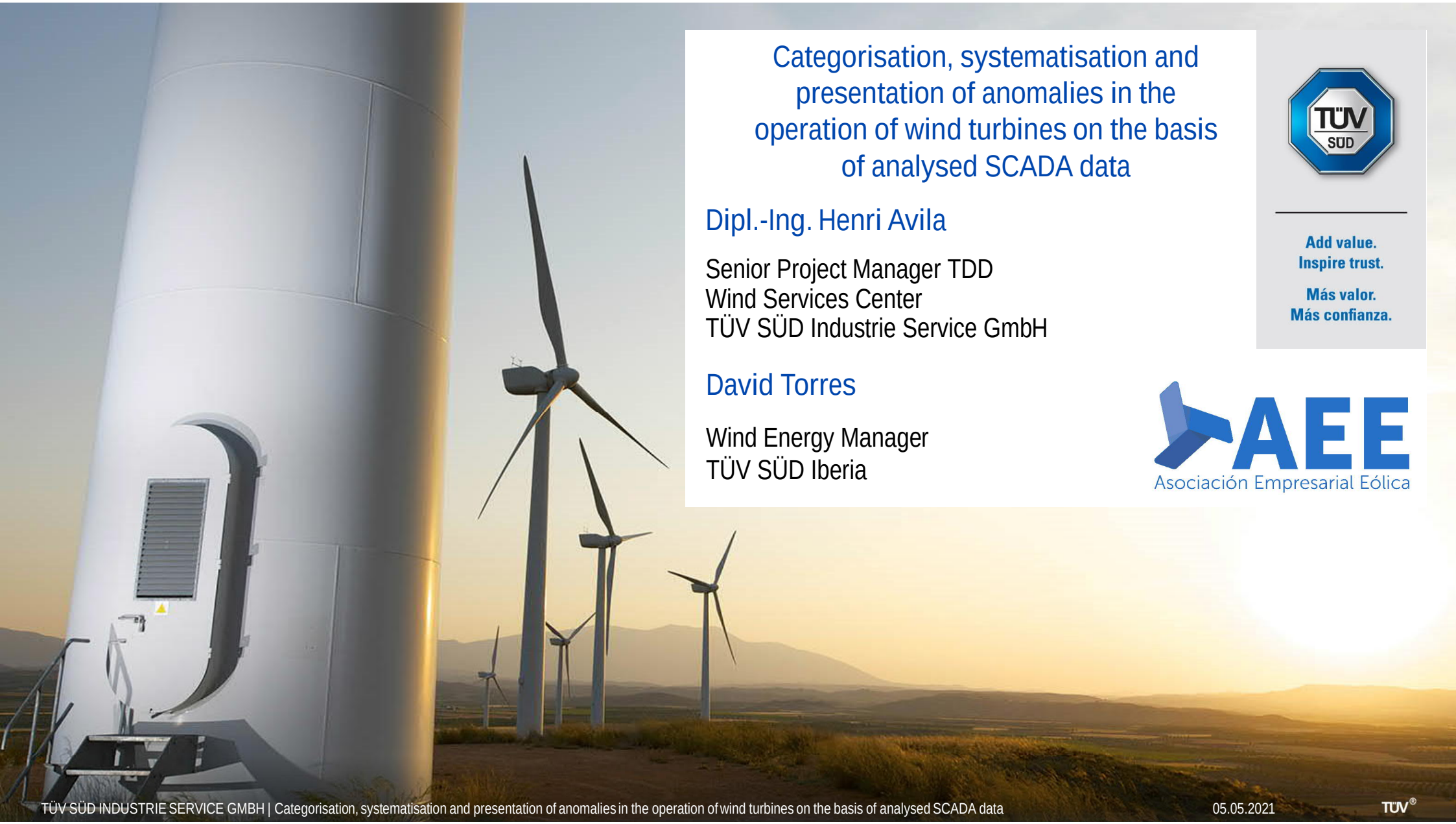

Categorisation, systematisation and presentation of anomalies in the operation of wind turbines on the basis of analysed SCADA data

