ESTABLISHING A COMMON DATABASE

FOR TURBINE FAILURES

Dipl.-Wi.-Ing. P. Lyding
Dipl.-Ing. M.Sc. Stefan Faulstich , M.Sc. Paul Kühn
Fraunhofer Institute for Wind Energy and Energy System Technology (IWES)

Fraunhofer IWES

The Fraunhofer Society in Germany

60 Institutes at 40 locations

2010

Staff	18 000
R&D-budget	1 650 Million €

Bremerhaven

Kassel

Fraunhofer IWES

Fraunhofer Institute for Wind Energy and Energy System Technology (IWES)

Bremerhaven and Kassel

Advancing Wind Energy and Energy System Technology

Research spectrum:

- Wind energy from material development to grid optimization
- Energy system technology for all renewables

Foundation: 2009 **Annual budget:** approx. 22 million euros

Personal: approx. 230 (full-time: 160)

Directors: Prof. Dr. Andreas Reuter, Prof. Dr. Jürgen Schmid

Formerly:

- Fraunhofer Center for Wind Energy and Maritime Engineering CWMT in Bremerhaven
- Institute for Solar Energy Technology ISET in Kassel

Fraunhofer IWES

ESTABLISHING A COMMON DATABASE

- Introduction
  - Motivation
  - Maintenance strategies / organization
  - Value of experience
- Failure Databases
  - Past
  - Present
  - Future
- Conclusions & Outlook

