



VGB - Research Project

Wind Turbine SCADA-based Condition Monitoring

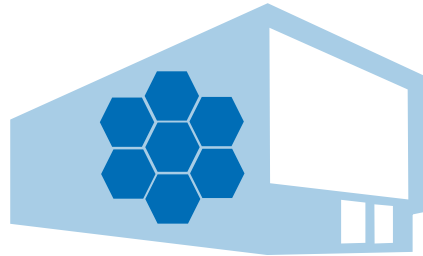
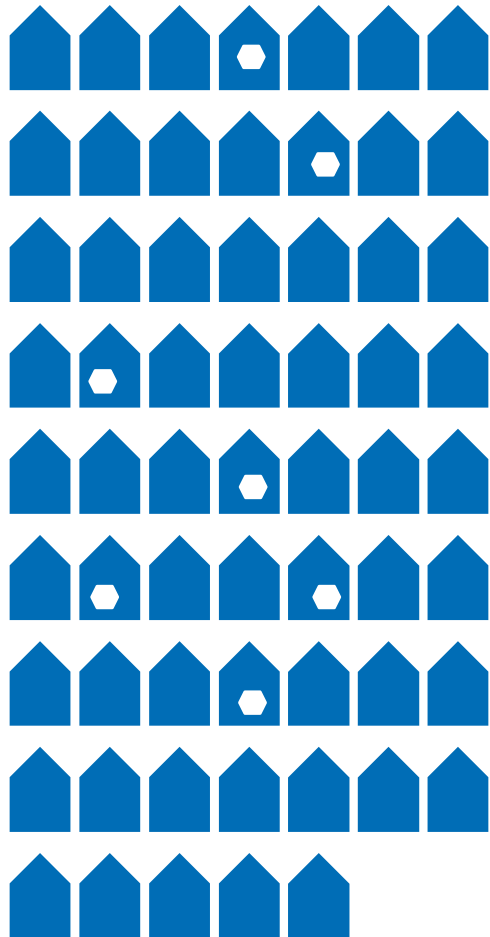
Prof. Dr. Ralf Schelenz

Björn Roscher, M. Sc.

Potsdam, 07th of November 2019

Center for Wind Power Drives – Concept and Integration

RWTH



I³-Institute: Integrated Interdisciplinary Institute:
 aerodynamics, control technology, electrical and mechanical engineering under one umbrella

Prof. Abel	 Institute of Automatic Control	Controls
Prof. Brecher		Gears
Prof. De Doncker		Power Electronics
Prof. Hameyer	 Institut für Elektrische Maschinen	Generators
Prof. Monti		Grids
Prof. Schröder		Aerodynamics
Prof. Stich		Logistics





Directorate: Prof. Abel, Prof. Brecher, Prof. De Doncker,
 Prof. Hameyer, Prof. Monti, Prof. Jacobs, Prof. Schröder

CTO: Prof. Schelenz





Chair for Wind Power Drives

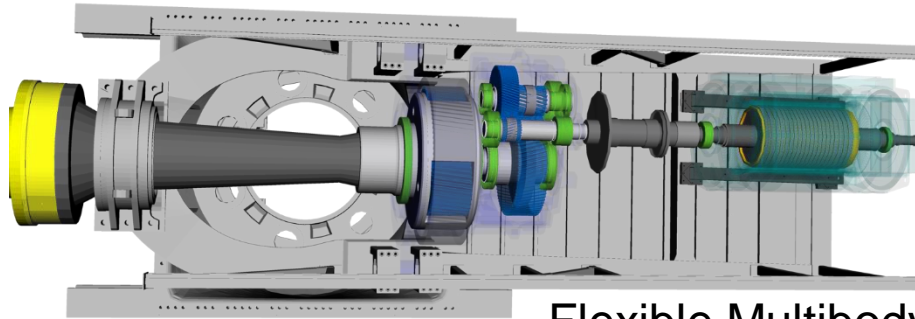


Systemdesign & Test

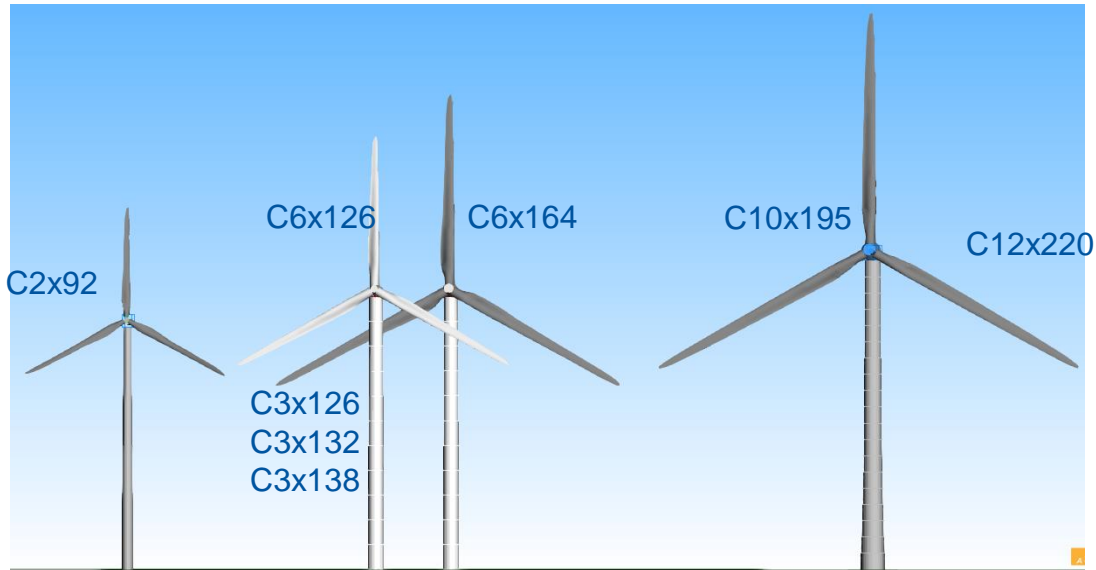
Industrial Partnerships: OEM & Suppliers

Wer ist CWD?