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TÜV SÜD at a glance

150+
YEARS OF SAFETY, SECURITY & SUSTAINABILITY

1,000+
LOCATIONS WORLDWIDE

€2.6
BILLION IN ANNUAL REVENUE

25,000+
EMPLOYEES*

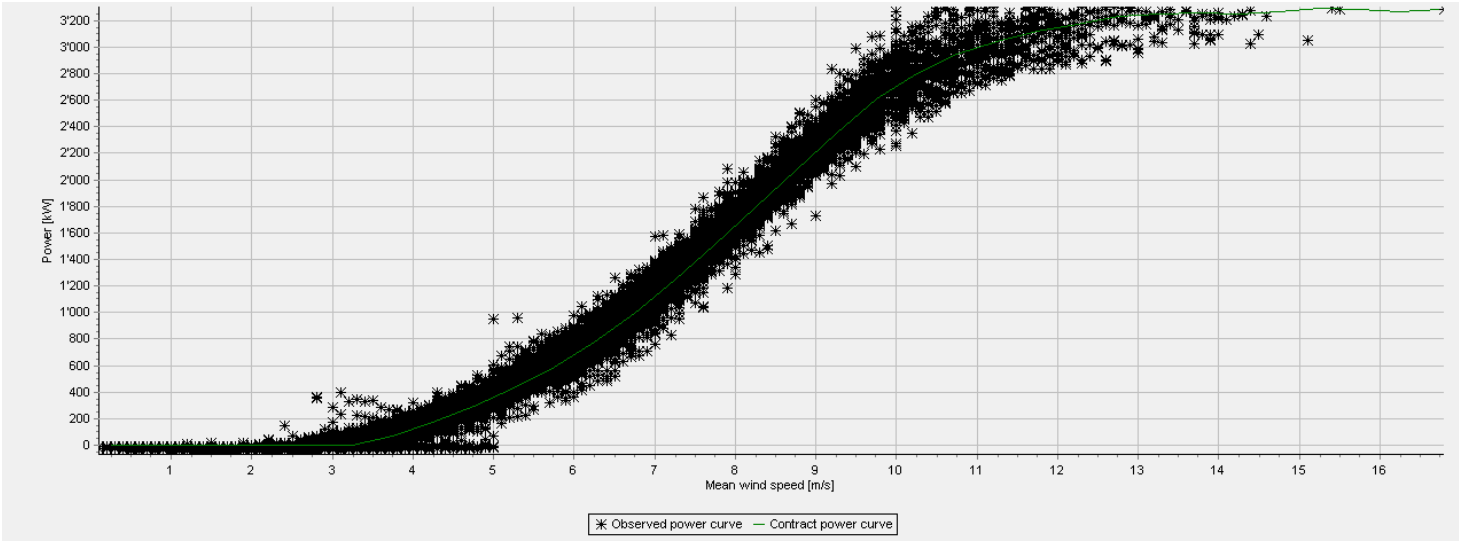
41%
OF REVENUE OUTSIDE GERMANY^

574,000
CERTIFICATES

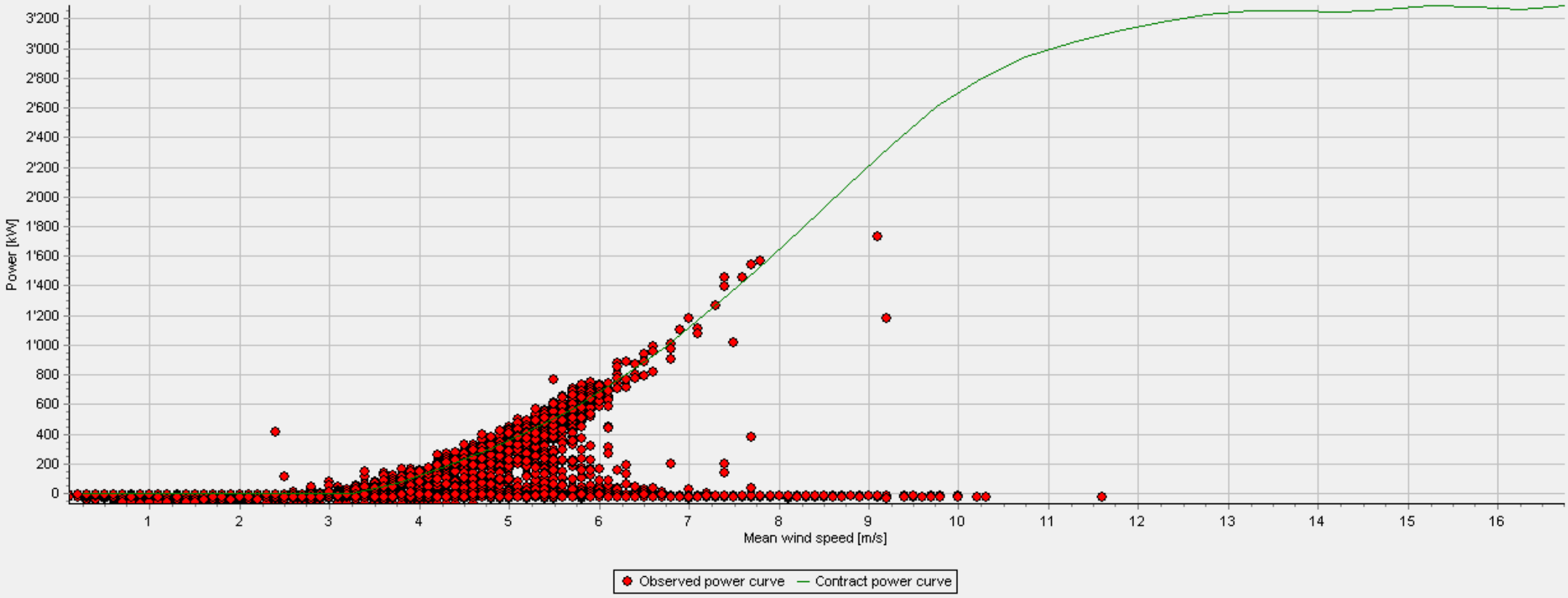
100%
INDEPENDENT & IMPARTIAL

1-STOP
SOLUTIONS PROVIDER

*As of 2019-12-31
^Based on clients' locations
Note: Figures have been rounded off.


Power [kW]
3'200
3'000
2'800
2'600
2'400
2'200
2'000
1'800
1'600
1'400
1'200
1'000
800
600
400
200
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Mean wind speed [m/s]
Observed power curve
Contract power curve

What is the problem?