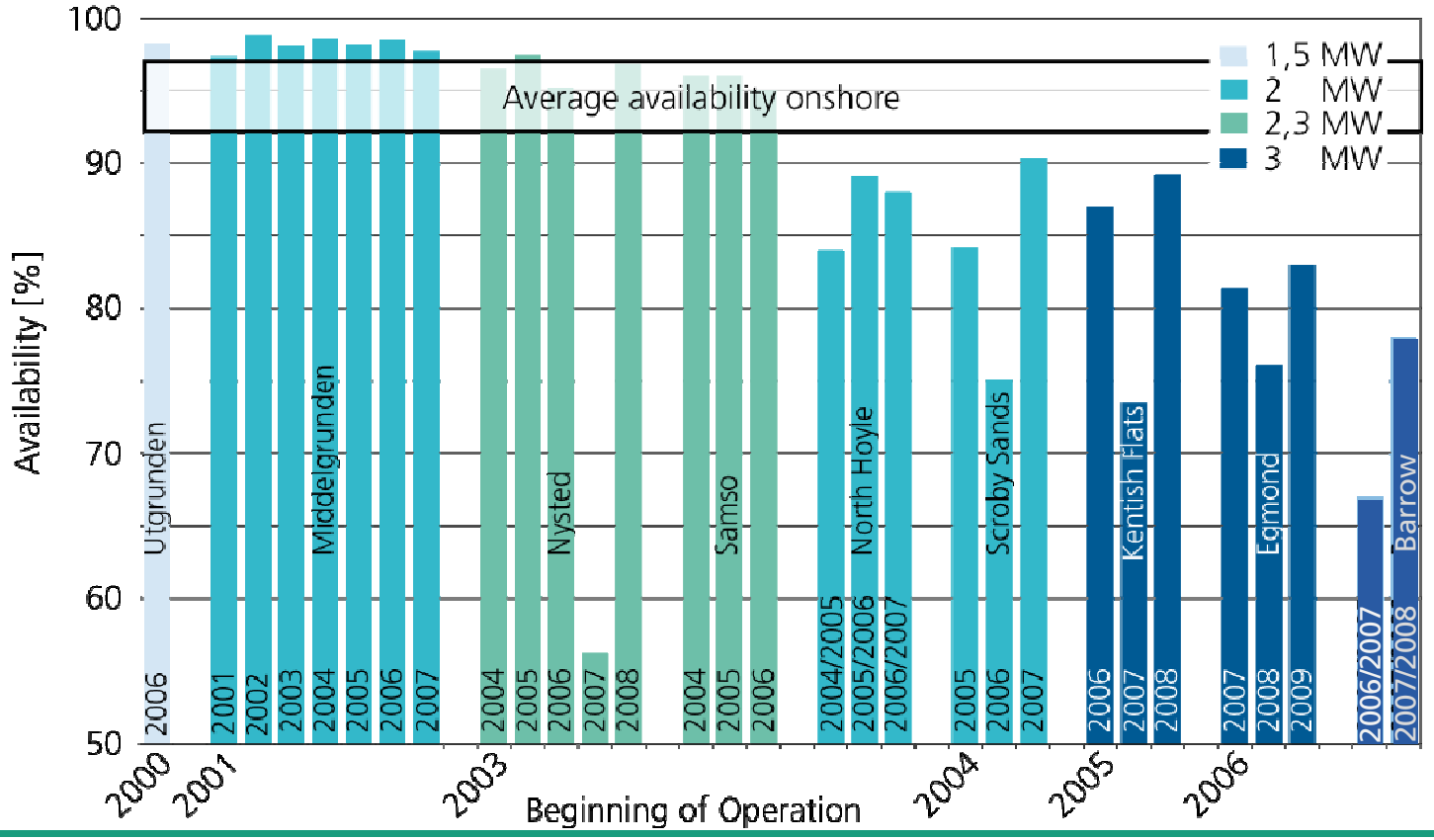
Introduction

Motivation

Starting Point: Modern wind turbines achieve high availability

Number of faults cause unplanned downtimes ➔ high maintenance efforts and costs

Offshore: drop of availability expected

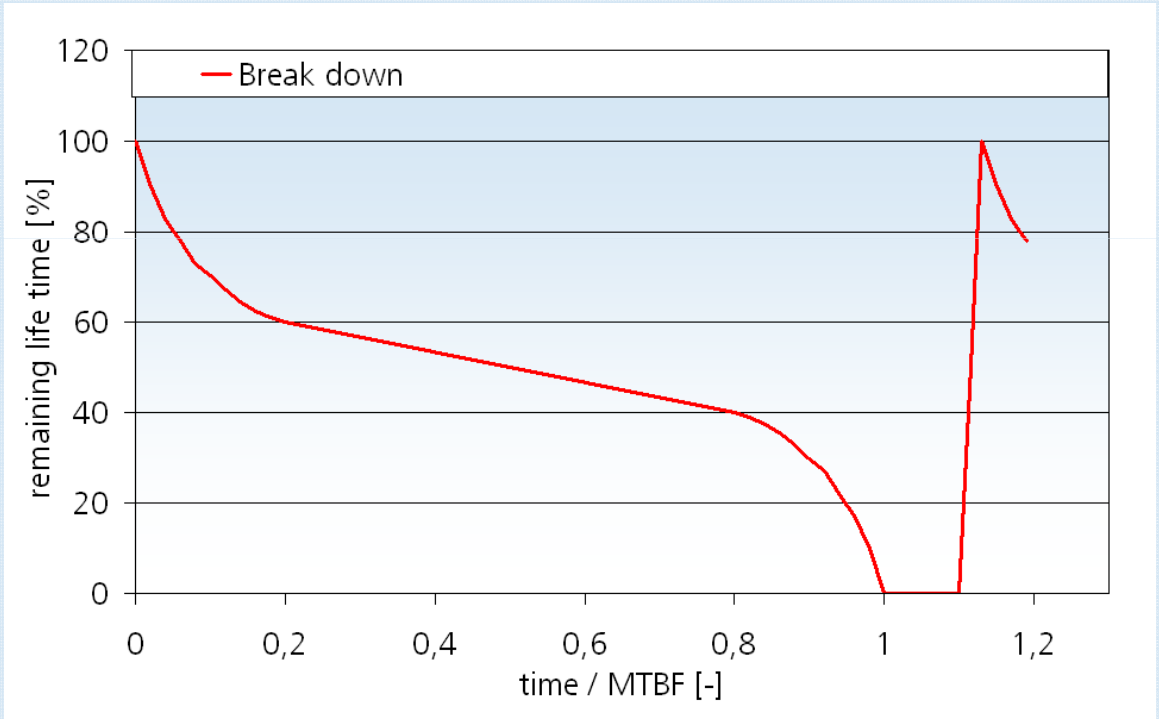


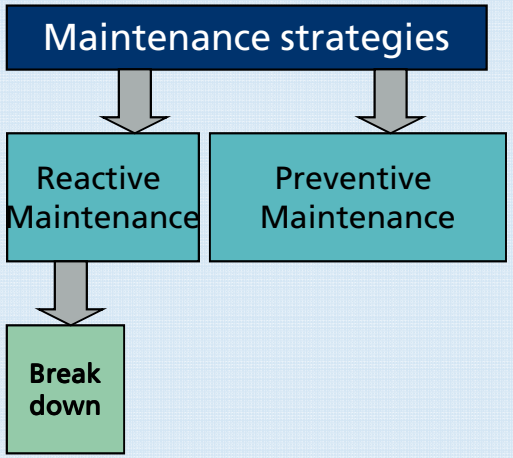
Fraunhofer IWES

Introduction

Maintenance strategies

It can be distinguished between reactive and preventive maintenance strategies.
Within the break down maintenance strategy the system will be operated until a major failure of a component will result in a shut down

