Advanced nacelle anemometry and SCADA-data, analysis techniques and limitations

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Outline

- Introduction
- State of the art
- Advanced methods
- Nacelle Power Curve standard
- Conclusion

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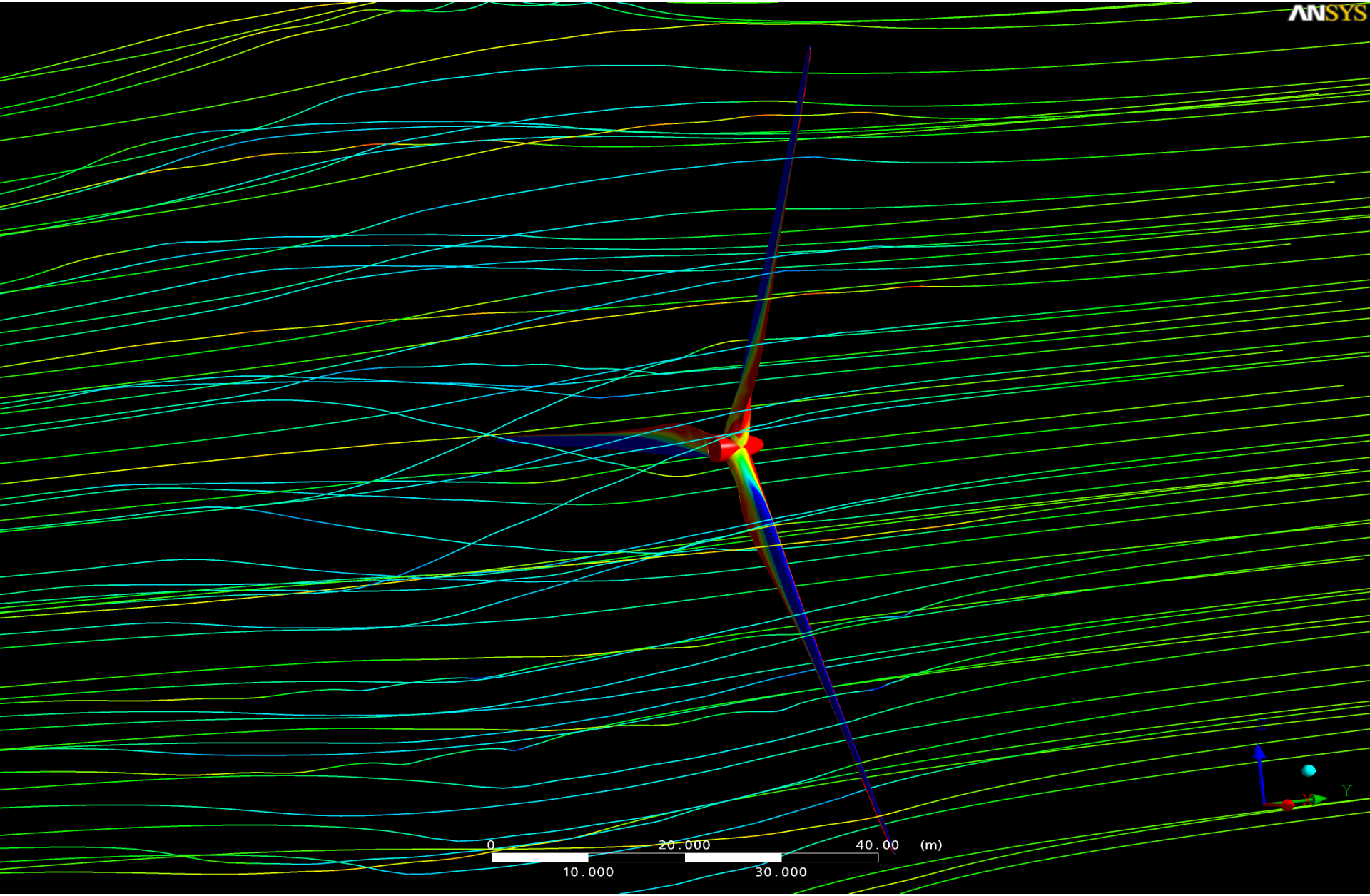
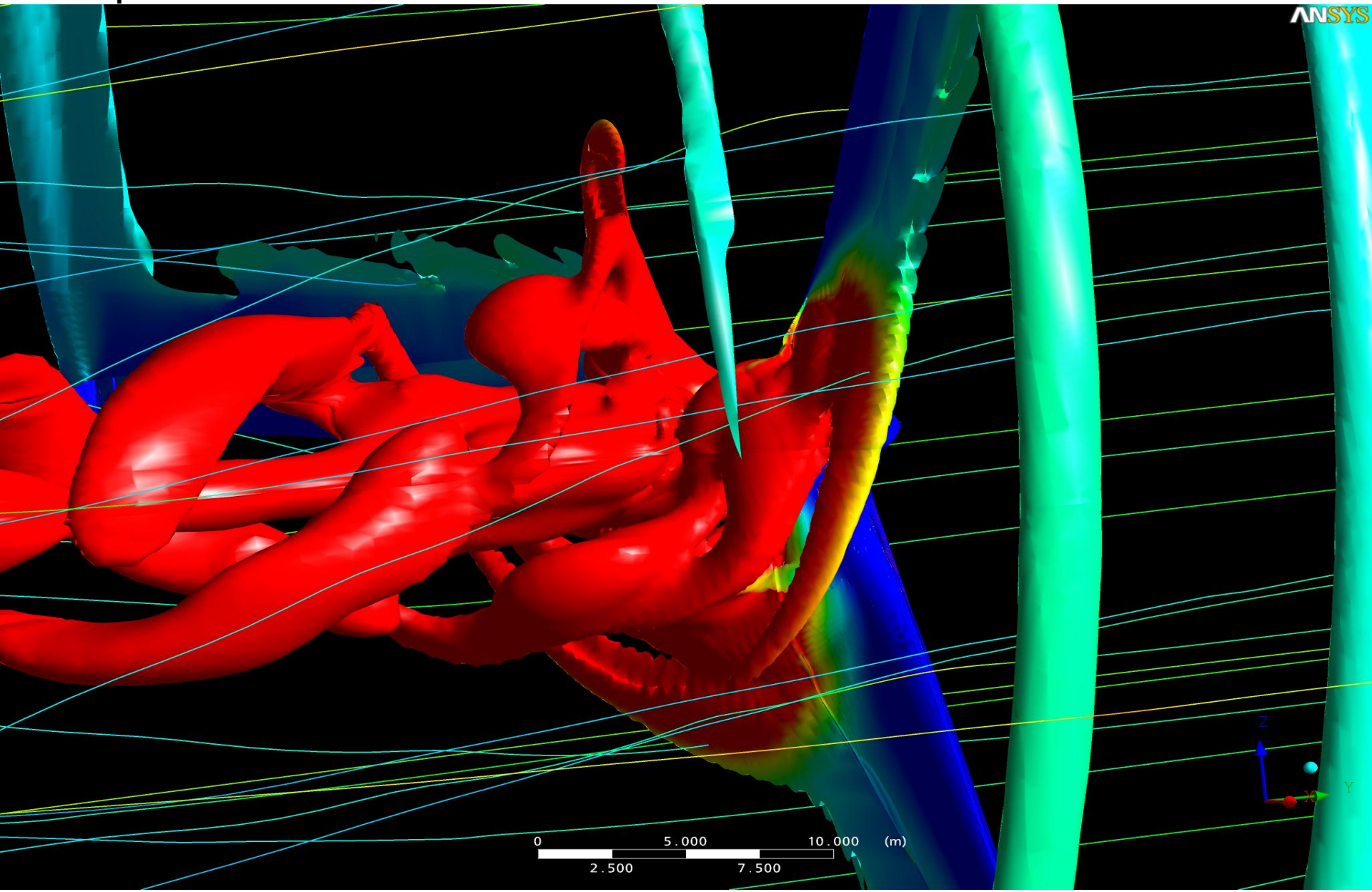
The purpose: performance monitoring and park optimisation

