Predictive analysis and benchmarking: Demystifying failure

PO.029

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Abstract

Benchmarking failure rates in this renewable energy industry can be challenging: data come in challenging and disparate formats (from OEM to OEM, from SCADA data to hand-written job books). How do we make sense of it? Given the myriad ways to define component failure and the importance of understanding component failure risk as it relates to operational costs, Natural Power presents a concise approach to cataloguing and defining downtime rates as well as criteria for assessing the applicability of historical data for future projects. **Natural Power Benchmarking** is a powerful tool but it must be carefully applied to avoid misinterpretation or use outside where it's applicable. Specific examples are given including recommendations for how to gather and use the best available information and a practical approach to extracting and applying knowledge without herculean effort.

Key performance indicators

Defining a meaningful key performance indicator (KPI) taxonomy allows for a comprehensive analysis of large amounts of data and a normalization of information for a common context across wind farms, portfolios and OEMs.

The case study presented below shows how failure rate benchmarking can be used to identify operational inconsistencies:

- Availability
- Mean downtime per event
- Mean energy loss per event
- Failure rate

Case study

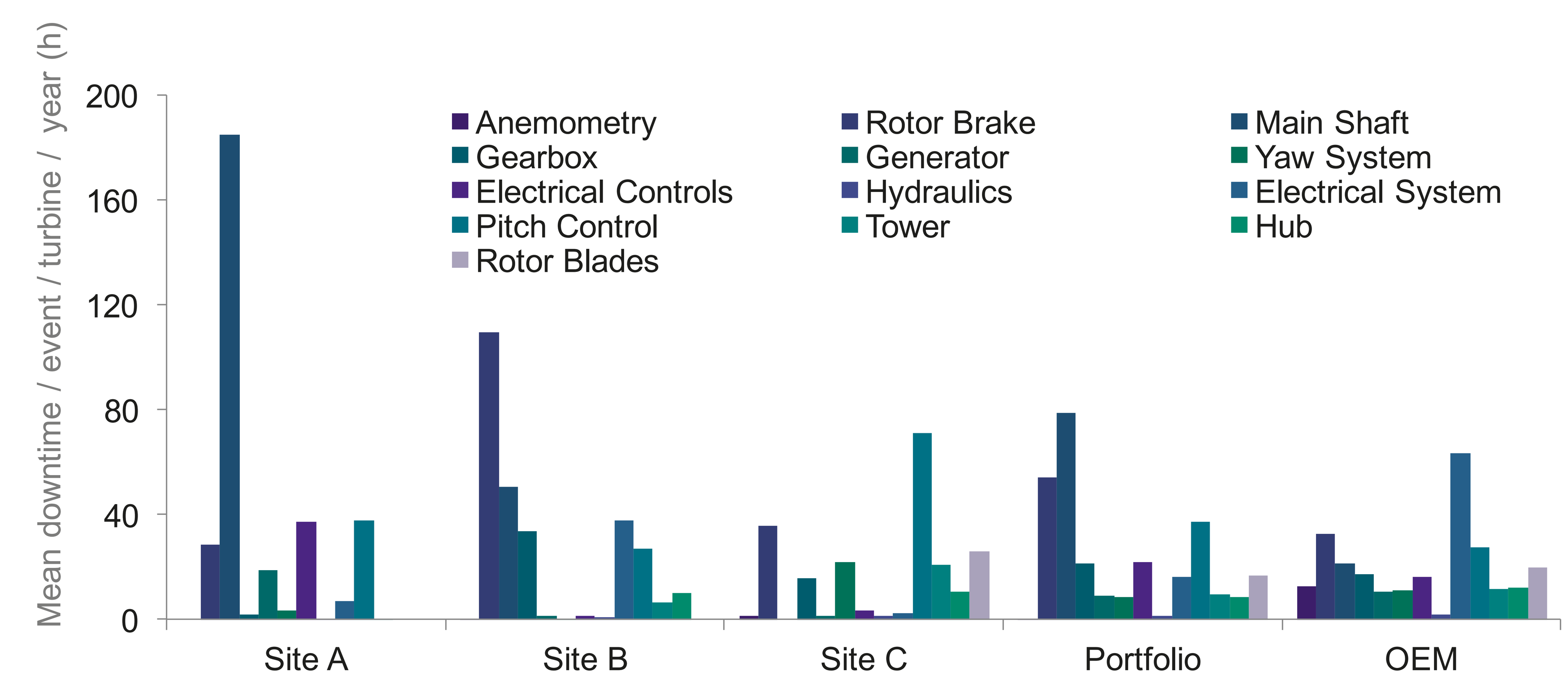
Introduction

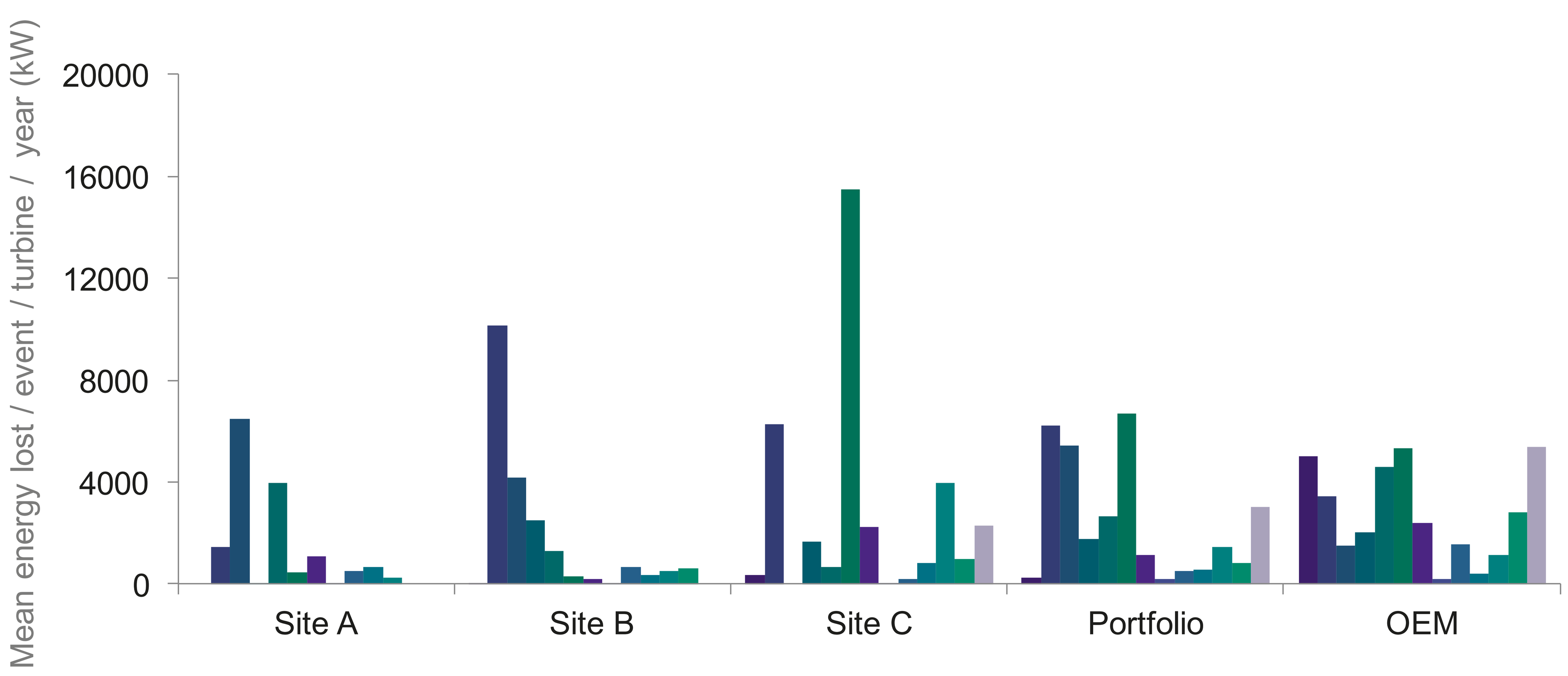
A case study comparing three sites, all with the same turbine type, to the portfolio and then against the OEM is examined. Below key site metrics and KPIs results are show.