Content

1 Definition of the problem

2 Development of categories

3 Analysis of operational problems

4 Yield category

5 Permit category

6 Loads/ Life time category

Definition of the problem

Problem:

Wind farm operator says my turbine is not doing well.

What does it mean? Tell me

Possible answers:

The production is too low

Something is no ok with power curve

The turbine is wrong

Definition of the problem

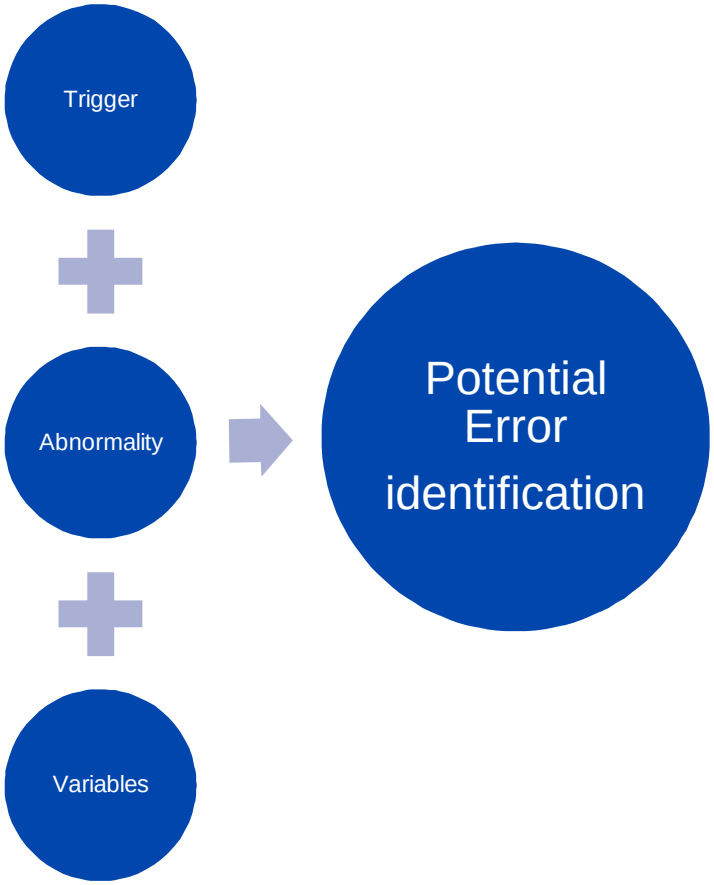
Current status of operational analysis in literature:

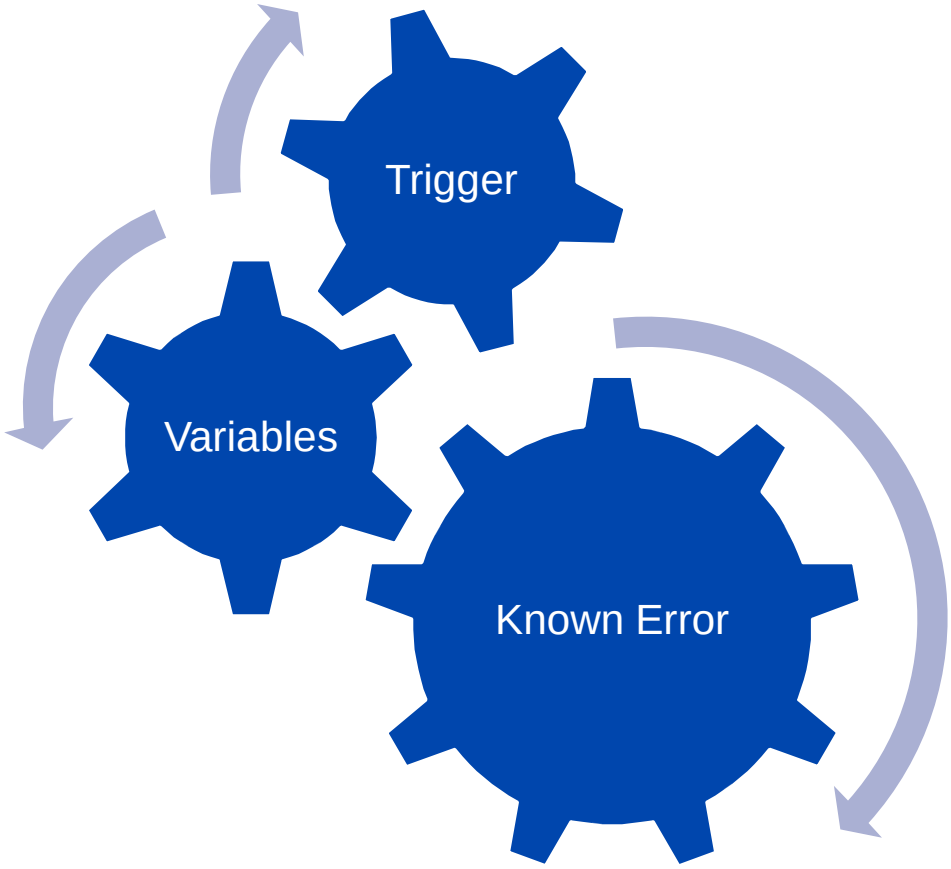
- No standard for failures or error description
- No common rules for data treatment
- No classification of errors
- No differentiation between errors and anomalies