The problem: correlation to free stream wind

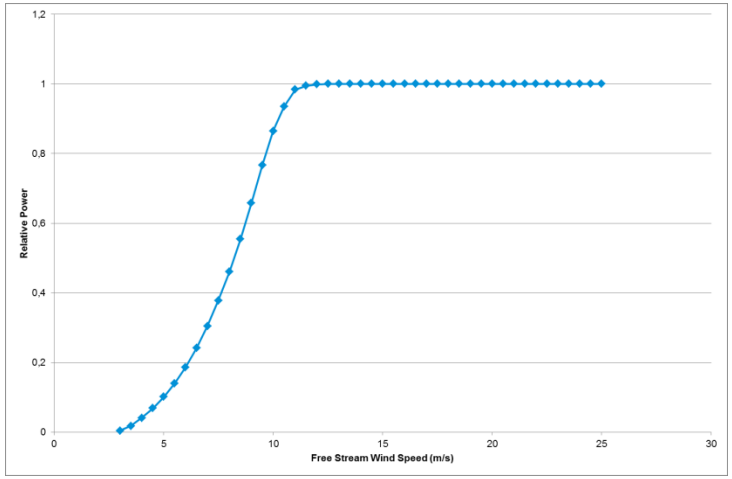


The problem: correlation to free stream wind

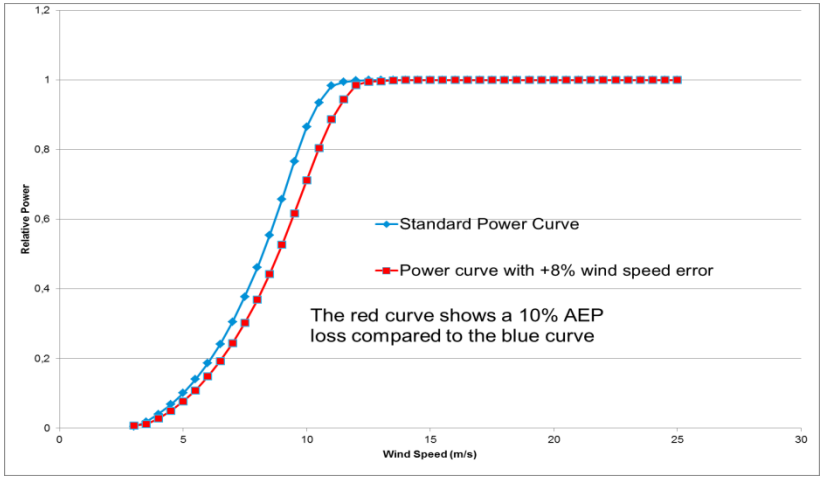


Apparent AEP & real AEP

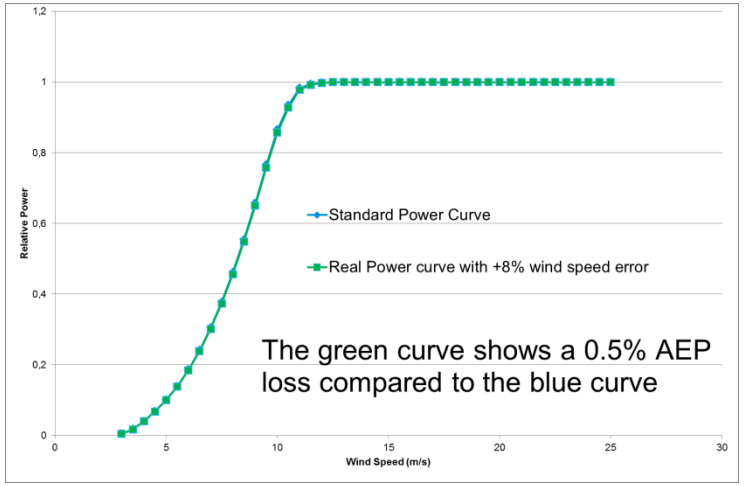
Original power curve



The apparent effect of a nacelle anemometer measurement error