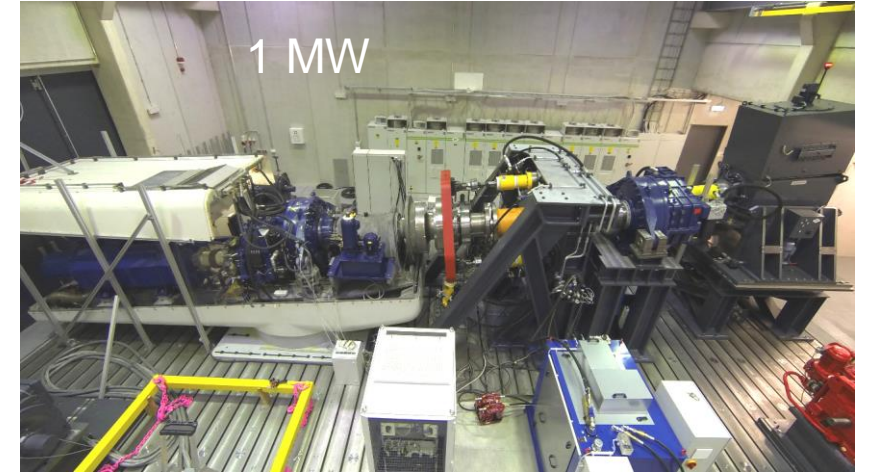
- Simulation

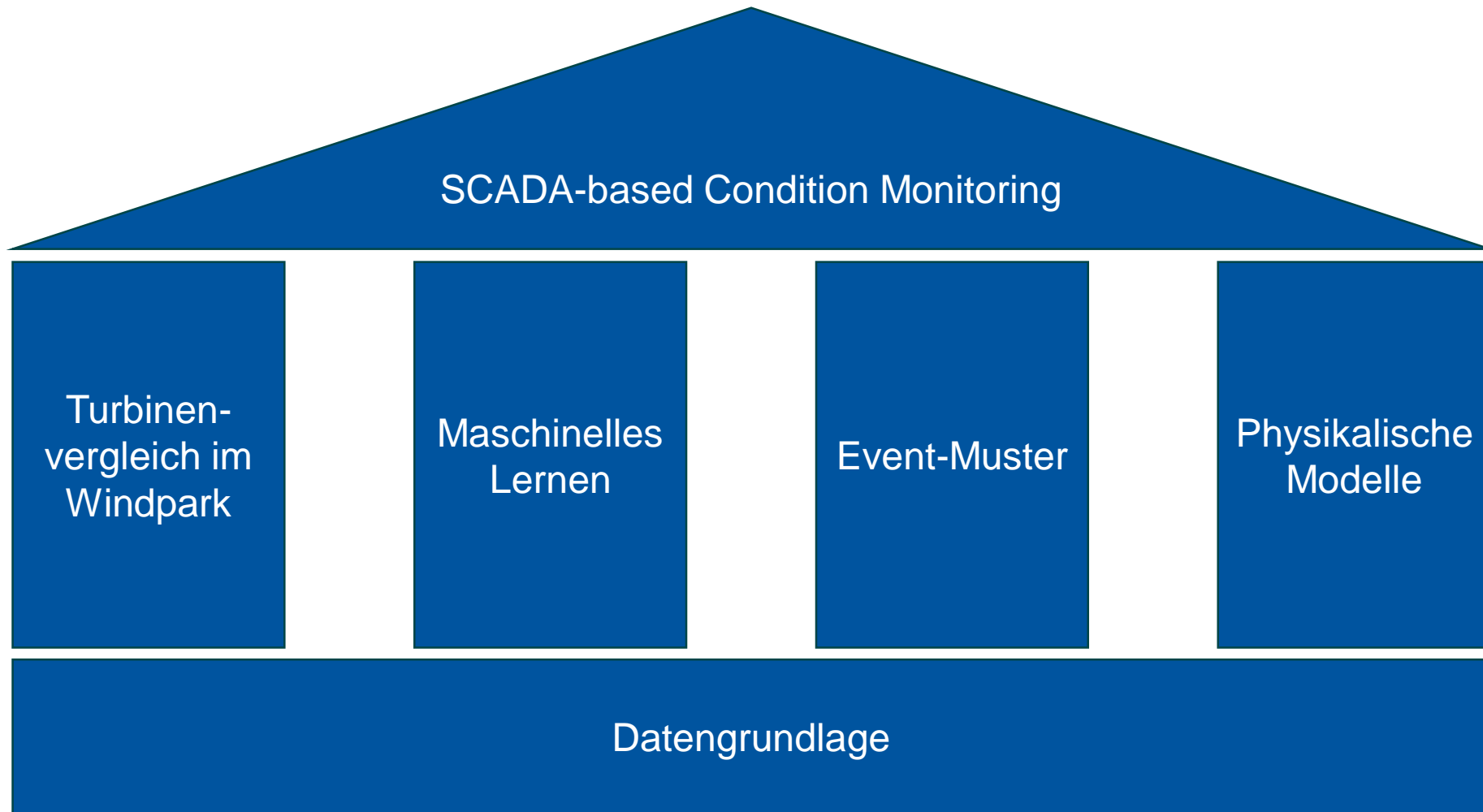


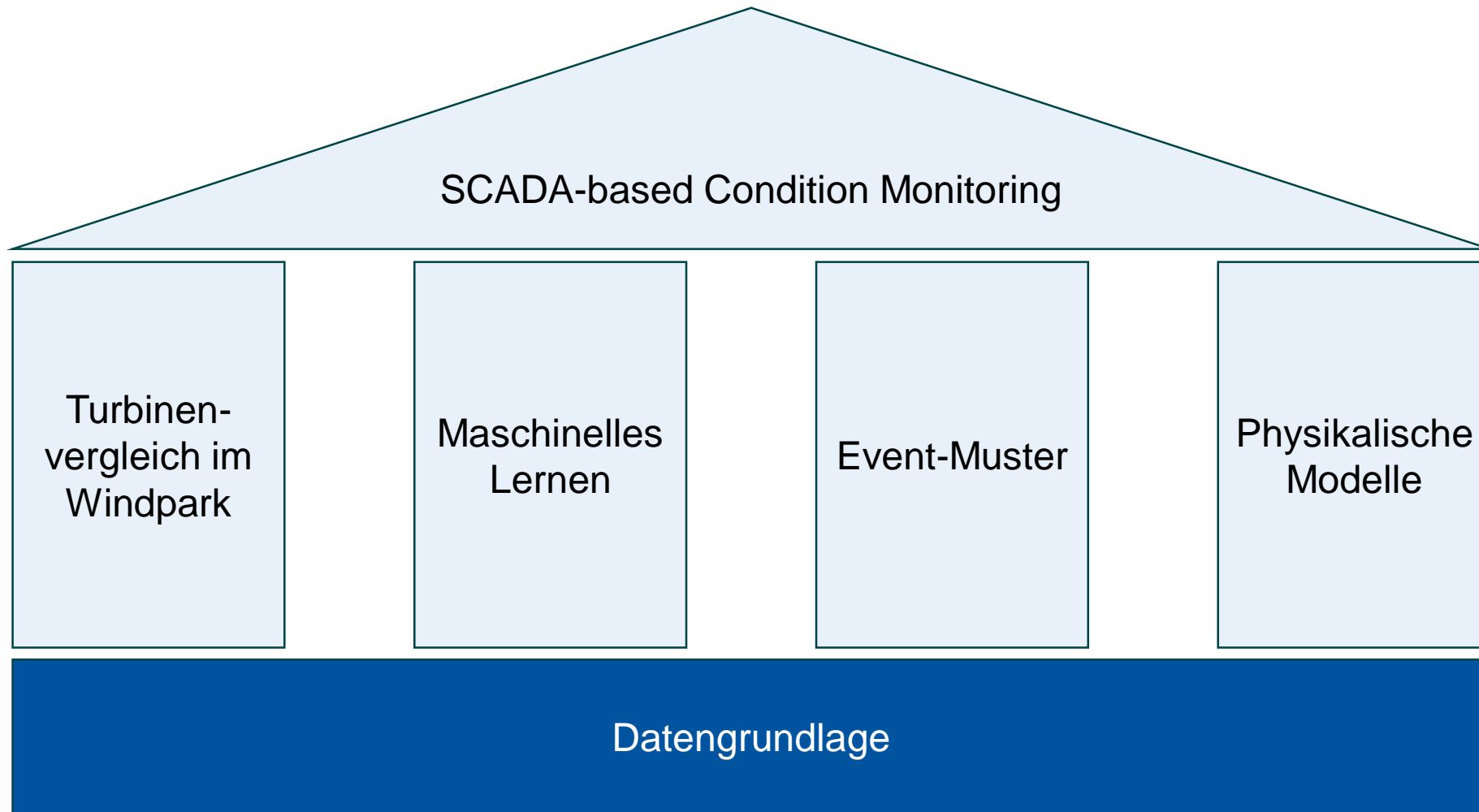
Flexible Multibody Simulation



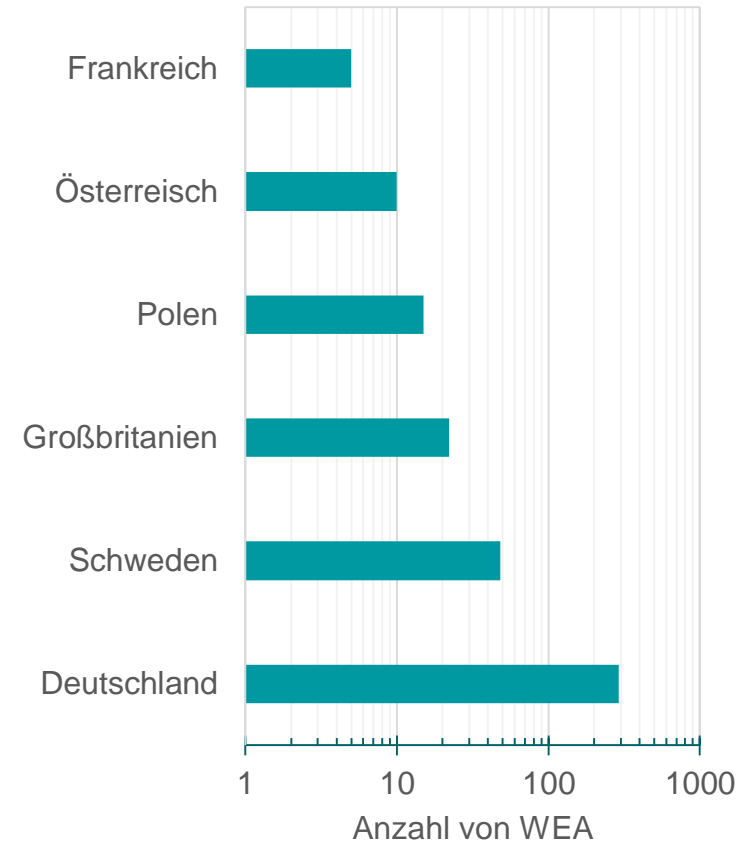
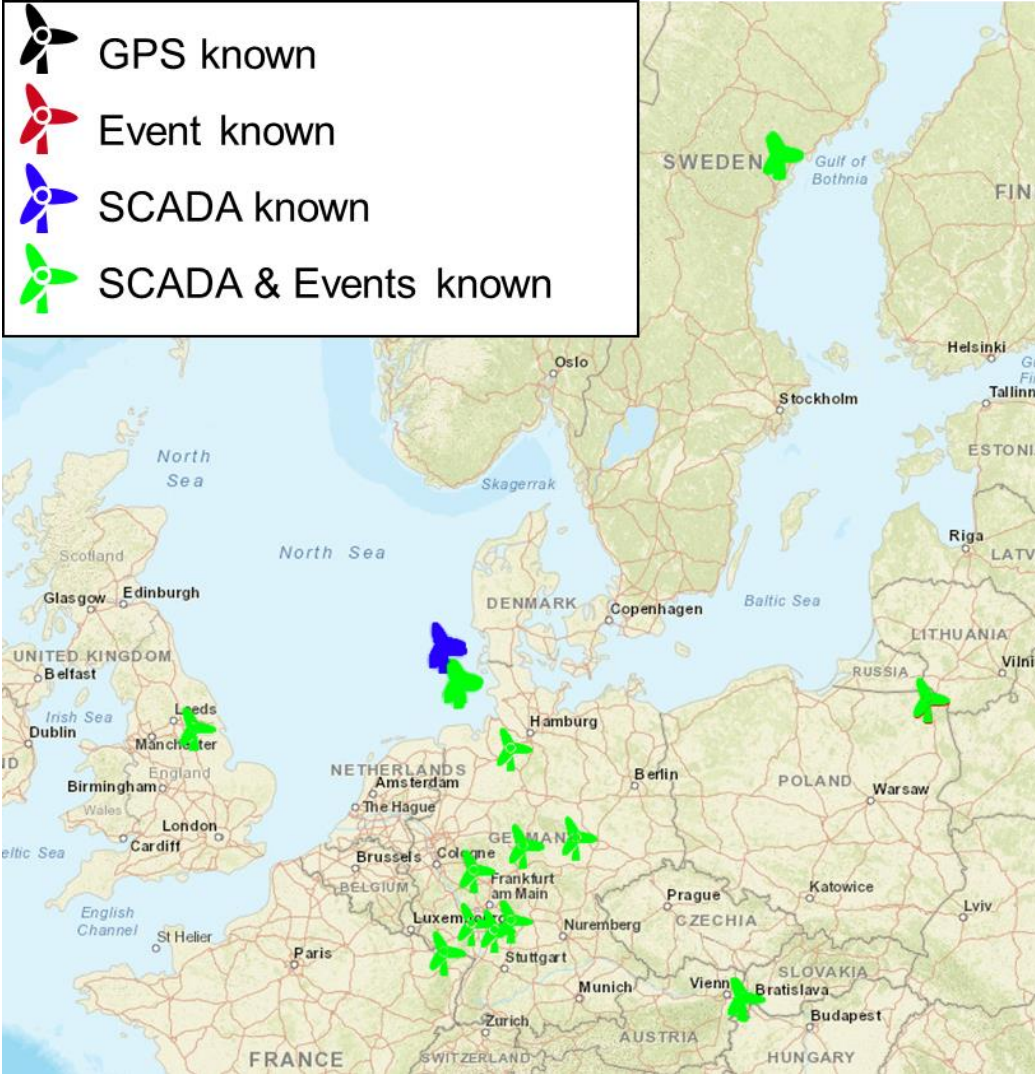
- Test