Development of categories

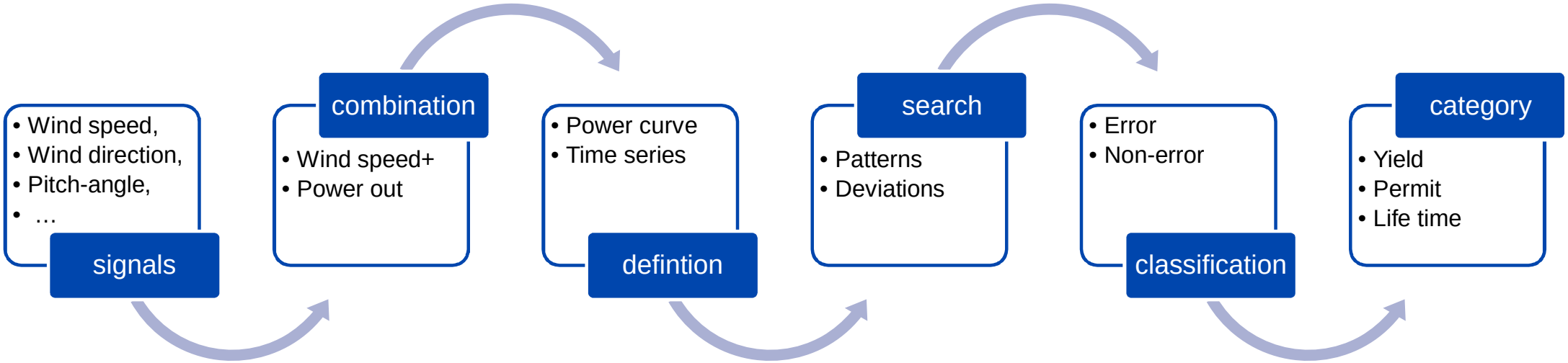
1. Energy Yield €€
2. Permit §§
3. Life time /Loads