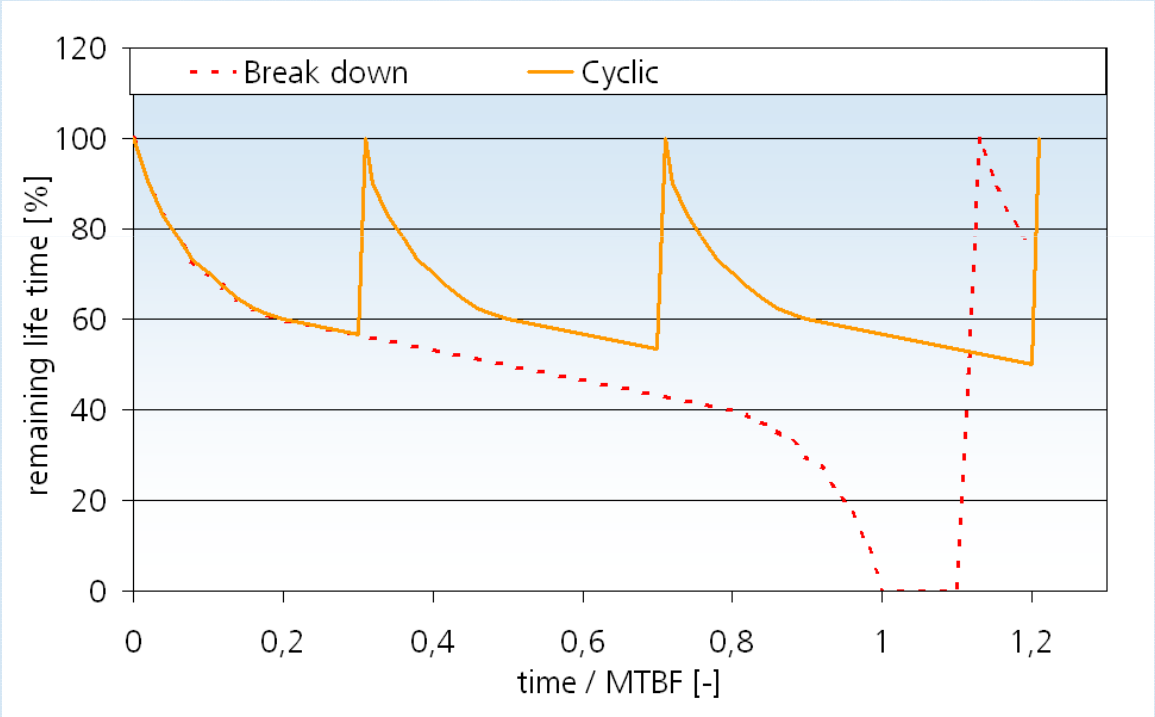


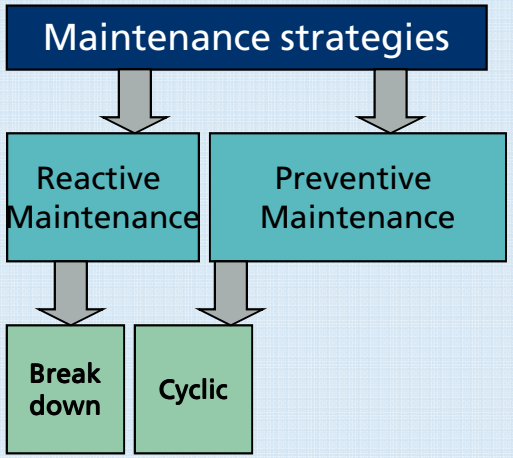


Introduction
Maintenance strategies

Preventive maintenance strategies try to react before a failure occurs

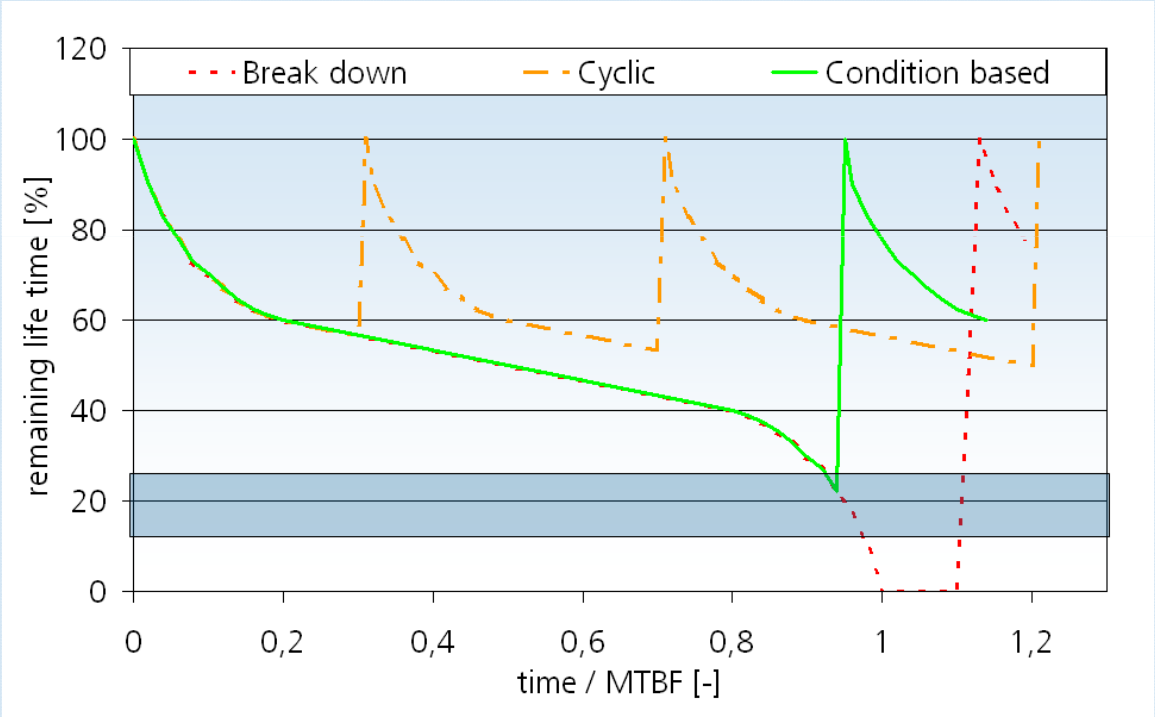
With the cyclic maintenance strategy components of the wind turbine will be inspected and maintained cyclically, e. g. on semi annual intervals