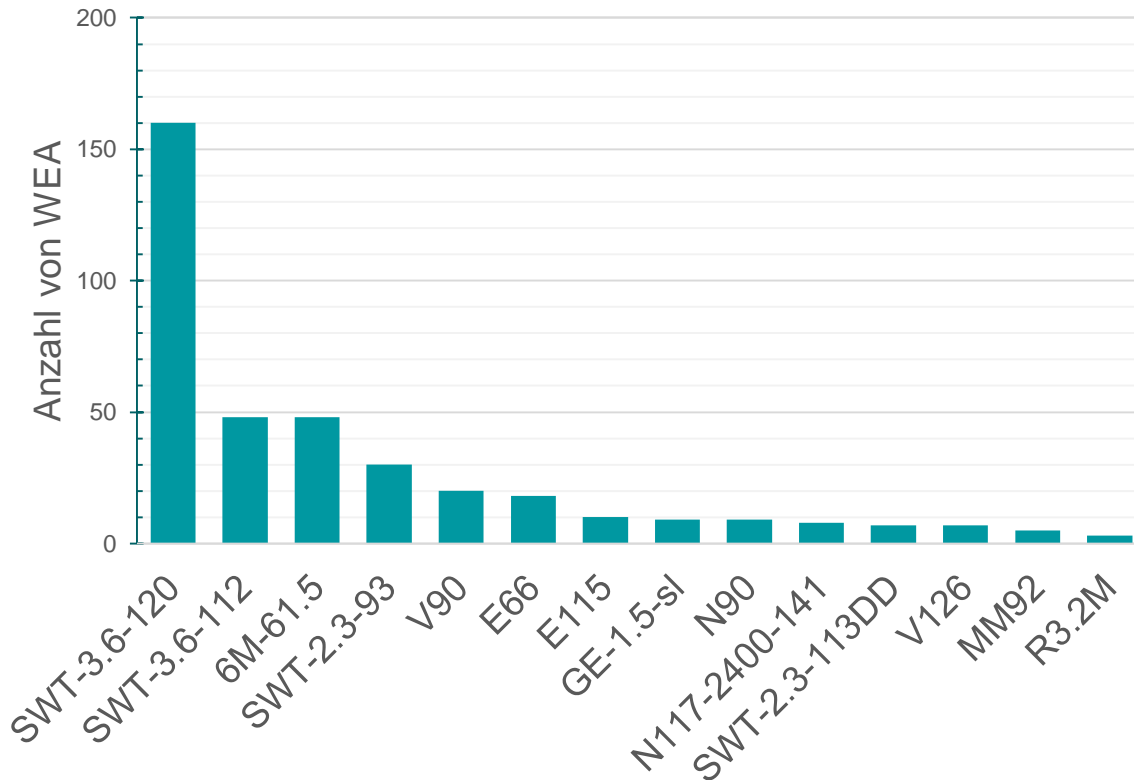




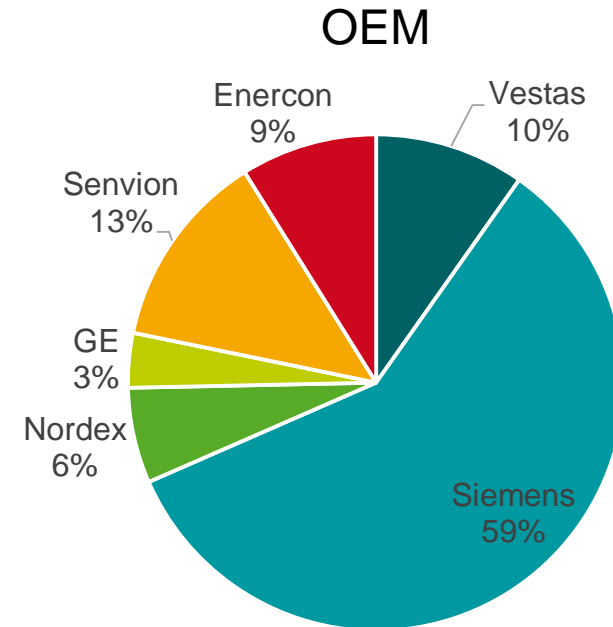
Datengrundlage



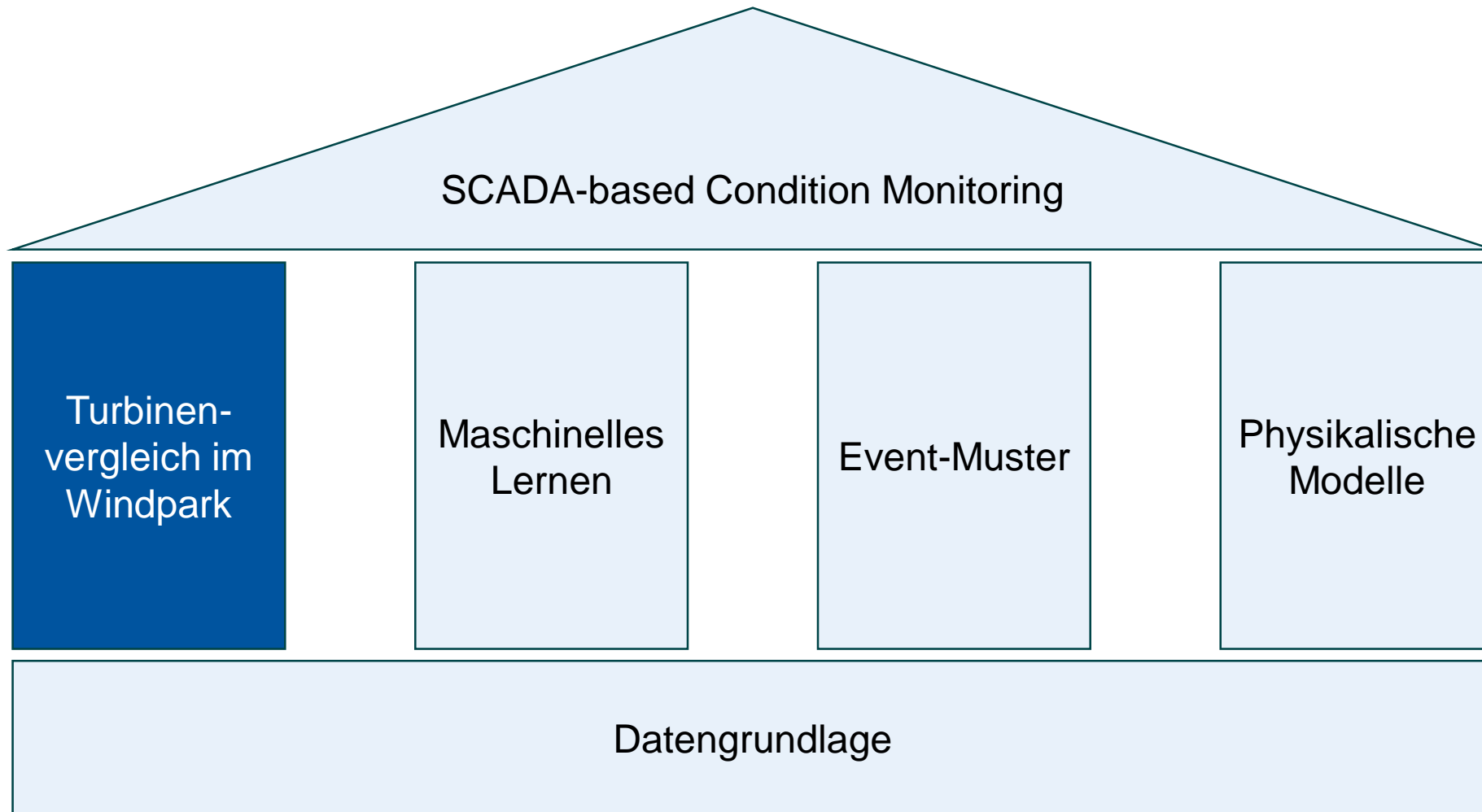
Datengrundlage



Gesamte Anzahl von SCADA Zeitpunkten von 2012-2018
1027 Jahre

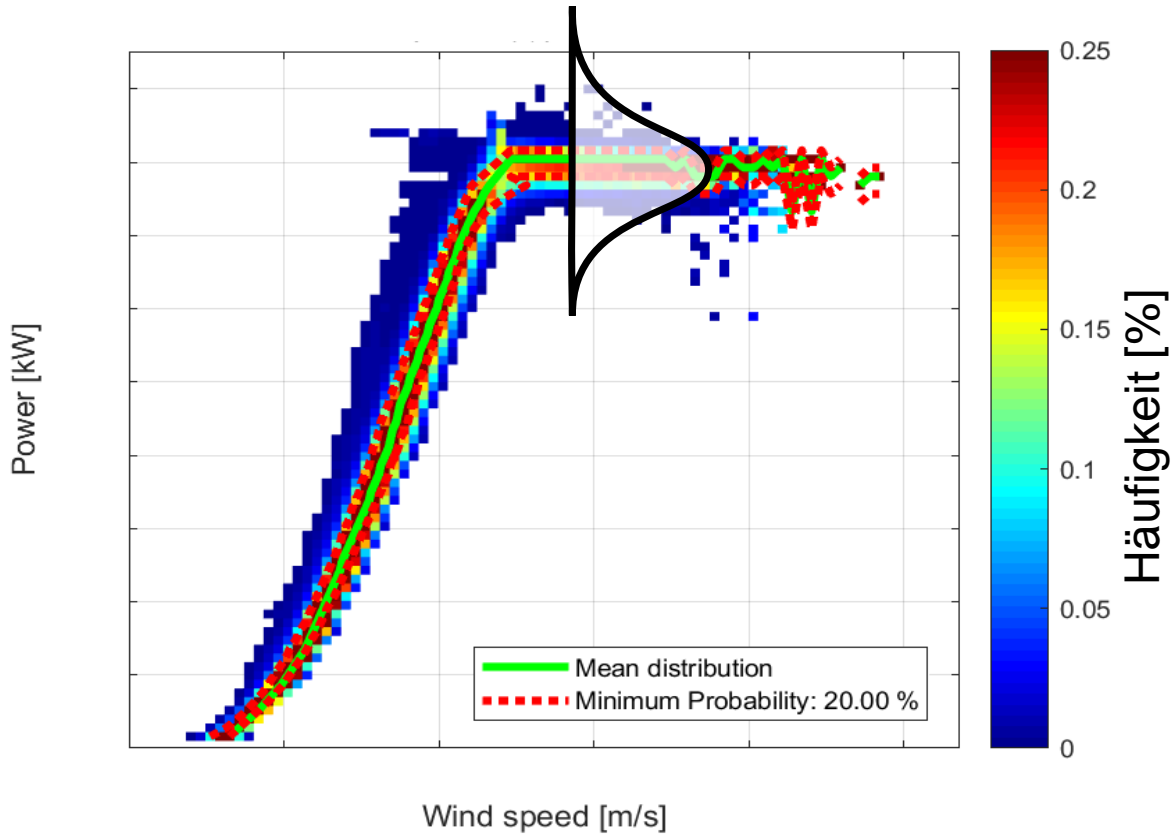


Über 5 TWh