Analysis of Operational problems

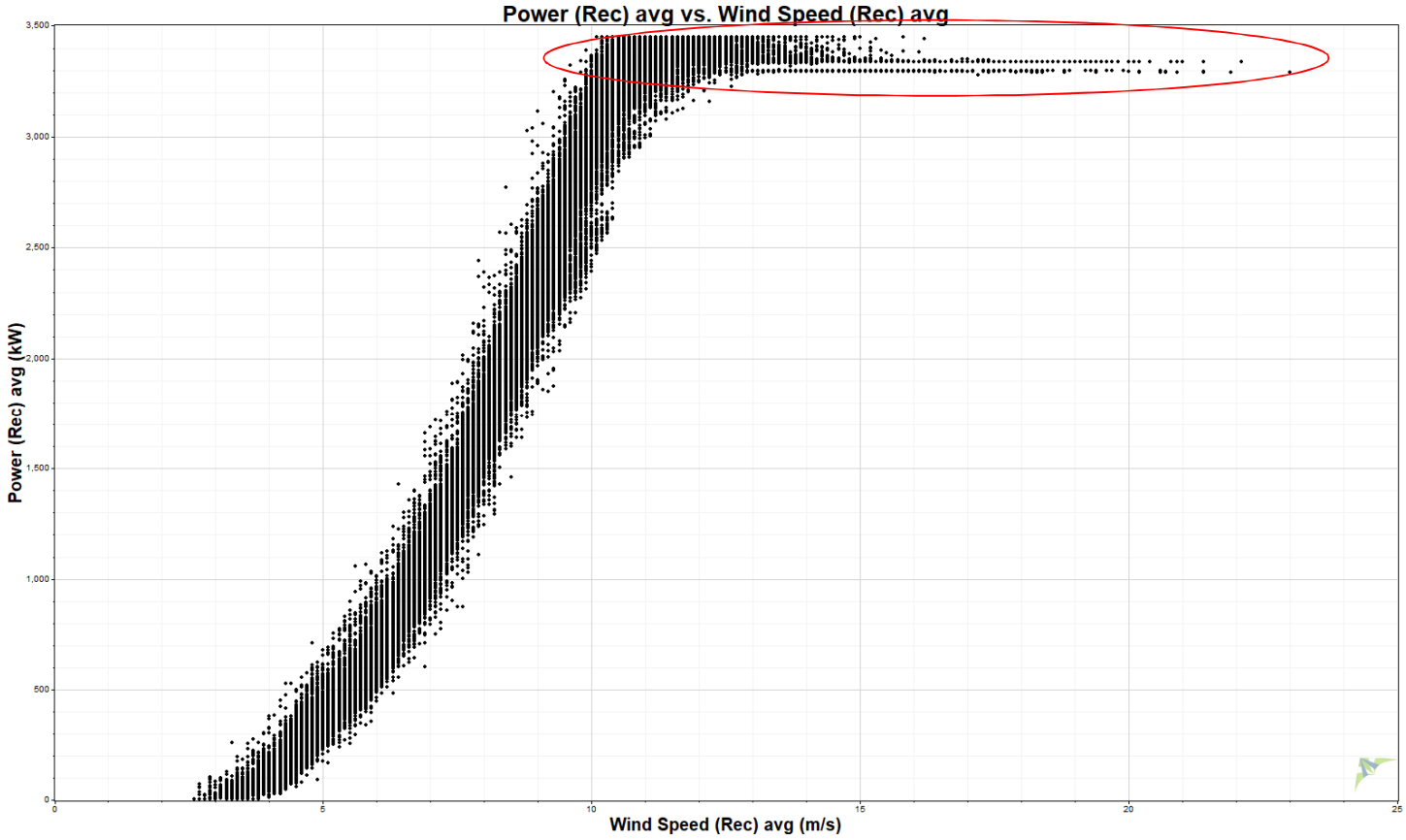




Analysis of Operational problems



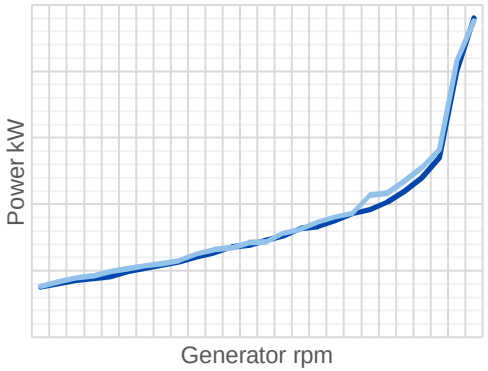
Yield category



1. Signal selection:
-Power out
-Wind speed
2. Combination
3. Definition
- Standard power curve
4. Search
- patterns
- deviation
5. Classification
- Error
- Non-Error
6. Category
- yield

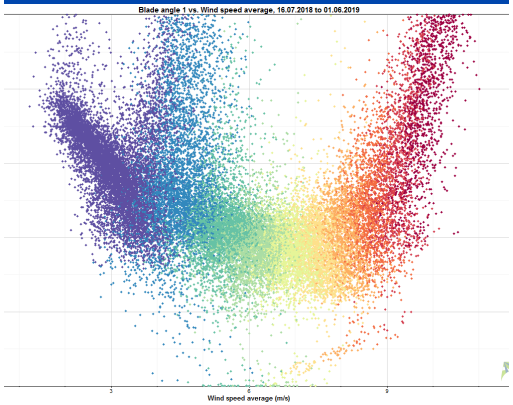
Yield category

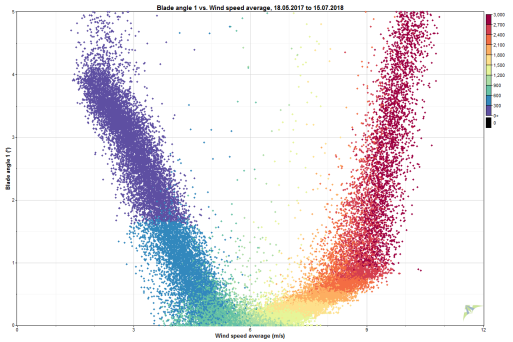
Speed-torque curves



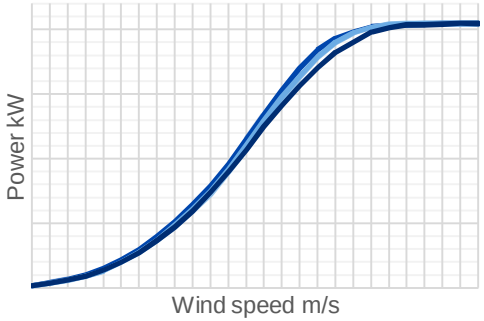
Wind independ evidence for turbine mal function