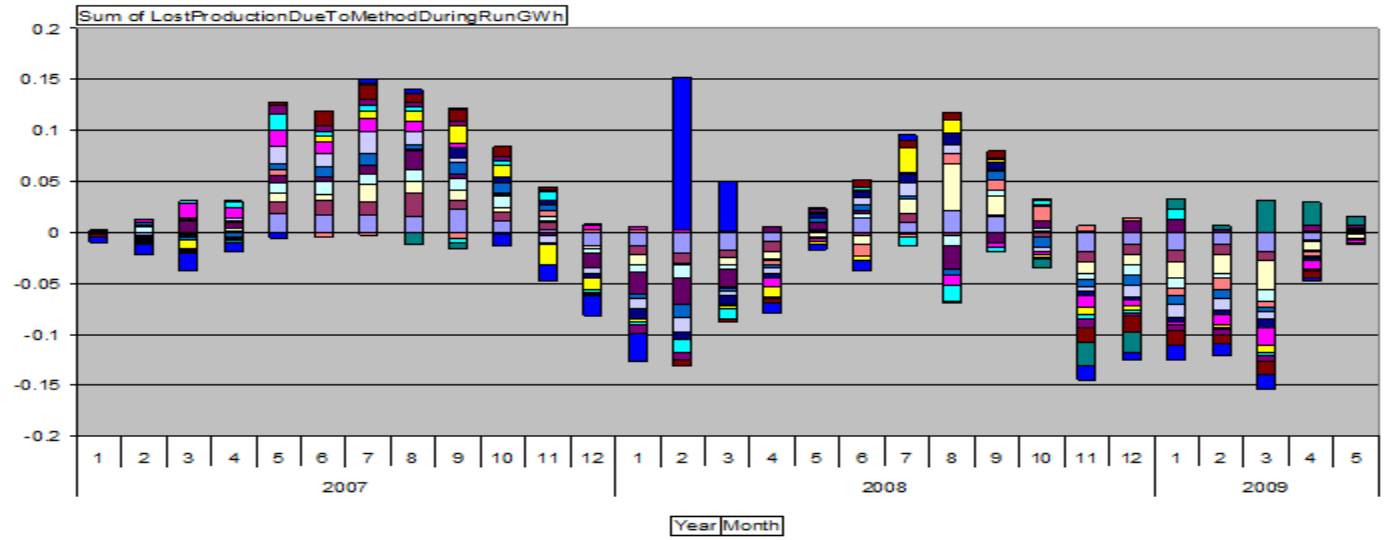


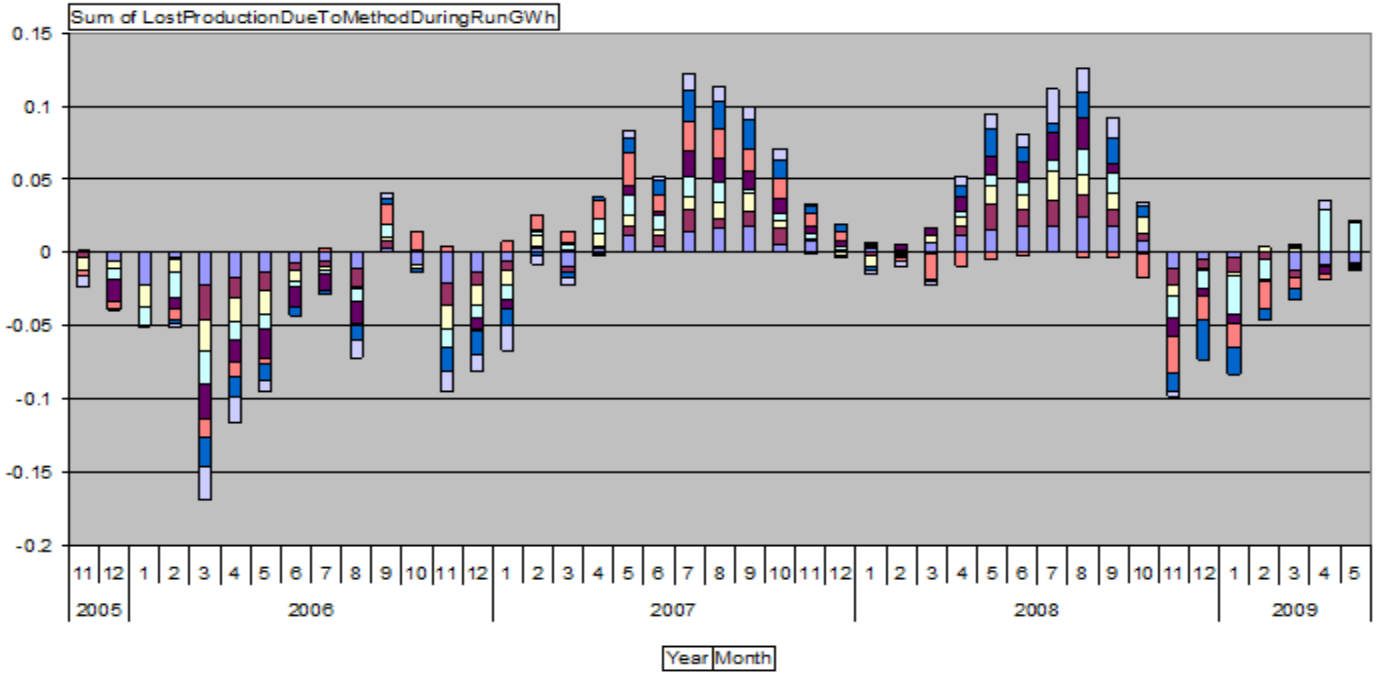
The real effect of the same nacelle anemometer measurement error



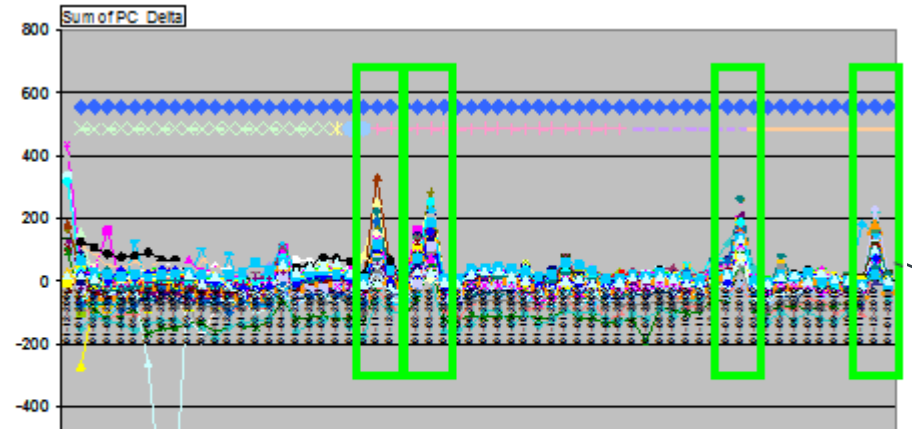
It seems like the power performance has ben reduced by 10% whereas in reality it has been reduced by 0.5%