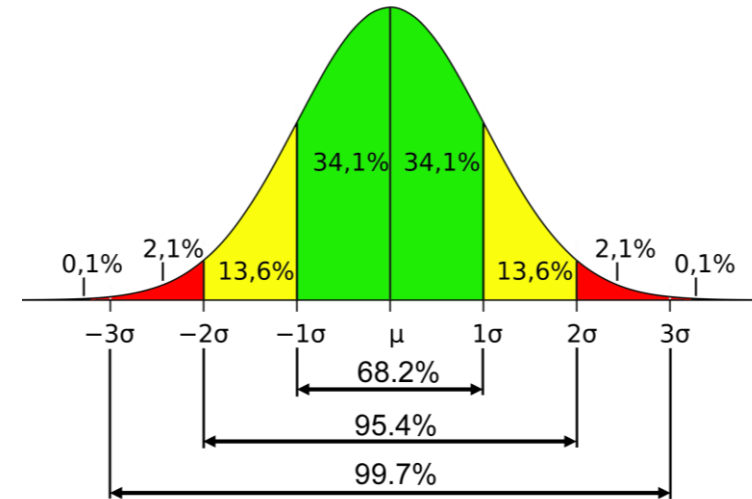


Windparkvergleich

- Erstellung einer idealen Leistungskurve für jeden Windpark

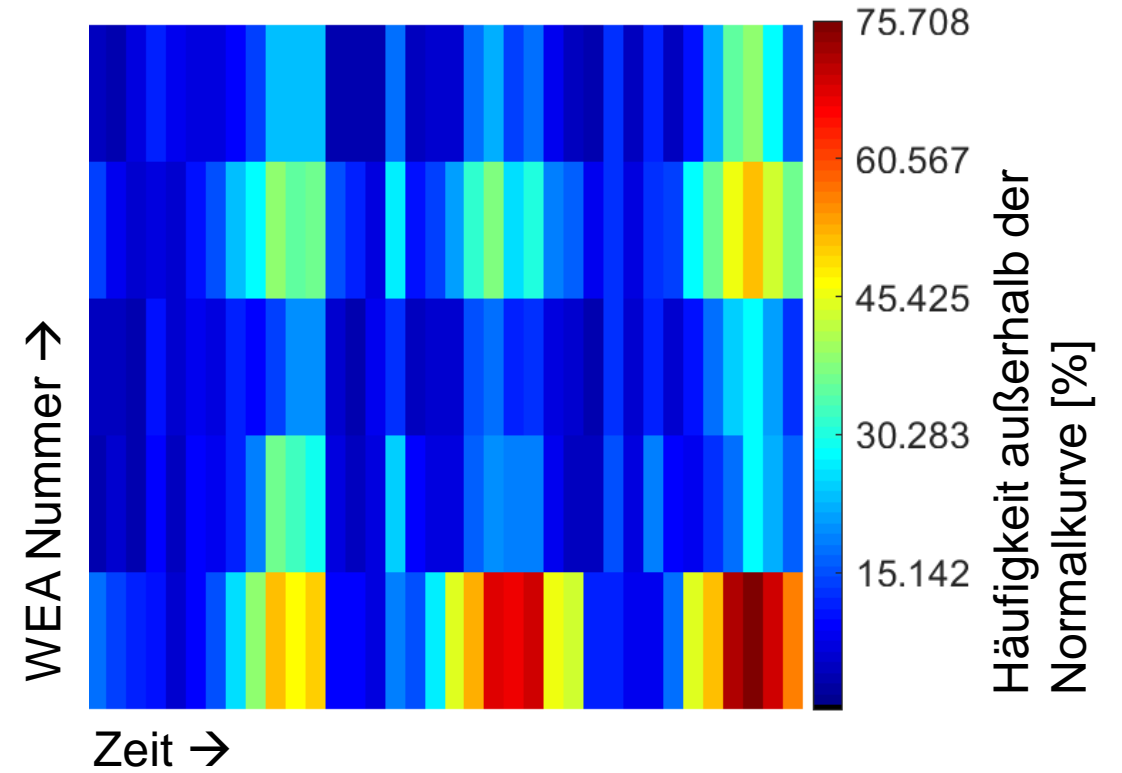
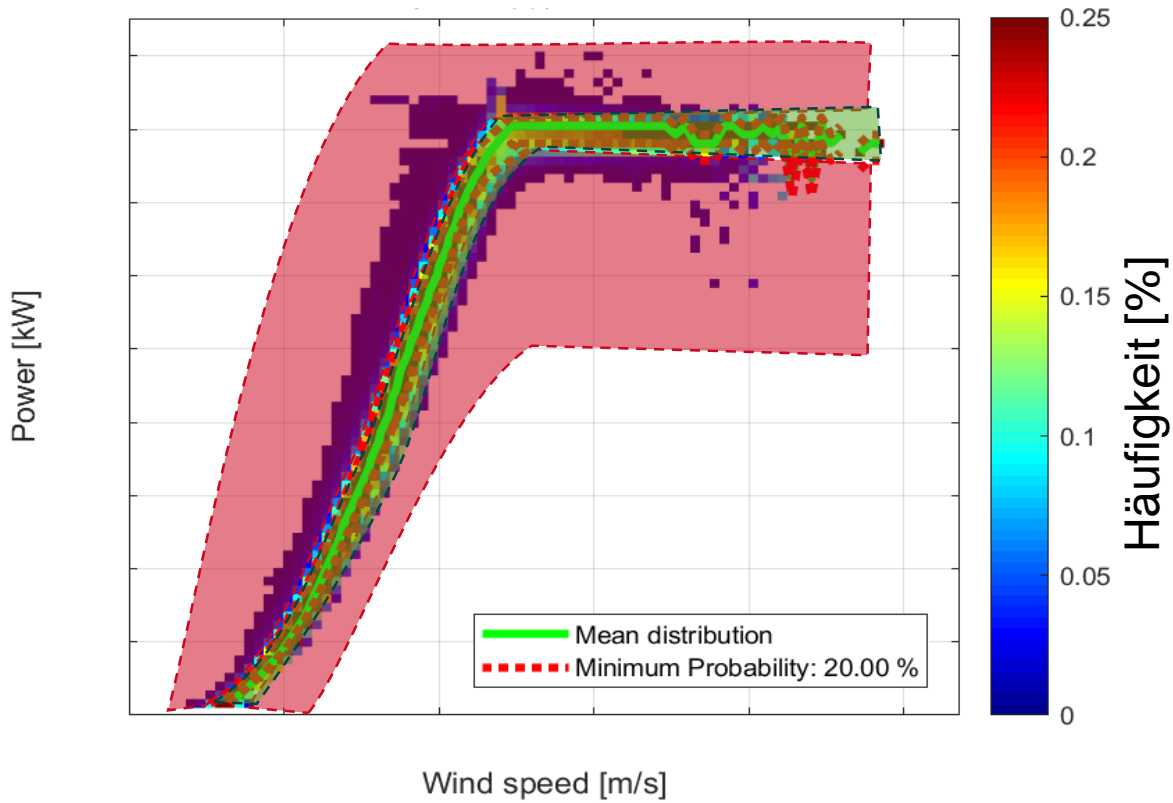


- Verwendung der Bin-Methode für jede Windgeschwindigkeit
 - Zählung der vorliegenden Leistungen