Pitch-angle



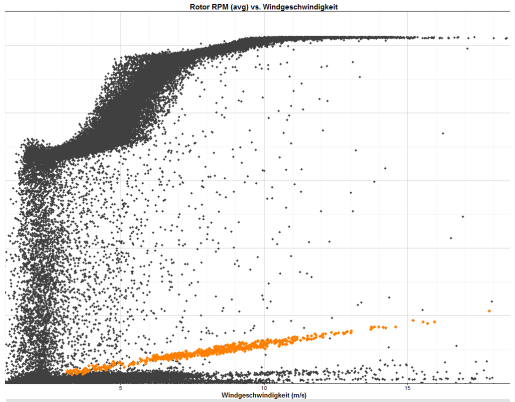


Power curve degradation



- Blade ageing
- Dirt on blade
- Damages

Ideling above cut -in



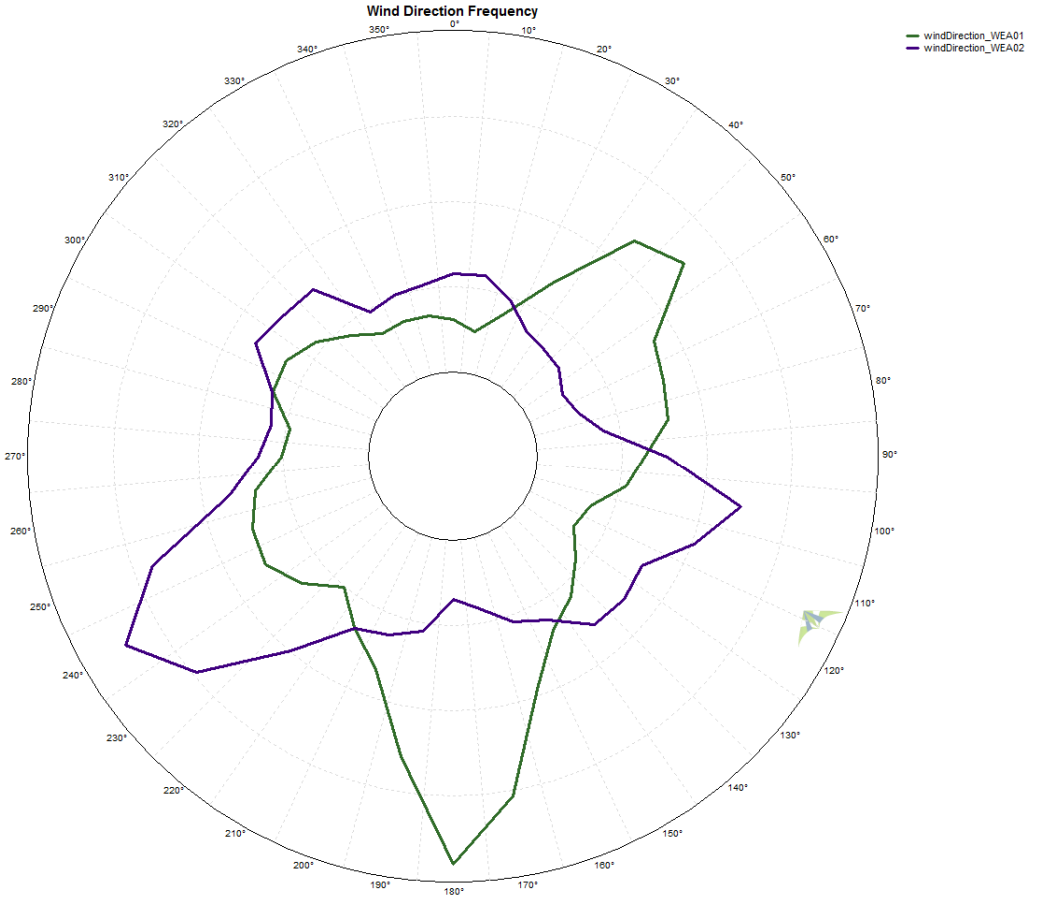
- Power curtailment
- Reduced grid capacity

Permit category

Deviation wind roses

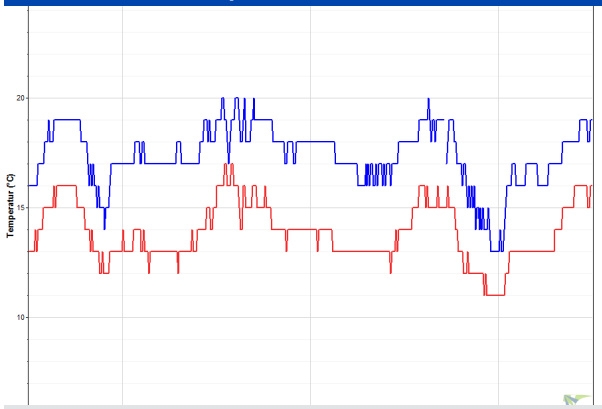
Problem:
Offset between Roses
Permit risk:
Violating of permitted sector management

Signal: wind direction of two turbines



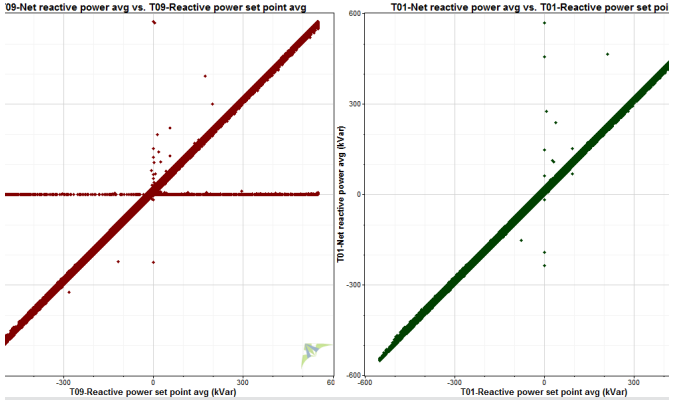
Permit category

Ambient temperature measurements



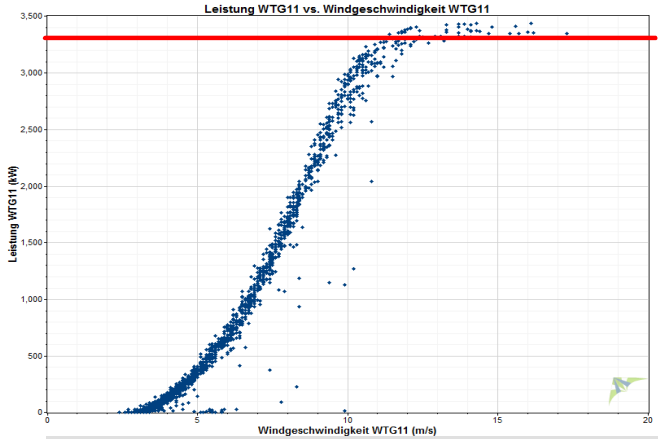
- Wrong temperature violates the bat shot down requirements

