

# Derivation Of Wind Turbine Reliability Profiles From Operational Data

## Abstract summary

This poster describes on-going work to derive wind turbine Reliability Profiles, showing the failure rate and downtime broken down by each subassembly. Historical operational data available to wind farm operators include 10-minute SCADA, automated fault logs and Operations and Maintenance reports. Processes have been developed to link these discrete and diverse data formats.

The results will allow the comparison between wind turbine subassemblies and, as more data is added, will permit wind farm owners and operators to compare their machines from one wind farm against others of a similar type in a different wind farm.



Figure 1: A Typical Wind Farm

The work described here forms part of initial work undertaken in the Reliawind project, which is a European Union 7<sup>th</sup> Framework Integrated Project with an overall budget of \$11M. The 10 industrial and academic partners include wind turbine manufacturers, major component manufacturers, renewable energy consultants and research institutions.

## Objectives

Reliawind has the overall aim of identifying and understanding critical failures and their mechanisms. The results will be used to improve turbine reliability through design for reliability and targeted condition monitoring.

The specific objectives of the work in this poster are to:

- Gather information about wind turbine reliability from the vast and diverse data sets that exist for operational wind farms;
- Derive Reliability Profiles;
- Assess the reliability of wind turbines quantitatively.

## Methods

Wind farm owners and operators have provided historical data including 10-minute SCADA data, automated fault-logs and O&M reports from operational wind farms representative of those currently installed. These sources are discrete and often of varying quality, but the authors have developed systematic and consistent processes to connect these data. An example of automated fault-log data is given in Figure 2.

Date/Time	Main status	Additional	Main/StatusText	Add/StatusText	Wind	Duration	Service	Time/Day
01:02:2008 02 06	62	319	Feeding fault	Mains contactor several in. off	14.5	00 00 21	FALSE	6
01:02:2008 02 06	60	15	Mains failure	Overvoltage L2	16.6	00 00 10	FALSE	3
01:02:2008 03 02	62	301	Feeding fault	Mains contactor inverter 1 off	11.7	00 00 16	FALSE	6
01:02:2008 03 02	60	15	Mains failure	Overvoltage L2	13.1	00 00 10	FALSE	3
01:02:2008 03 14	60	15	Mains failure	Overvoltage L2	12.8	00 00 10	FALSE	3
01:02:2008 03 14	62	319	Feeding fault	Mains contactor several in. off	12.2	00 00 20	FALSE	6
02:03:2008 19 56	67	508	Overtemperature	Thermoswitch feedback error	8.1	00 00 29	FALSE	6
01:12:2007 18 04	60	15	Mains failure	Overvoltage L2	3.9	00 00 11	FALSE	3
01:12:2007 18 04	62	301	Feeding fault	Mains contactor inverter 1 off	4	00 00 20	FALSE	6
02:12:2007 20 18	60	15	Mains failure	Overvoltage L2	11.7	00 00 21	FALSE	3
02:12:2007 20 19	62	319	Feeding fault	Mains contactor several in. off	7.2	00 00 16	FALSE	6
03:12:2007 16 08	240	0	Remote control PC	switched on	0	00 00 08	FALSE	5
03:12:2007 16 20	240	1	Remote control PC	switched off	0	00 01 12	FALSE	5
03:12:2007 16 21	240	0	Remote control PC	switched on	0	00 00 07	FALSE	5
04:12:2007 03 33	60	15	Mains failure	Overvoltage L2	9.8	00 00 26	FALSE	3
04:12:2007 03 45	60	15	Mains failure	Overvoltage L2	8.2	00 00 29	FALSE	3
04:12:2007 03 48	60	15	Mains failure	Overvoltage L2	13.8	00 00 26	FALSE	3
04:12:2007 05 26	8	0	Maintenance		20	07 35 22	TRUE	6
04:12:2007 16 01	9	4	Generator heating	Hygrostat rectifier	26.2	00 23 39	FALSE	1

Figure 2: Wind Turbine Fault Logs

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Previous work in this area has used publically available data [1, 2], but this work has processed data direct from operational wind farms leading to more accurate results.

## Results

Reliability Profiles showing failure rate and downtime can be derived from the data tables. This allows wind farm owners and operators to assess sub-assembly or component reliability and make comparisons to the industry average. An example showing the form of the reliability profiles is given in Figure 3.

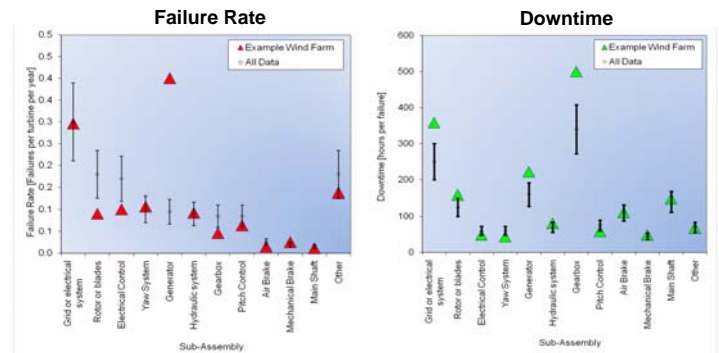


Figure 3: Example Reliability Profile

These example Reliability Profiles demonstrate, for example, that this wind farm has a lower than average gearbox failure rate, but the downtime for those failures that do occur is longer than the wider population.

These results are of benefit to:

- **Wind farm operators** to influence maintenance strategies and explain downtime; and
- **Wind farm owners / developers** who want compare failure rates between technology types.

## Conclusions

The Reliability Profile of a wind farm allows an owner or operator to determine specific reliability issues at a sub-assembly or, possibly, component level. This on-going project has so far:

- Determined the methods required to derive Reliability Profiles;
- Highlighted the importance of Reliability Profiles to wind farm owners and operators;
- Shown how these results can be used in wider reliability work.

## Acknowledgements

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## References

1. Tavner, P. J., Xiang, J., Spinato, F., Reliability Analysis for Wind Turbines, Wind Energy 2007 10:1-18.
2. Spinato, F. The Reliability of Wind Turbines, PhD Thesis, Durham University, UK, December 2008.