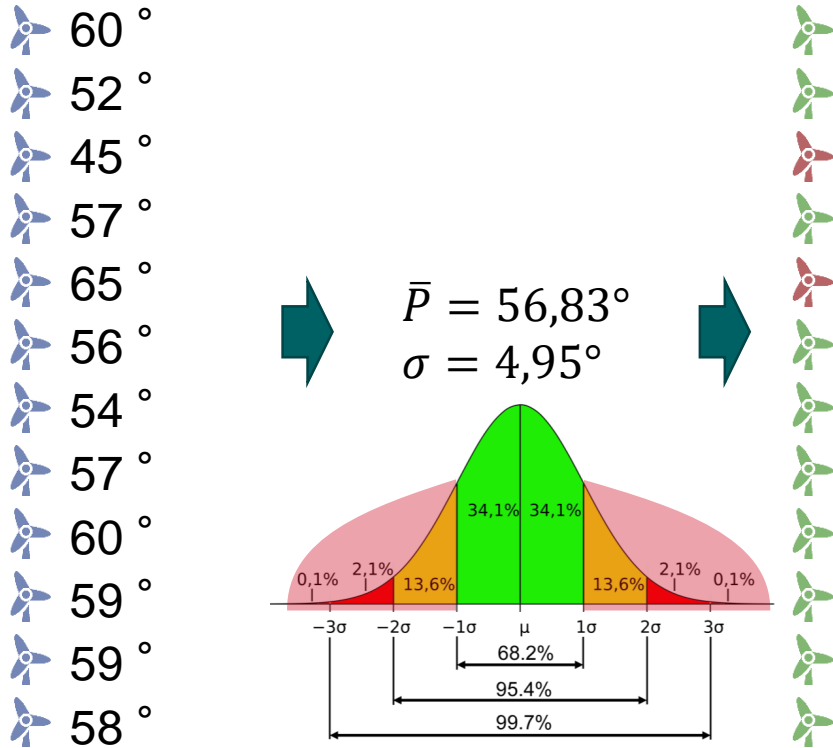
Windparkvergleich

- Erstellung einer idealen Leistungskurve für jeden Windpark

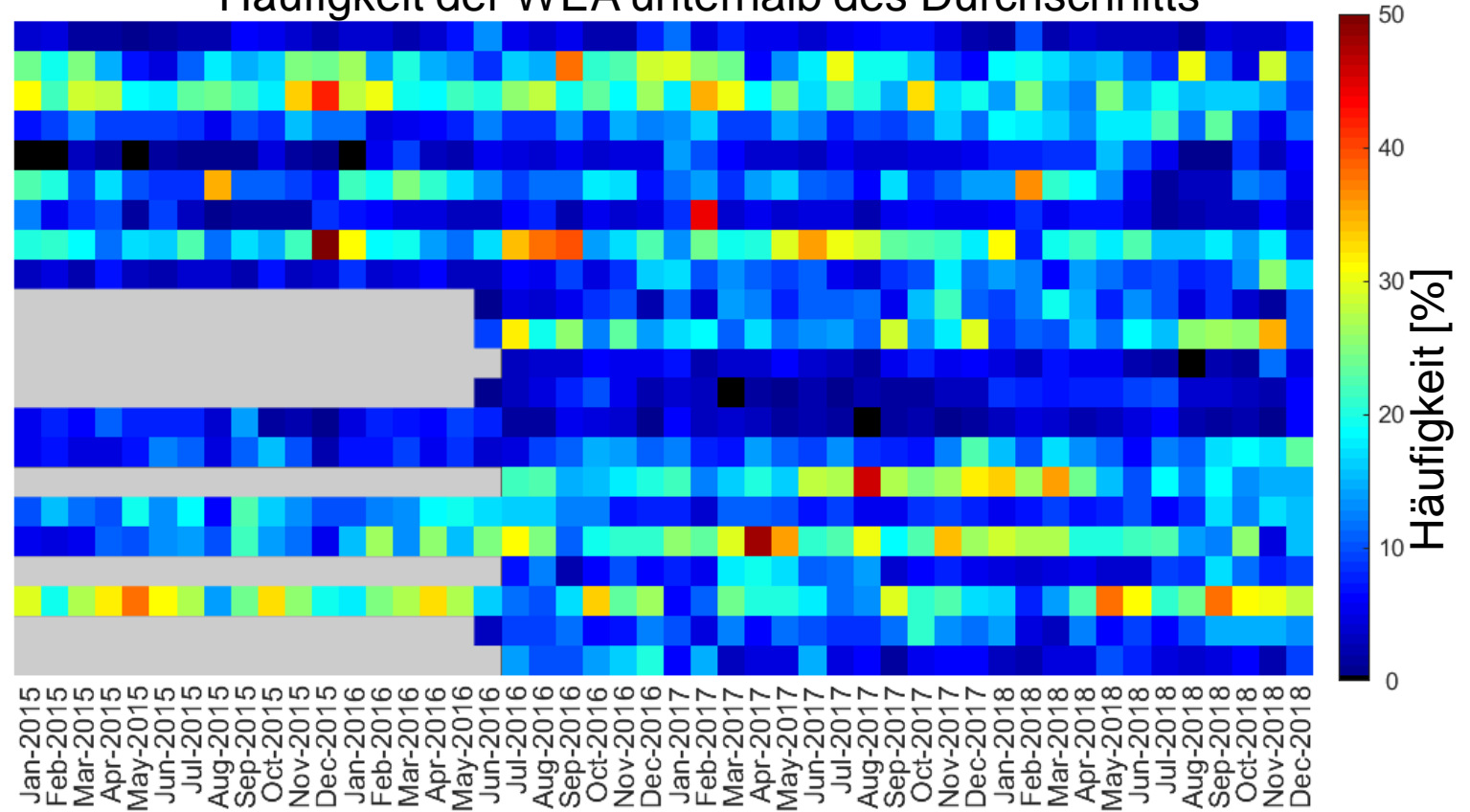


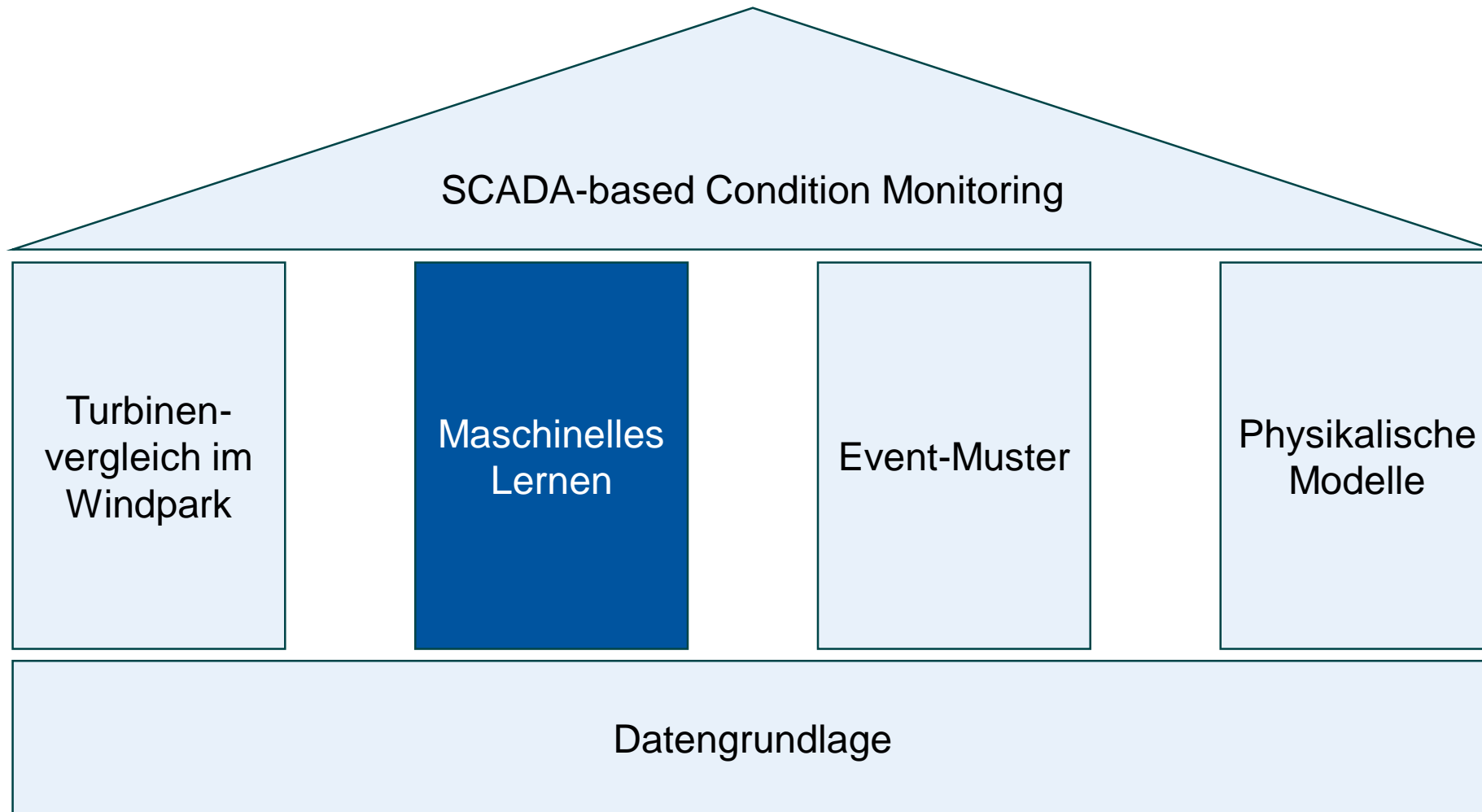
Windparkvergleich

- Vergleich der Lager Temperaturen zwischen den WEA für jeden Zeitpunkt
- Berücksichtigung des aktuellen Betriebs



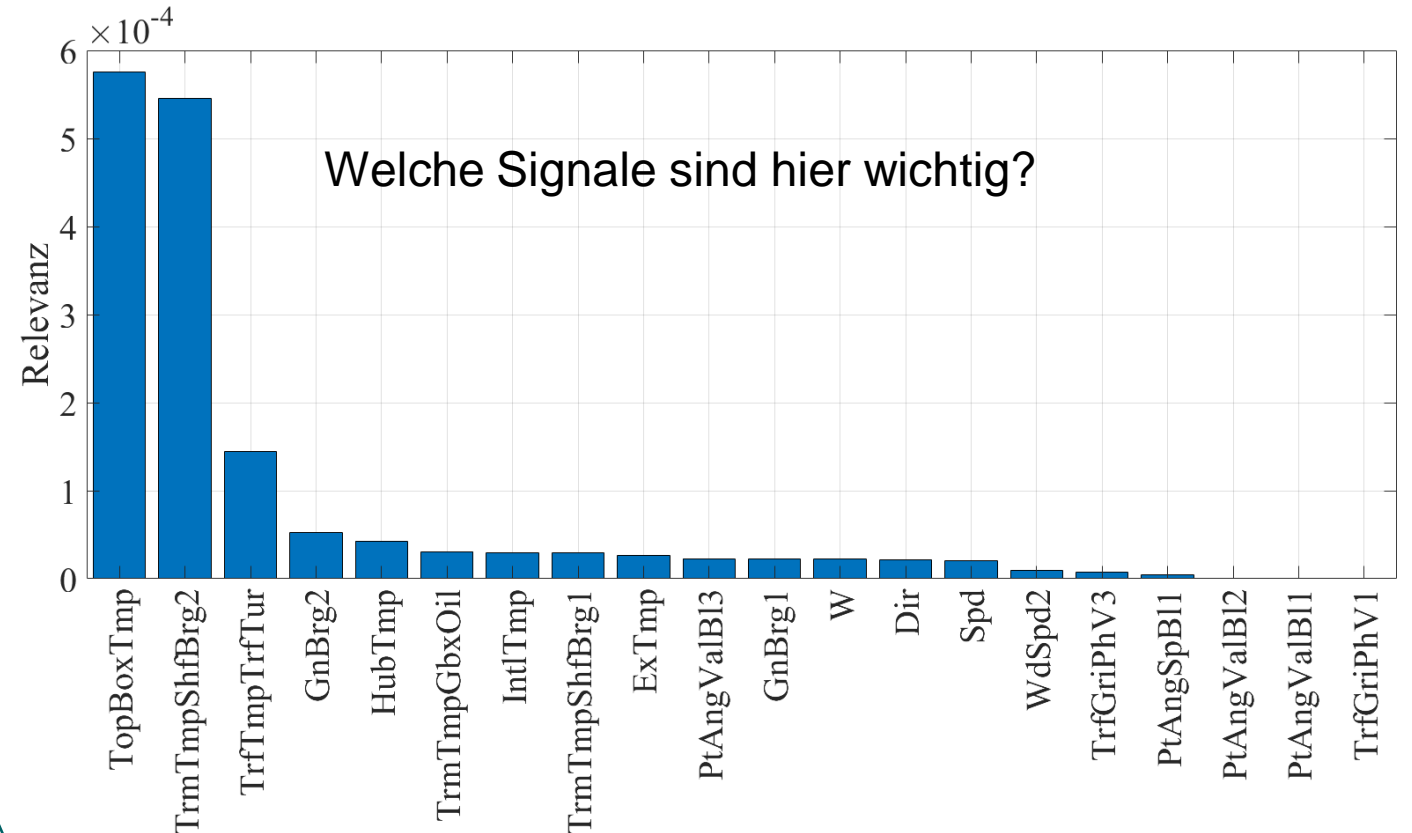
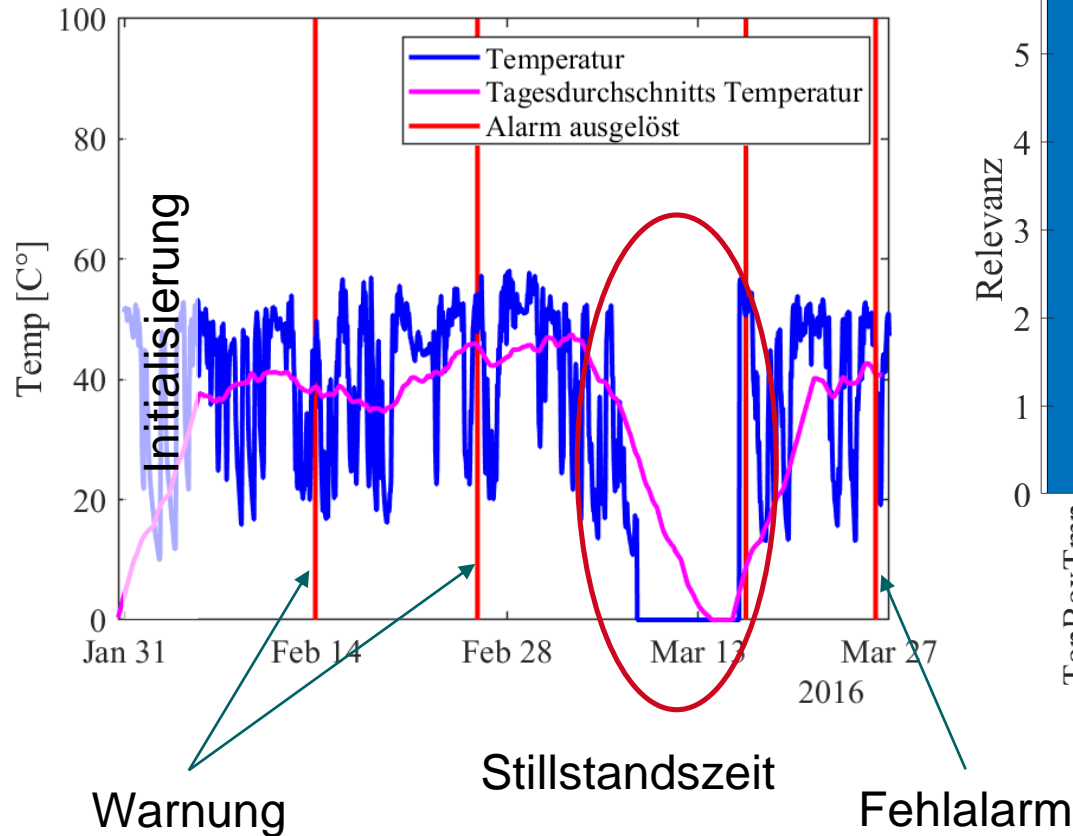
Häufigkeit der WEA unterhalb des Durchschnitts