Wrong reactive power setting



- Failing the grid requirements

Exceeding permitted power



- Exceeding of permitted feed production

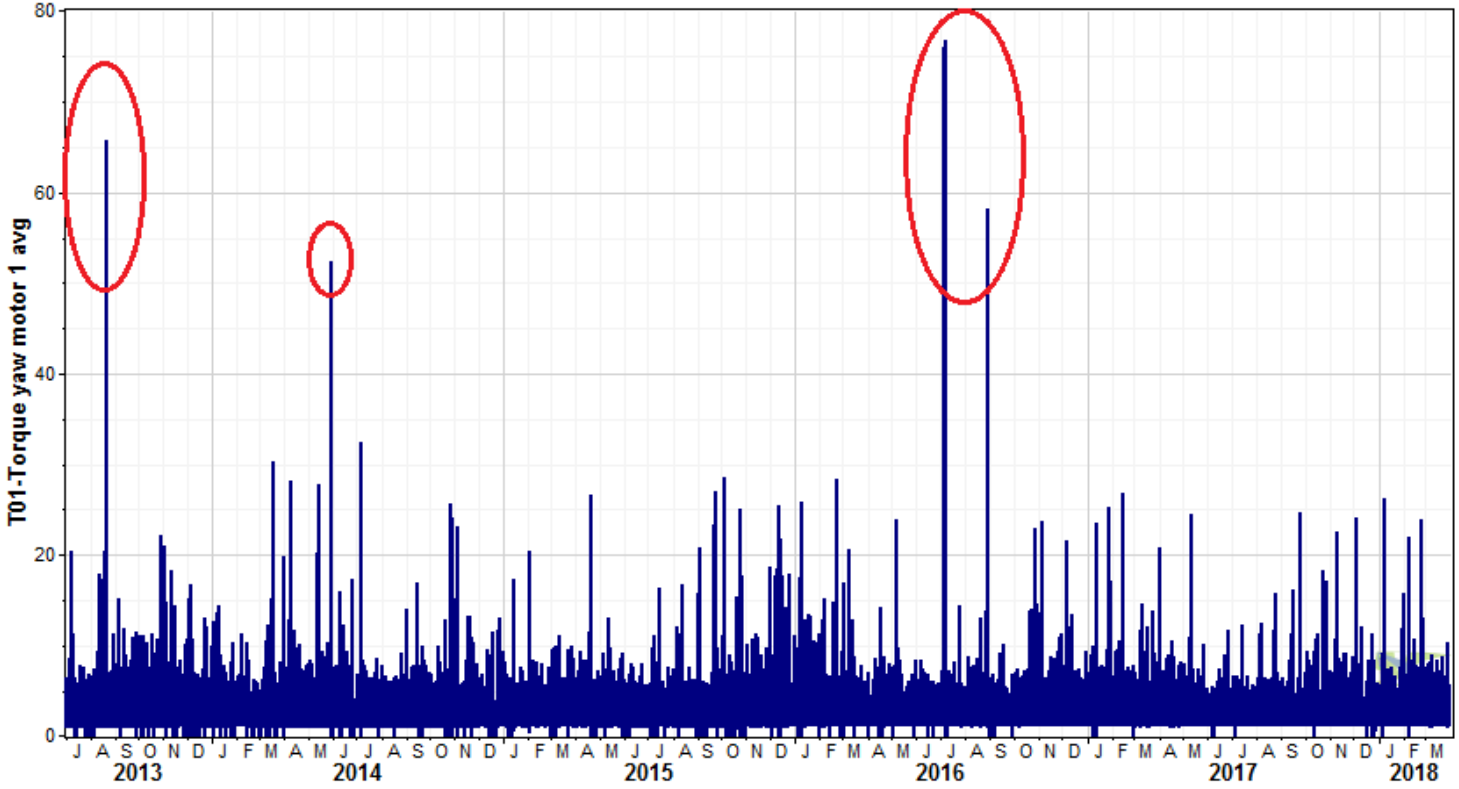
Life time

high torque on the azimuth drives

Problem:
Exceedance of design torque

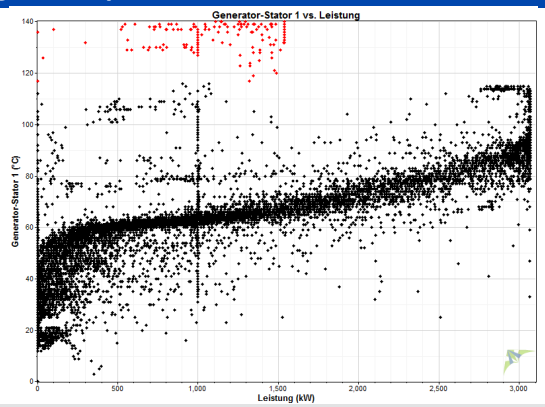
Life time risk:
High torque destroys the azimuth drives

Signal: torque of azimuth drives



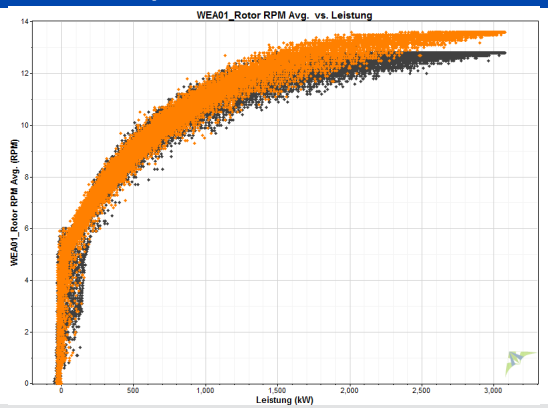
Life time

High temperatures



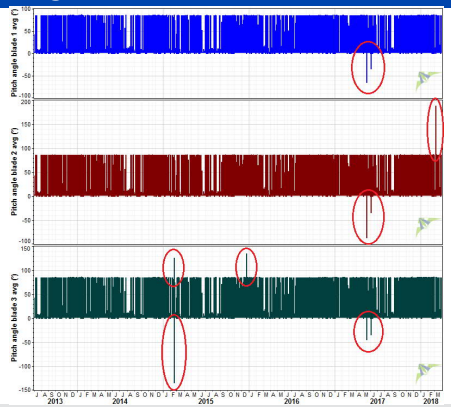
- Temperature signal high above normal
- Signal: Temperature in Generator Stator, Power
- Risk: Isolation melting

