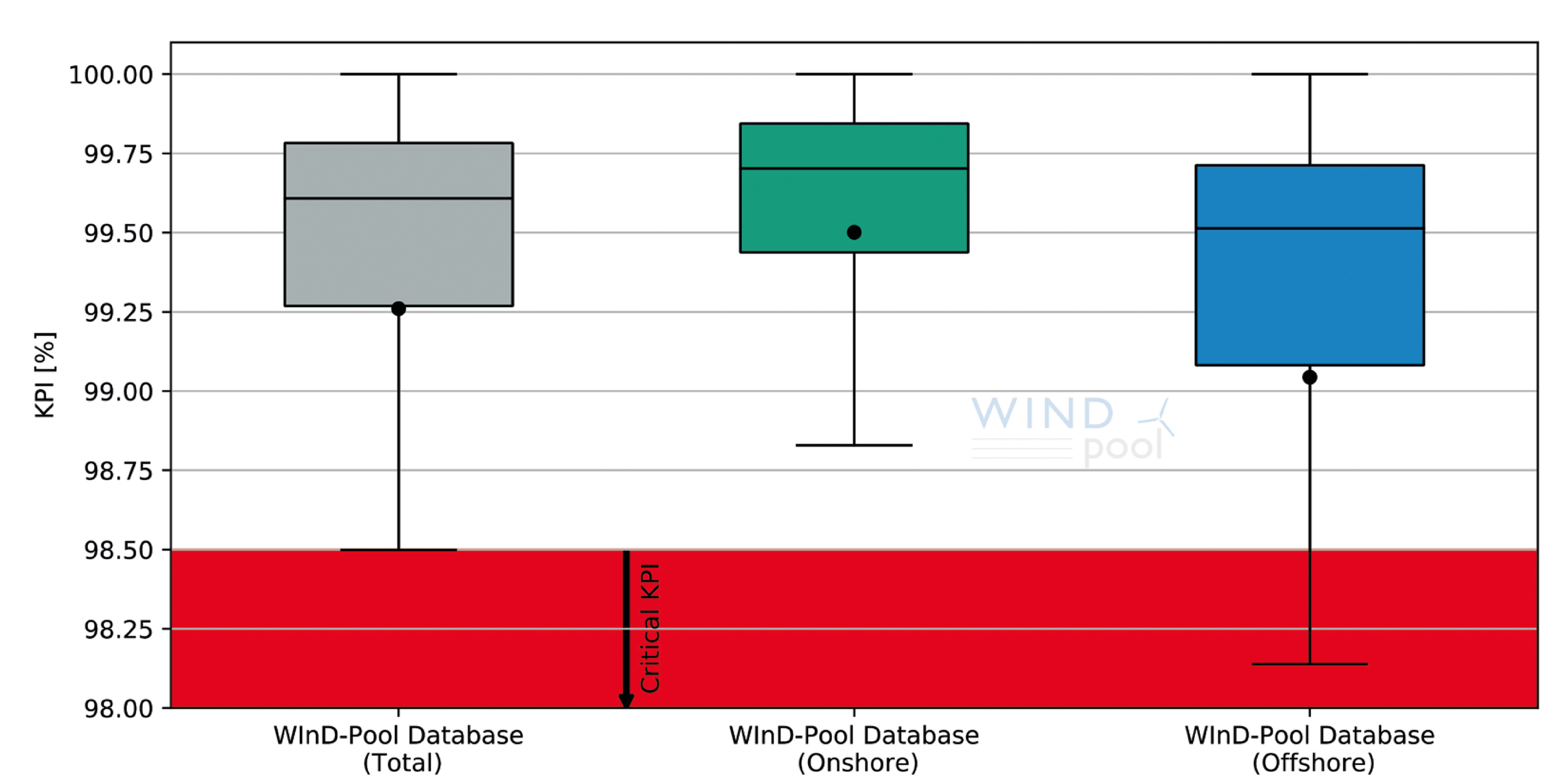
Methology

The methology to calculate the defined KPI is summarized in the following process model:



Results

The statistical distributions derived from the application of presented procedure are shown in the following figure:



The results show that the majority of all analysed turbines have a **normal power performance behaviour in at least 98.50%** (lower whisker) of their operational time. This value is derived from a sufficient data basis and therefore can be defined as a critical limit under which a turbines power performance should undergo a deeper investigation. A further differentiation between on- and offshore turbines shows that turbines at onshore sites tend to have a higher average KPI (99.5%) compared to turbines at offshore sites (99.04%).

Conclusion

The proposed method provides an elementary and adaptive way of assessing the performance of a turbine and attempts to eliminate the weaknesses of commonly used KPIs (e.g. time based or energy based availability). With increasing relevance to exploit the maximum energy potential of the wind, the importance of identifying "poorly running turbines" and their main causes also increases. In order to identify the causes for bad performance behaviour of a wind turbine, additional KPIs with possible focus on the control system, wind measurement system or component degradation have to be defined and benchmarked.