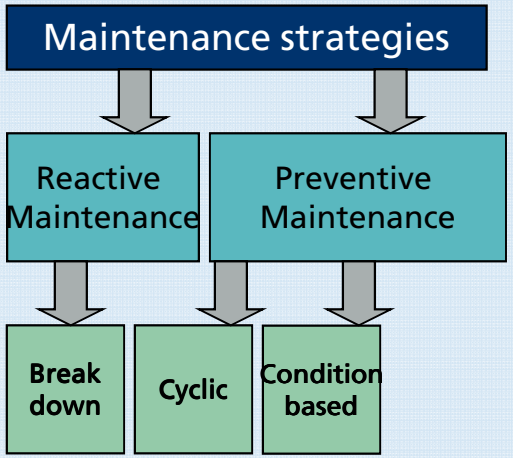




Introduction
Maintenance strategies

The condition based maintenance strategy tries to find the optimum point in time for carrying out the required maintenance actions by monitoring the current state of a specific component

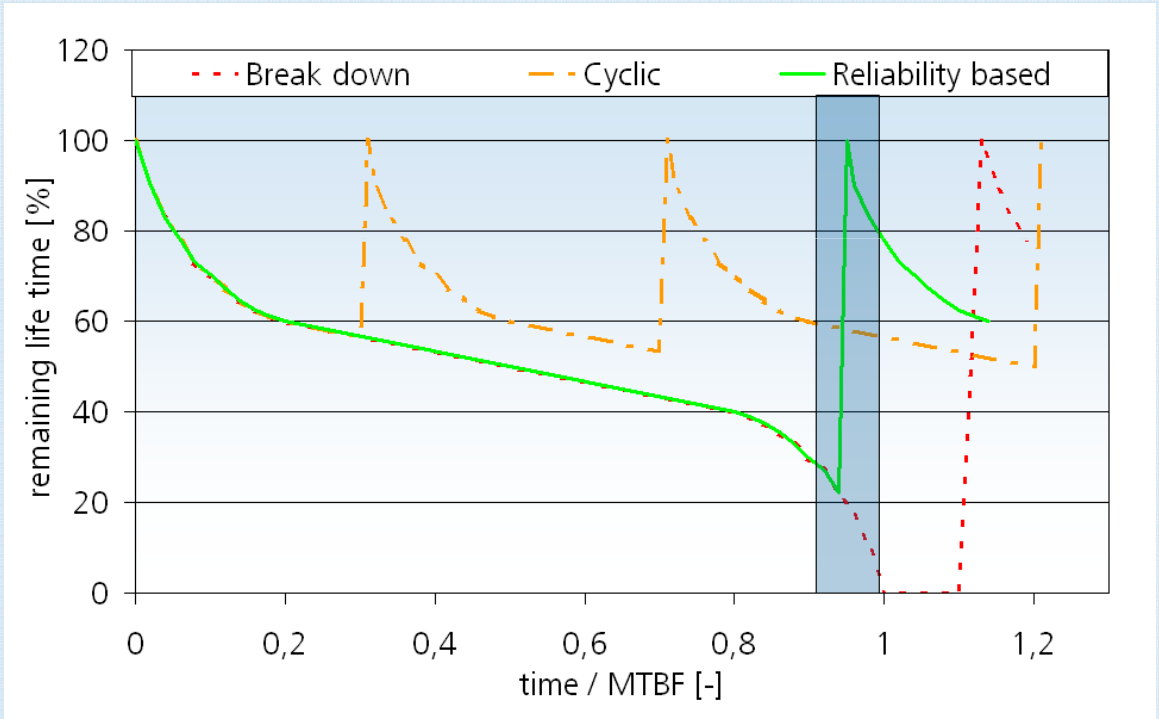