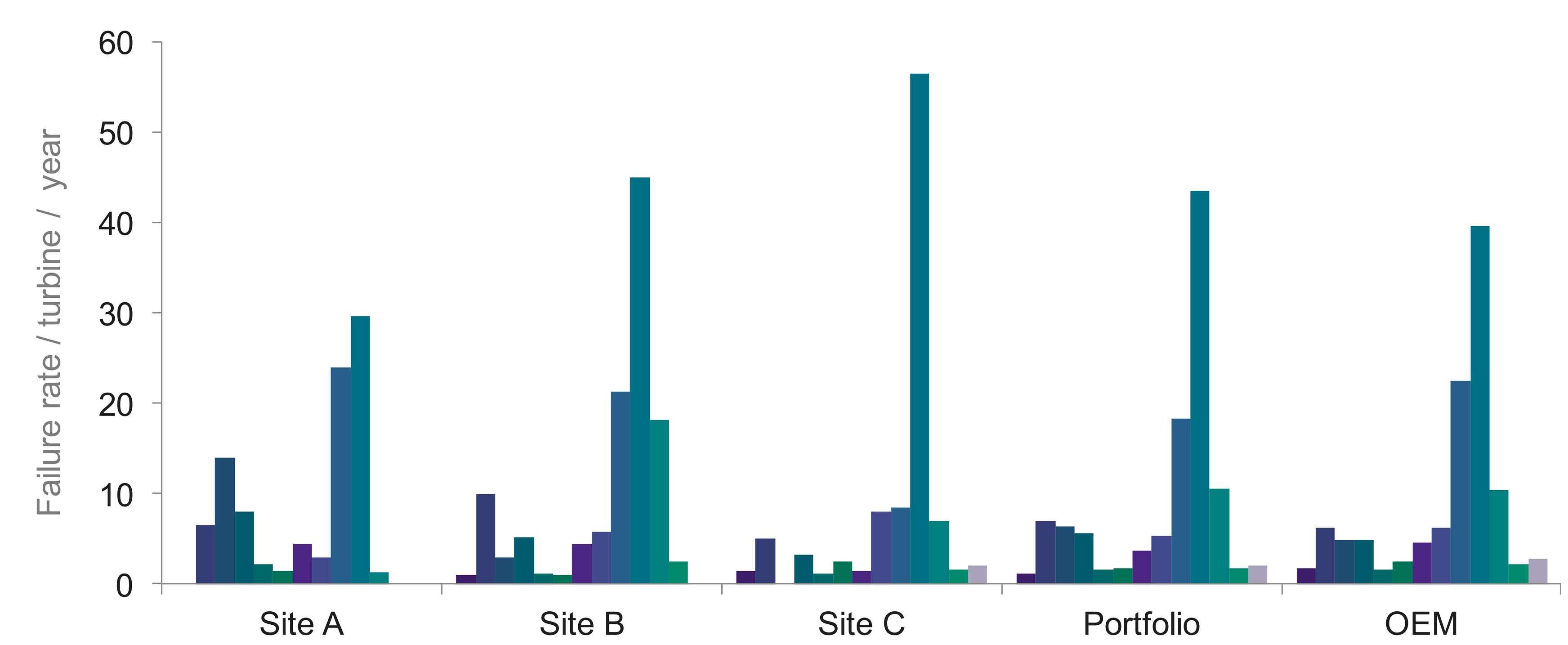
Results

Table 1. Benchmarking key metrics and KPIs for the case study

	Site A	Site B	Site C	Portfolio	OEM
Turbine-days	1,278	1,904	1,460	5,737	23,601
Reported events	780	1,108	521	3,029	11,651
Availability (generation)	94.2%	94.7%	95.9%	94.7%	94.1%
Technical availability (generation + reserve shutdown)	96.1%	95.5%	98.0%	96.9%	96.9%
Mean downtime / event (h)	2.3	2.2	2.8	2.4	2.9
Mean time between failures (h)	37.4	39.4	64.6	43.3	45.5
Failure rate: event frequency / turbine / day (day^{-1})	0.6	0.6	0.4	0.5	0.5
Event frequency / turbine / year (y^{-1})	130.0	184.7	18.4	159.4	138.7
Mean energy lost / failure (kWh)	1,061	1,290	2,304	1,516	1,717







Conclusions

The following can be drawn from the benchmarking figures by comparing each individual site to the portfolio, the OEM, and the other individual sites:

- The failure taxonomy varies significantly between the sites
- Very different distribution of component and subsystem contributions to unavailability across the individual sites
- The events with the highest failure rates have some of the lowest energy losses per event
- Component and subsystem which score consistently higher on these metrics than the portfolio or OEM should be prioritised for maintenance and inspection works

Additional analysis on an individual turbine basis can then be performed to determine if the failures are due to specific turbines located in challenging locations or if it is related to a specific component impacting turbines site-wide.

Recommendations

Based on this analysis, the following recommendations are made:

- If OPEX projections and spare parts planning are based on distribution shown for site A, may not be appropriate for Site B or C
- A combination of all three measurements is required to get an appreciation for the performance of an individual site
- Access to large amounts of turbine data, either over a specific portfolio or an OEM, allows for accurate and in-depth benchmarking activities

Conclusions

Wind farm owners, operators, lenders and investors are faced with an increasingly complex matrix of information. Decision making and planning can be streamlined by using these data intelligently to quantify risk and implement proactive O&M strategies. Information taxonomy can benchmark individual assets, whole sites or portfolios against an OEM fleet leading to improvements in plant availability and energy generation through targeted improvements and maintenance programmes.

With thanks to Eva Fernandez Moran, Gary Winslow, Graham Gow, David Baillie & Selena Farris.