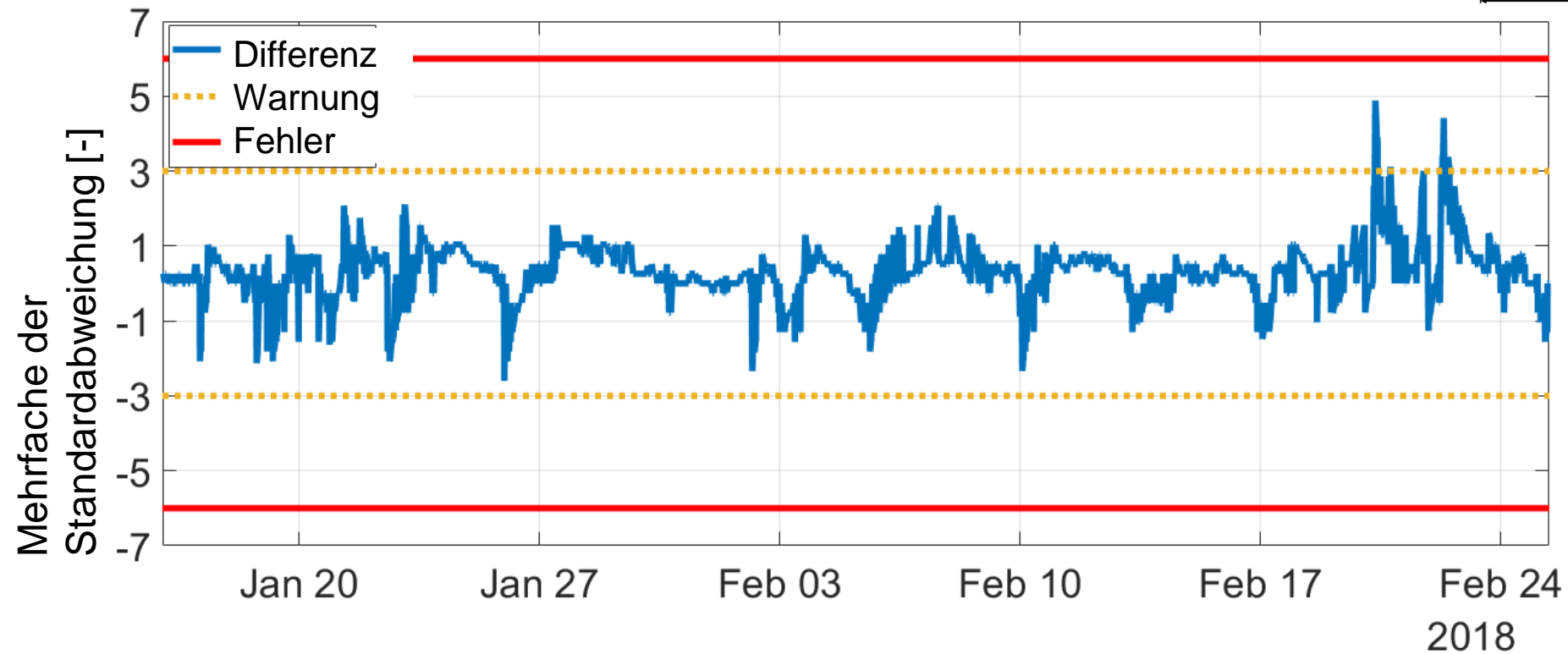
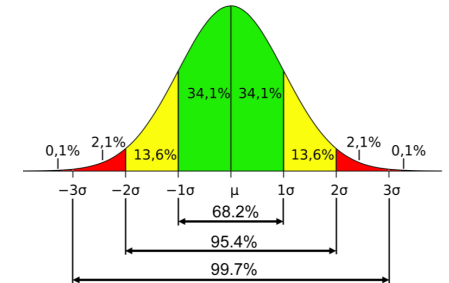
Maschinelles Lernen

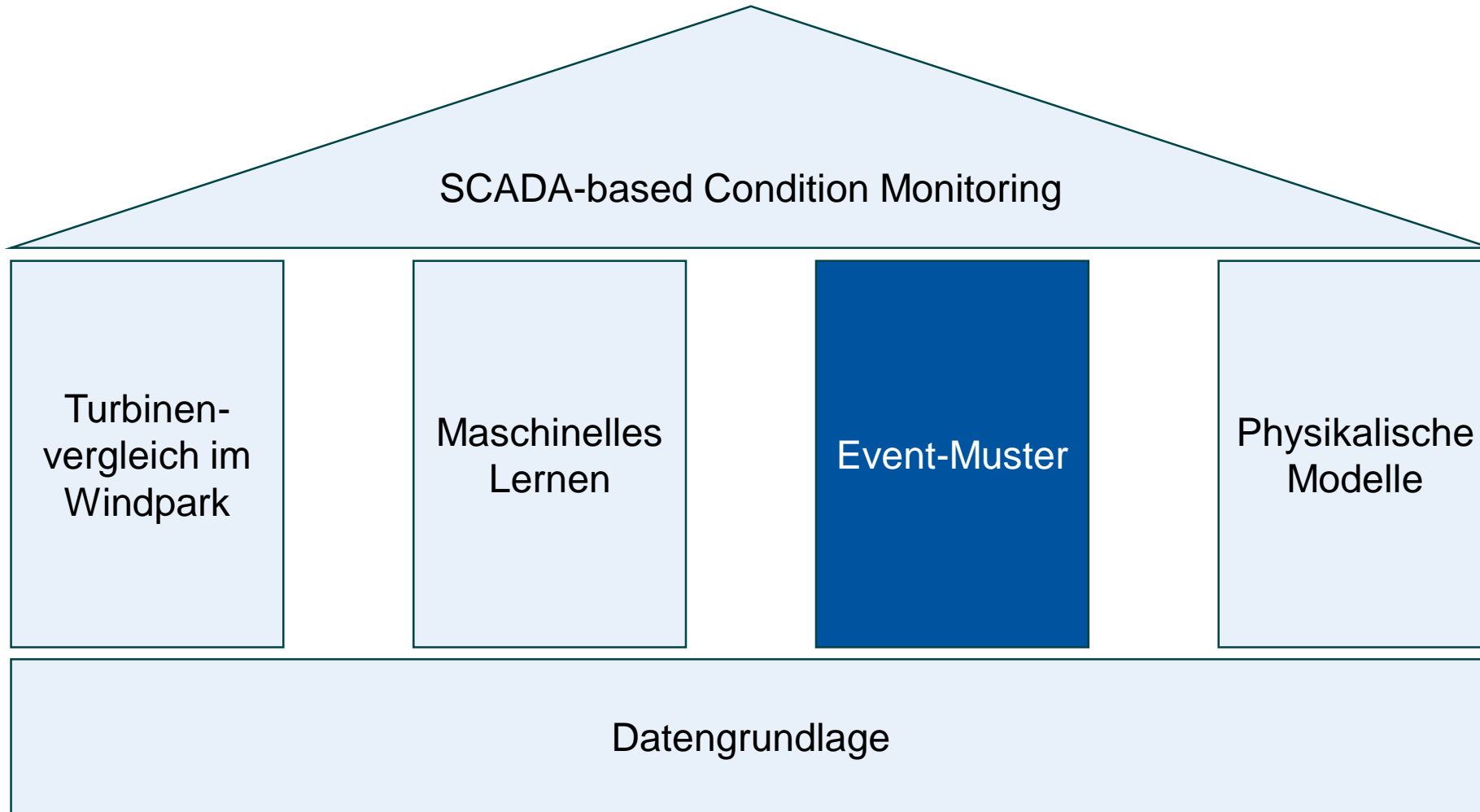
- Verwendung von Feed-Forward Neuronale Netze und Entscheidungsbäumen
 - Stündlich gemittelte Daten
 - Ignorieren von längeren Stillstandzeiten