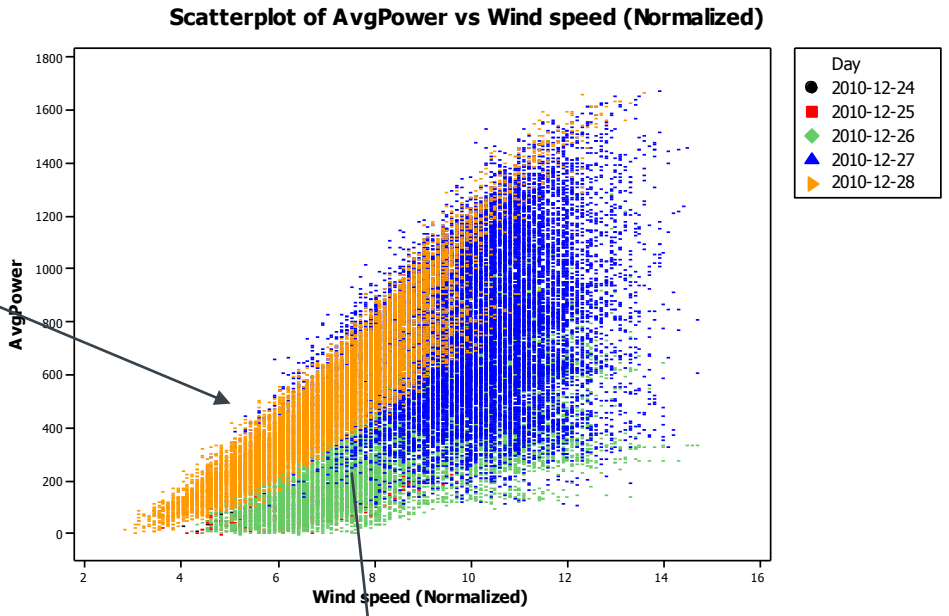
The problem: seasonal variation

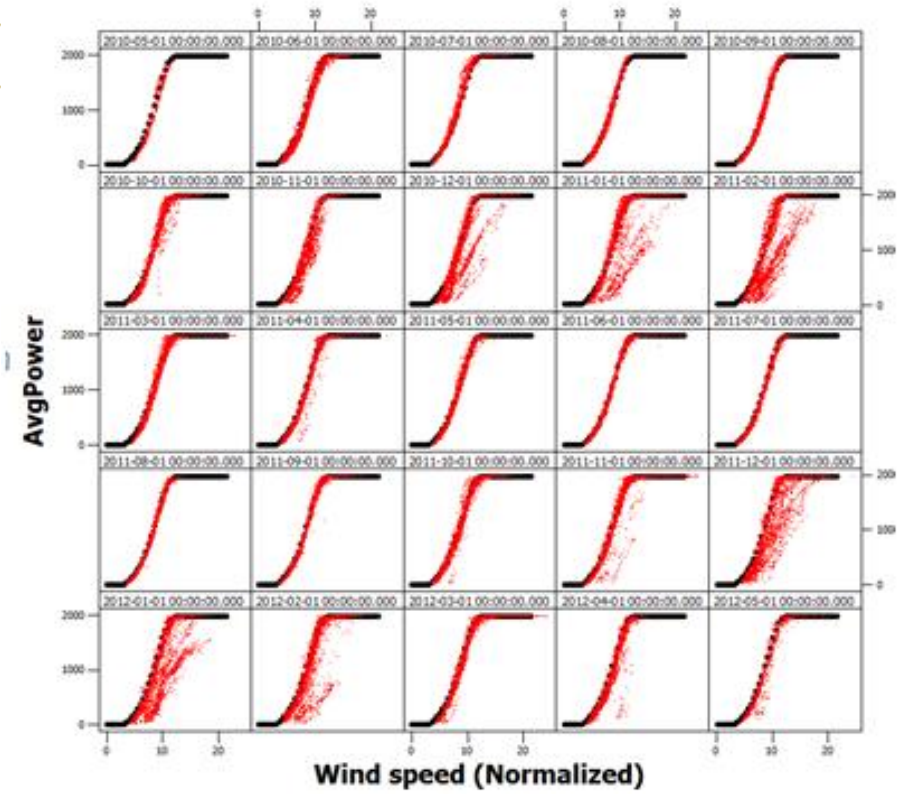


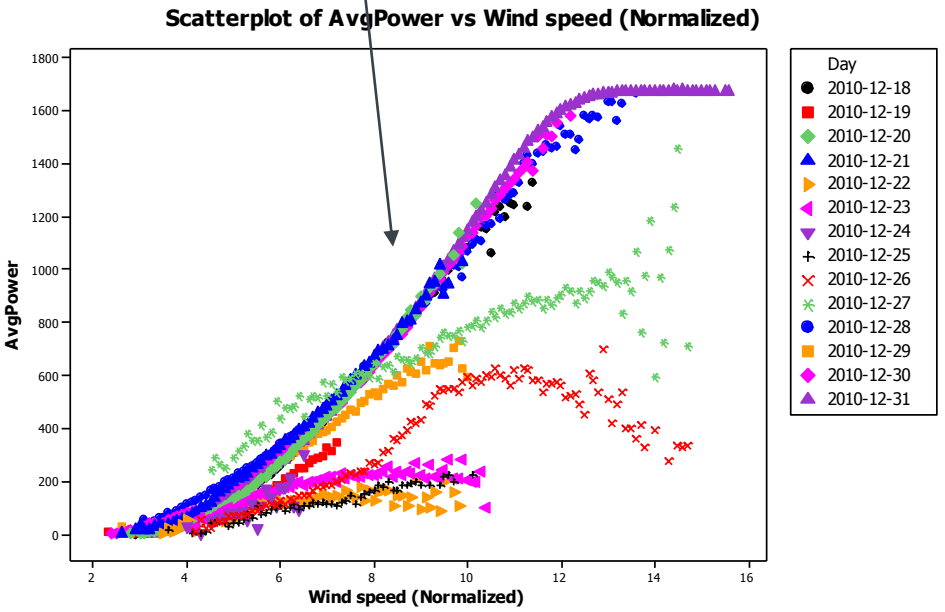


State of the art: detection of icing

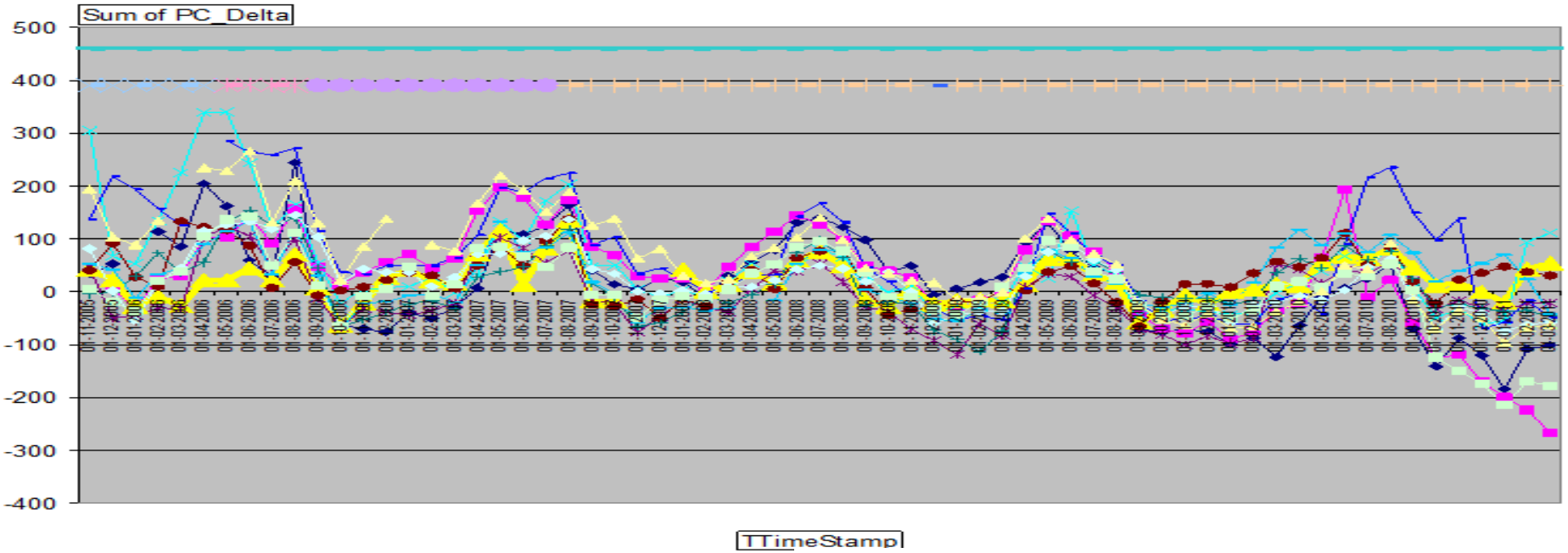