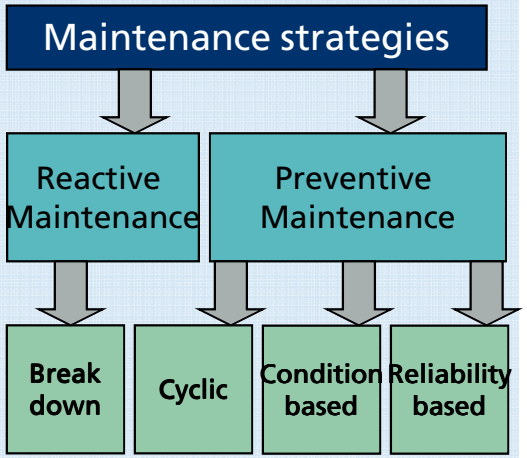


Fraunhofer IWES

Introduction
Maintenance strategies

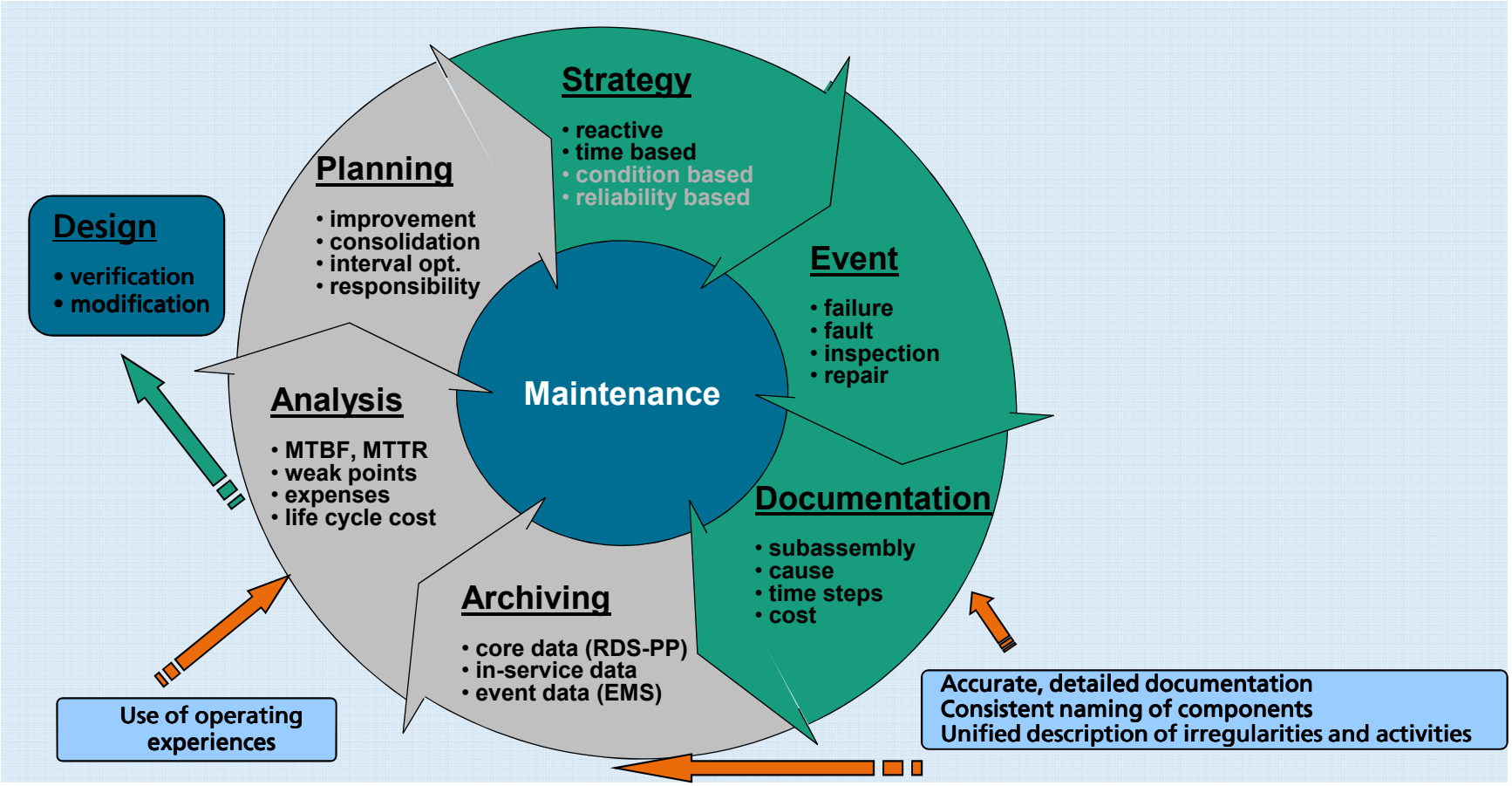
The reliability based maintenance tries to find the right time for maintenance measures through analysing a broad database filled with experiences from the past