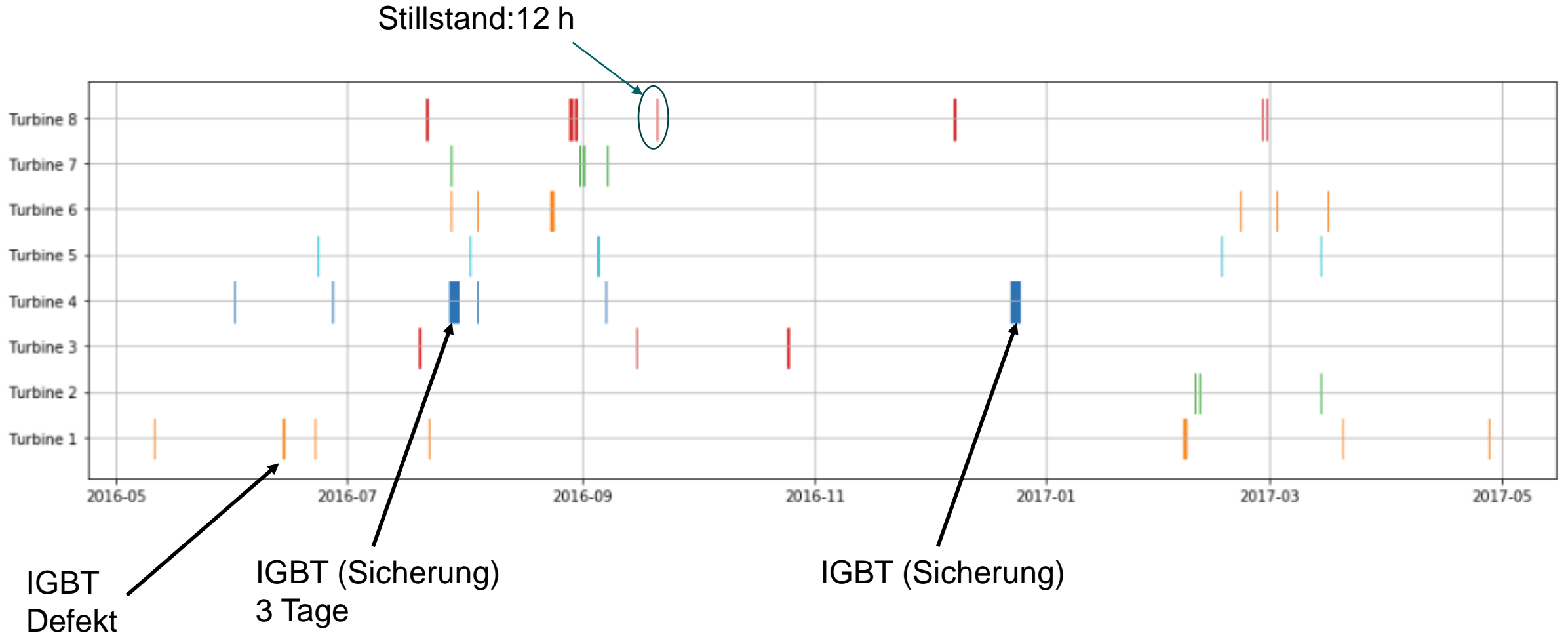
Maschinelles Lernen

- Verwendung von Feed-Forward Neuronale Netze und Entscheidungsbäumen
 - Stündlich gemittelte Daten
 - Ignorieren von längeren Stillstandzeiten
- Beobachtende Simulation in Abgleichung mit Messwerten





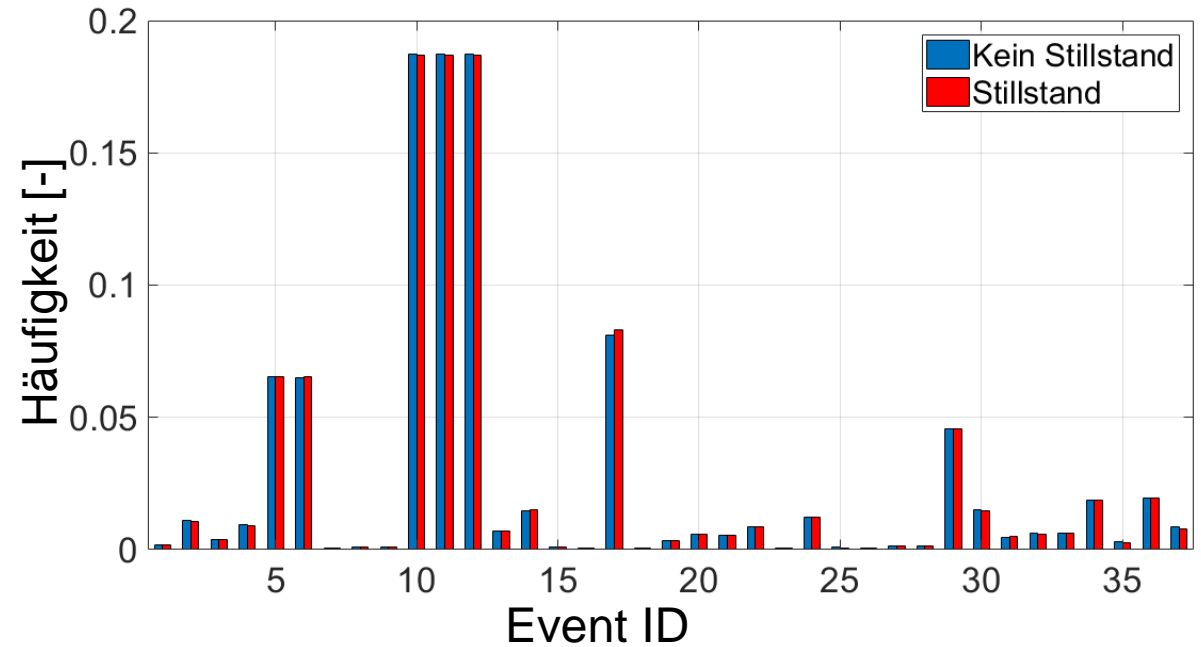
Event-Muster



Event-Muster

- Erstellen einer Sequenz der Events
 - Zeitraum von 2 Wochen
 - Resultierender Stillstand länger als 6 h
 - Zählung der Häufigkeiten der Events
 - Ignorieren von Remote-Zugriffen

Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	⋮	Stillstand (>6h)
31	8	14	0	0	55	52		0
42	38	24	1	1	90	84		1
27	8	26	0	1	63	62		1
27	40	17	0	0	75	67		0
18	2	25	0	0	39	38		1



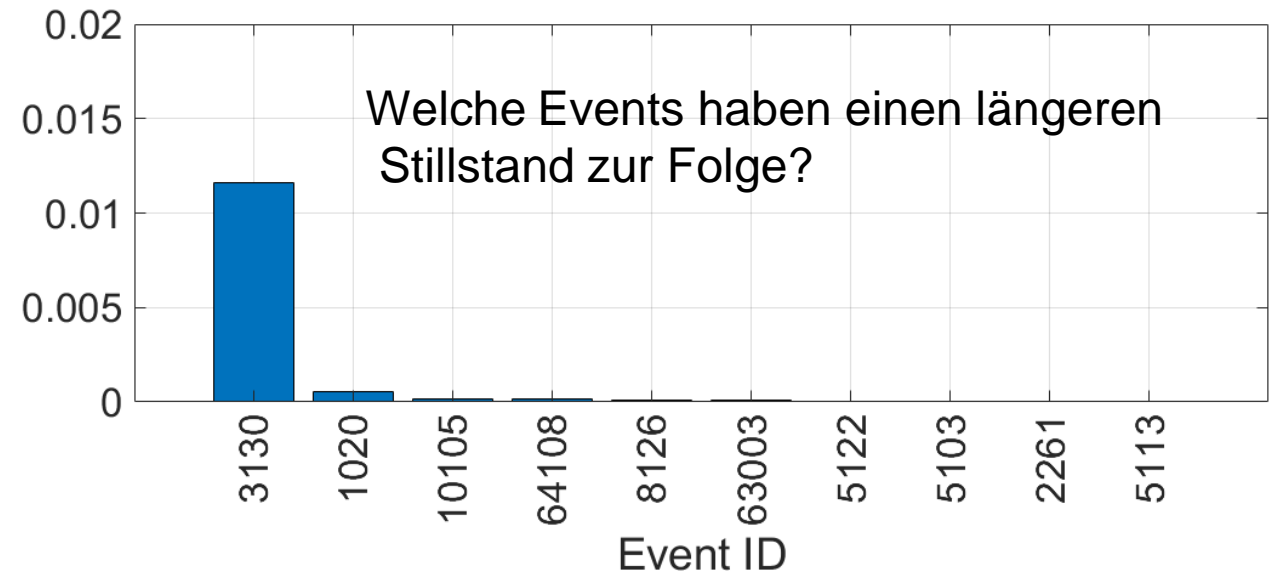
Kein Stillstand	Stillstand
475	425

Stillstand ist unabhängig von der Häufigkeit der meisten Events.