Rotor overspeed



- Rotor speed above design speed
- Signal: Rotor Rpm, Power
- Risk: Mechanical loads above design loads => Turbine break down

Pitch-angles



- Pitch-angles outside operational area
- Signal: Pitch-angel over time
- Risk: failure pitch system => worst case turbine break down

Mixed case

Deviation wind measurements

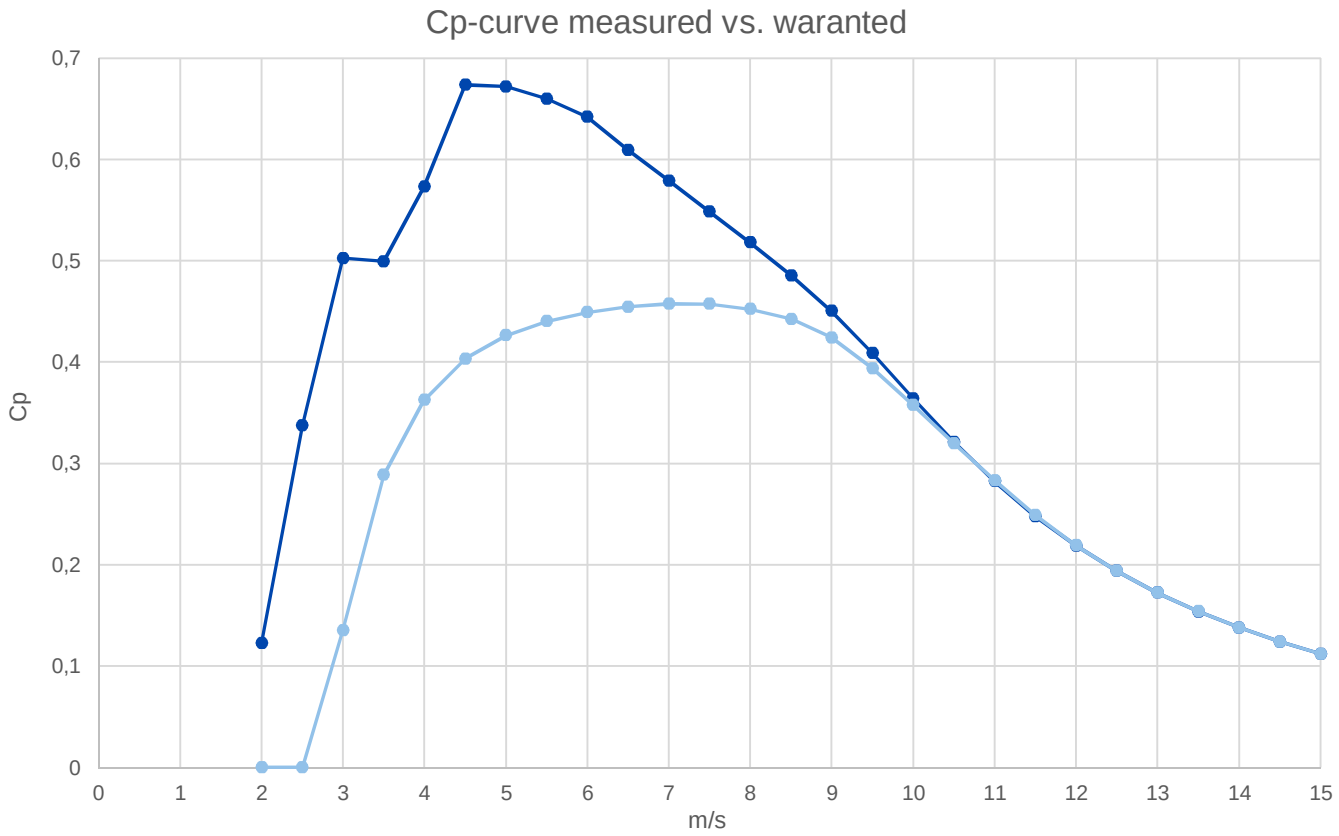
Problem:
Wind speed wrongly estimated

Signal: wind speed signal compare with the Cp-curves

Risks:
Yield: wrong power curve

Permit: wrong bat signal

Life time: Wrong cut off wind speed



Outlook

Ongoing:

- Development of more case per category

Steps in Progress:

- Taking the analysis from a qualitative assessment to a quantitate one

Future

- Achieving acceptance of SCADA-data findings in warranty discussions without inspections
- Applying the results for probabilistic failure identification
- Applying the review on real time data assessment

Summary

- SCADA signals used to identify problems
- Categorisation and classification of problems
- Yield category
- Permit category
- Life time category

Questions?

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