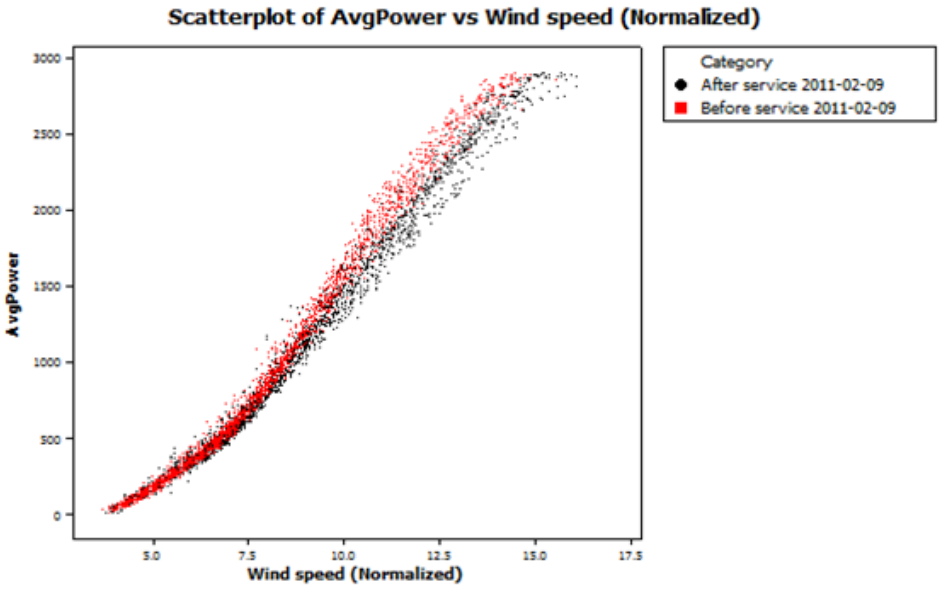


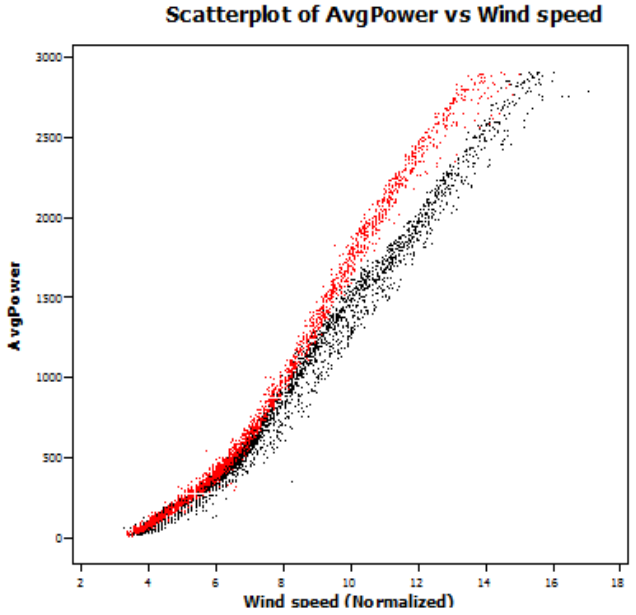




State of the art: incorrect pitching







State of the art: overview

In general, we can confidently detect the following field performance issues:

- Icing
- Yaw error
- Pitch problems
- De-rating problem
- Curtailment
- Incorrect control parameters influencing performance
- Incorrect nacelle transfer function
- Directional influence

Standardisation: IEC 61400-12-2 standard

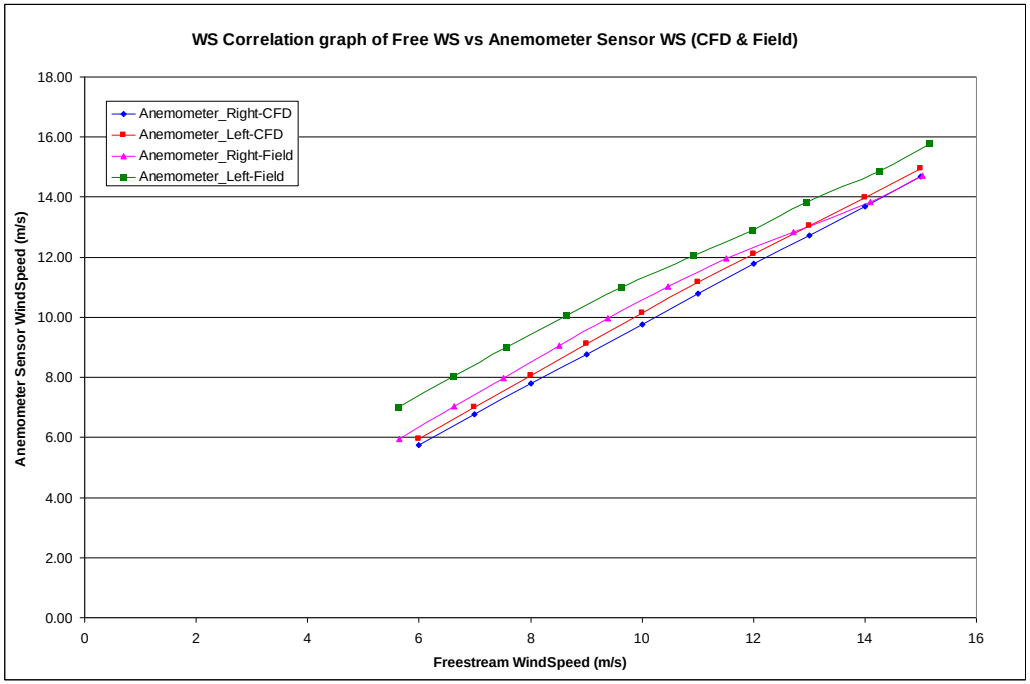
The project team has submitted the FDIS to the IEC June 2012. When approved by the national committees the standard can be expected around summer 2013

The standard is not easier than -12-1; a lot of focus has been put in to reduce variance. Still, total uncertainty of the test is higher than -12-1 standard (power curve test with met-mast)

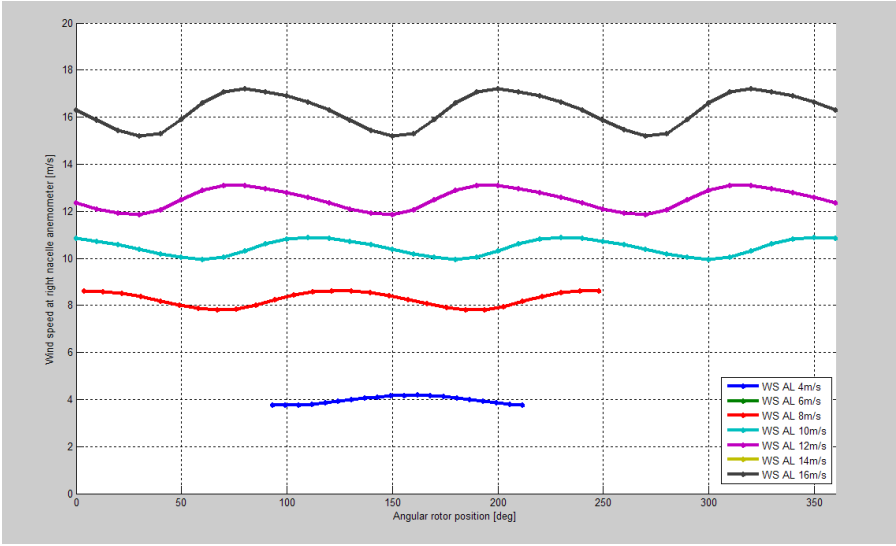
Useability will largely depend on OEMs to be compliant with this standard through their software – in which case costs are significantly lower than for a -12-1 test

Main challenge is to separate terrain influence on wind speed from rotor infuence