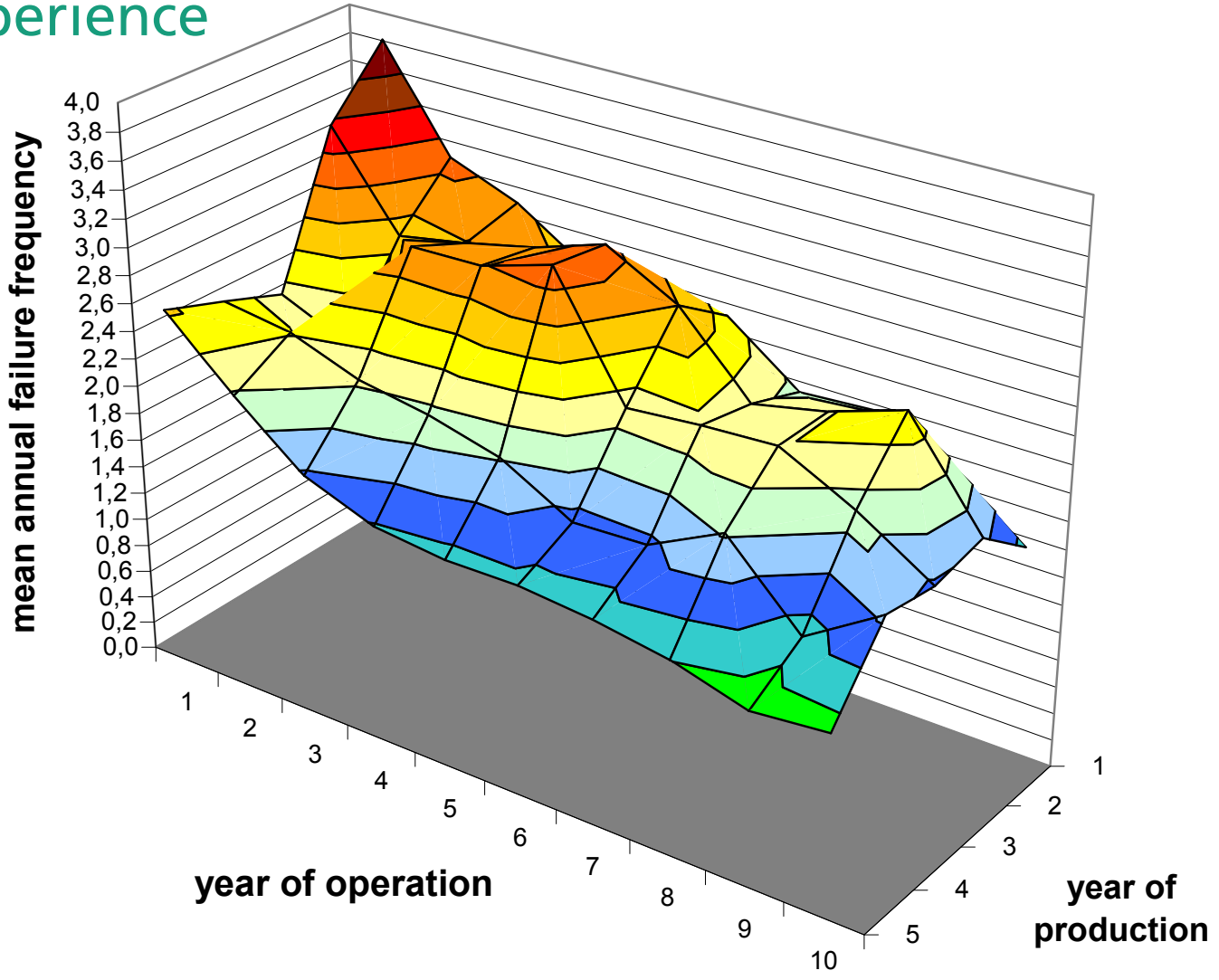
Introduction
Maintenance organisation

- Lacking of a closed maintenance loop



Fraunhofer IWES

Introduction
Value of Experience



Fraunhofer IWES

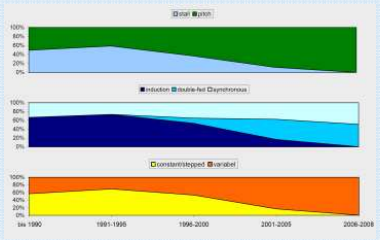
Failure Database – WMEP

Past

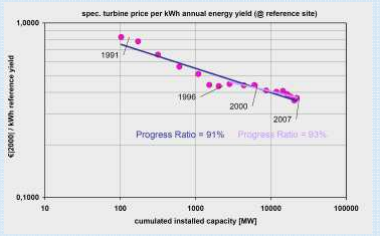