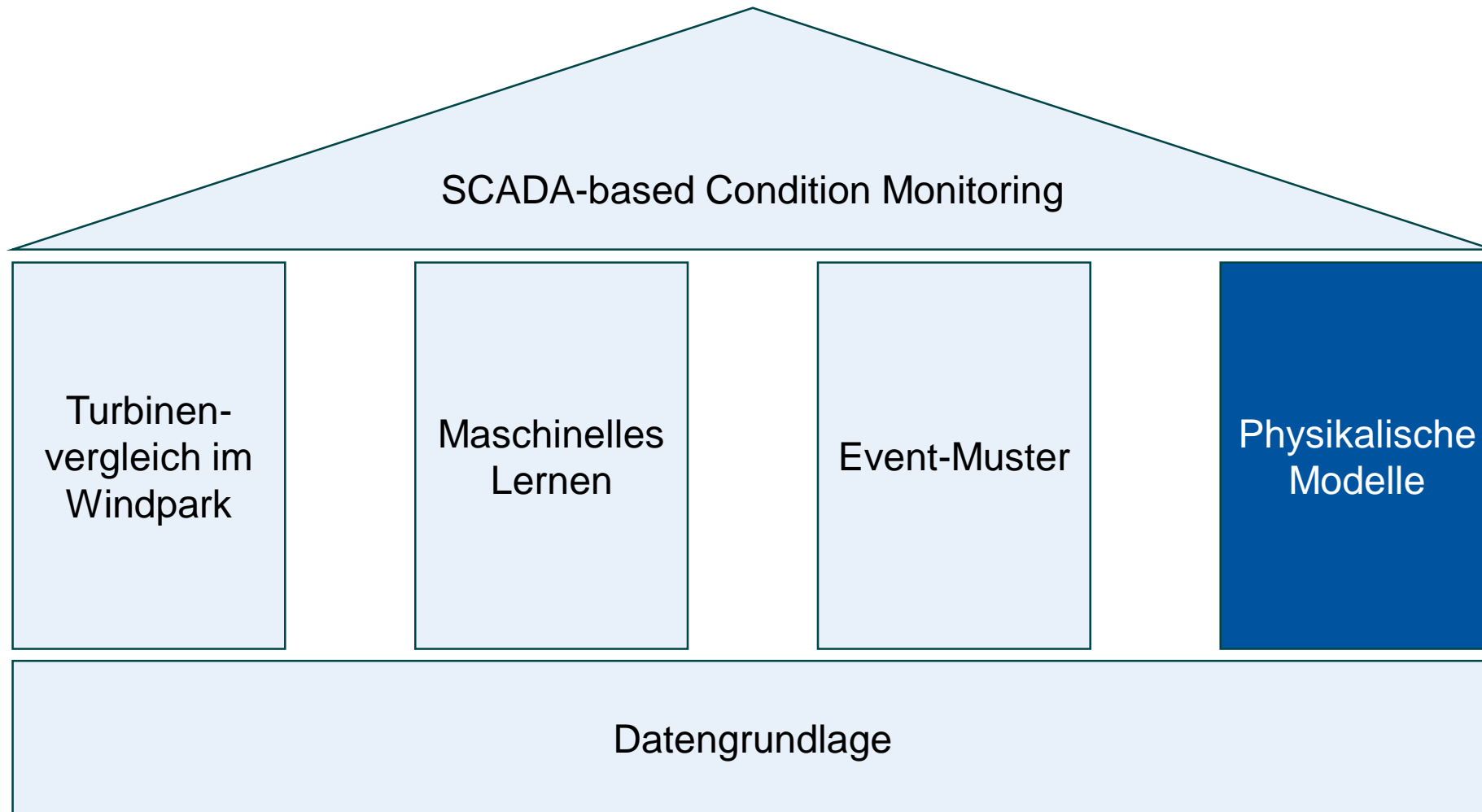
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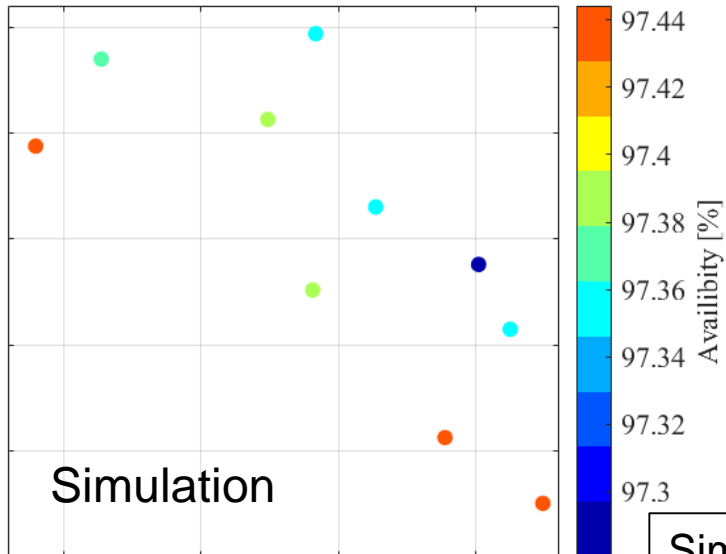
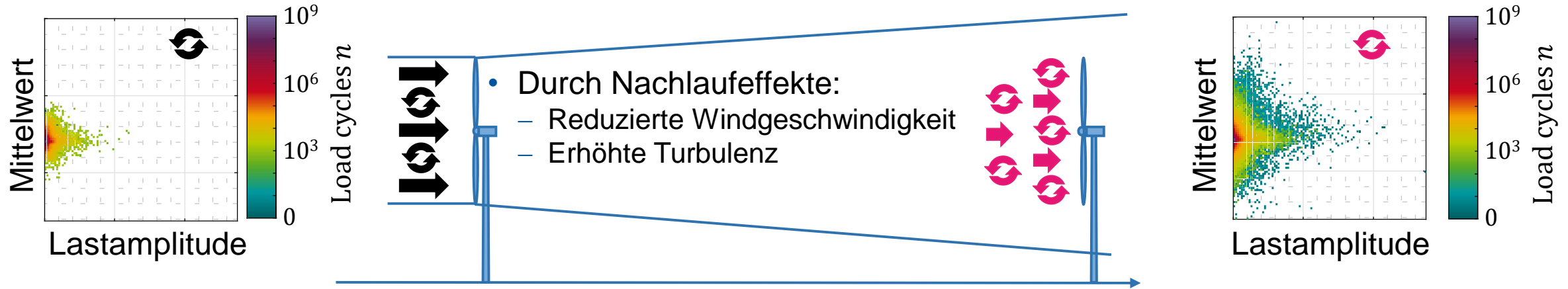
		Realität	
		Kein Stillstand	Stillstand
Vorhersage	Kein Stillstand	89,8%	2,4%
	Stillstand	10,2%	97,6%



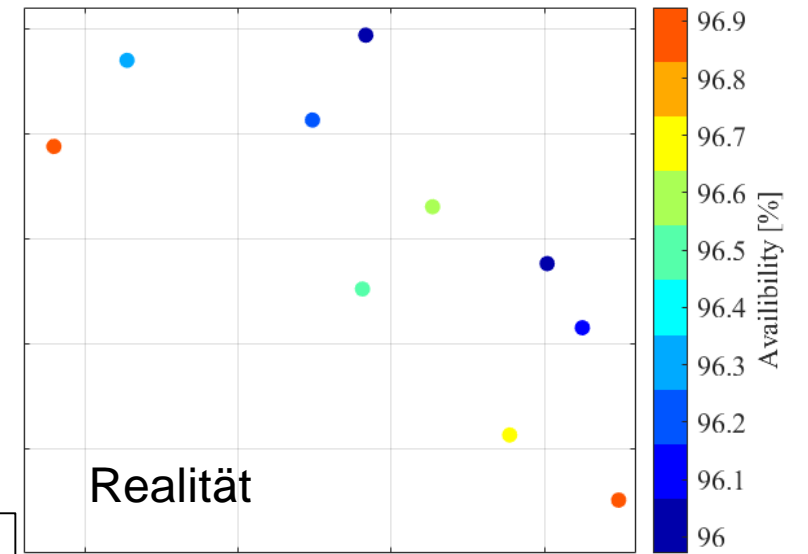
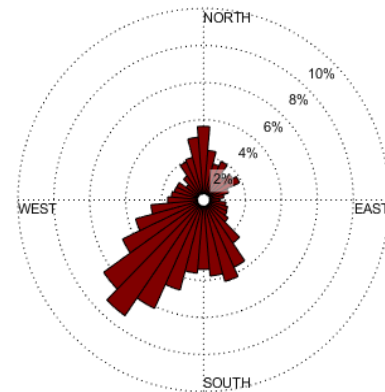
Bei Auftreten bestimmter Events folgt ein Stillstand.



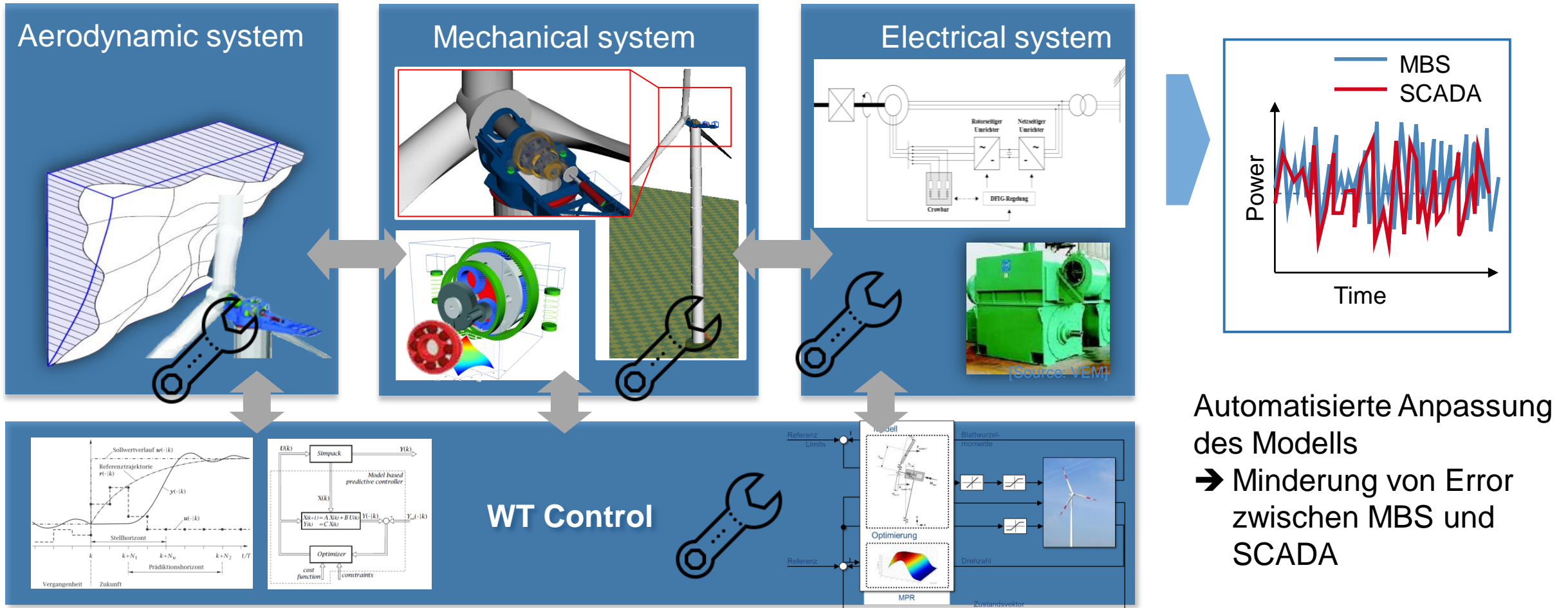
Physikalische Modelle



Windverteilung



Simulation und Messung zeigen ähnliche Trends.



**Thank you
for your Attention!**