Advanced techniques: NTF calculated by CFD

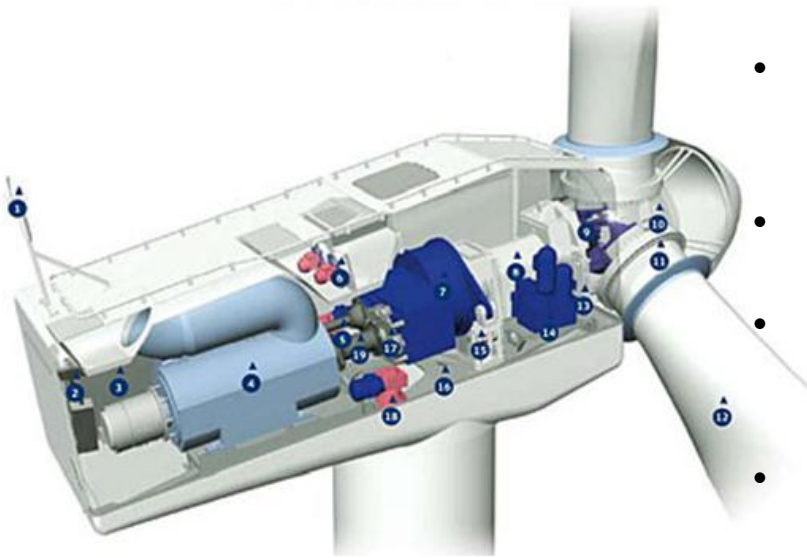


Some encouraging results but high variability from site to site and operator to operator. Not ready for field testing or standardisation



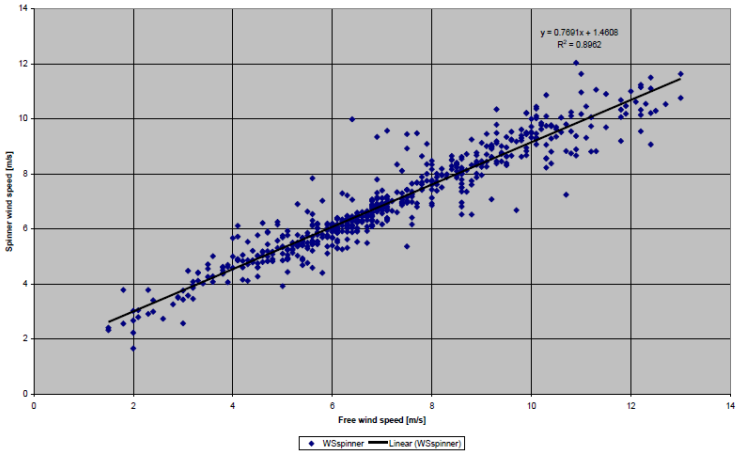
Wind speeds	Actuator disc	Actuator line	Field data
4	0.998	0.982	1.010
6	1.024	-	1.105
8	1.018	1.025	1.036
10	1.021	1.037	1.025
12	1.024	1.032	1.052
14	1.015	-	-
16	1.009	1.008	-

Advanced techniques: Spinner anemometry

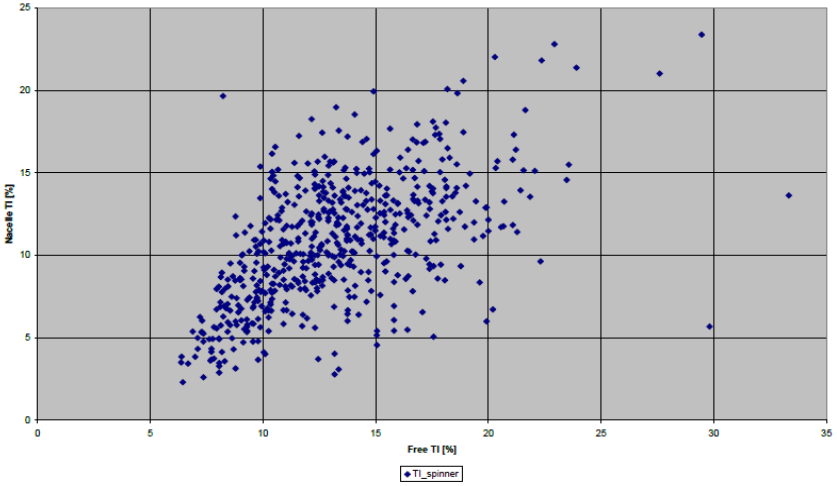


- Site calibration done
- Turbine running with spinner anemometer for half a year
- Availability 51% (100% of the data) per 10-min data set, 97% available (99% of the data per 10-min data set)
- Correlation to free stream wind has R^2 of 0.89, which is less than standard anemometer (R^2 = 0.97)
- Correlation to free stream turbulence is equally bad between standard anemometer and spinner anemometer
- More data requirement for spinner anemometery to establish itself as a valuable option

Spinner wind speed vs free wind speed



Spinner TI vs free TI



Limitations and Conclusions

In order to get value out of nacelle anemometry data we have to overcome these limitations:

- Data quality currently lowers the capability of the analysis – we are looking with ‘foggy glasses’ and results are not clear
- Main challenge of understanding the physics through the available data – data must be used to verify hypotheses, not only to postulate problems
- Data must be used together with other sources (other turbines, met-masts, other signals, logbooks

While addressing these challenges, we can identify and solve a number of problems with park operation and add value by optimising park performance

Thank you for your attention