Scientific **M**easurement and **E**valuation **P**rogram („250 MW Wind“ (1989-2006))

193.000 monthly operation reports
and 64.000 Incident reports
from 1.500 wind turbines

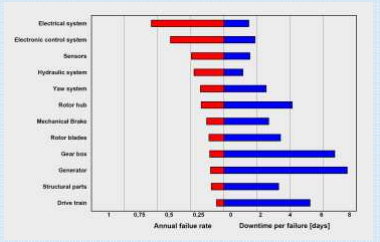
Technology development

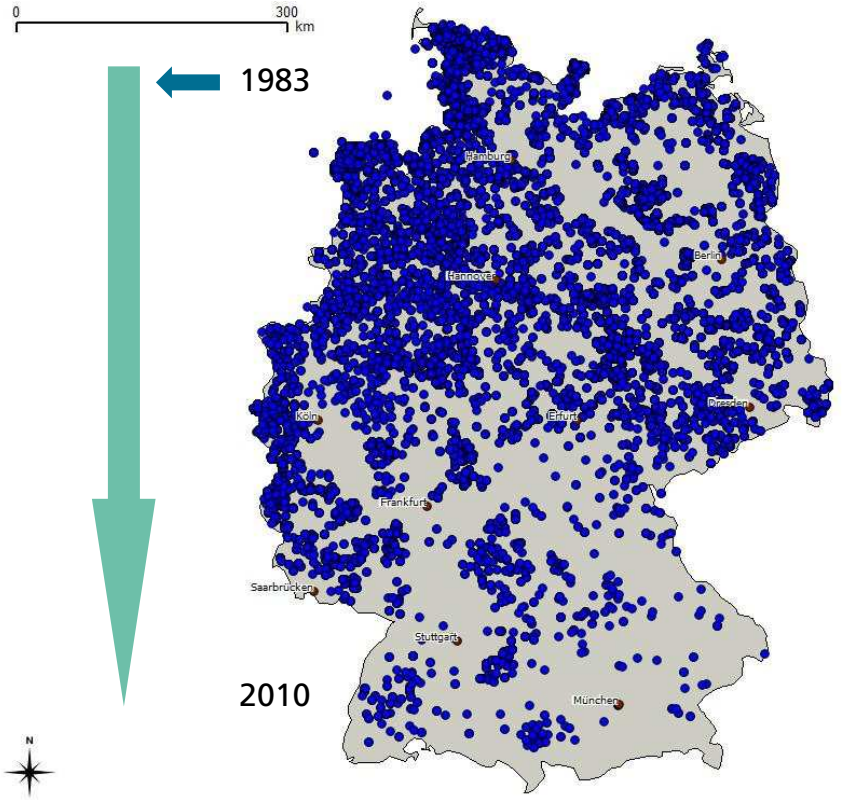


Learning curves



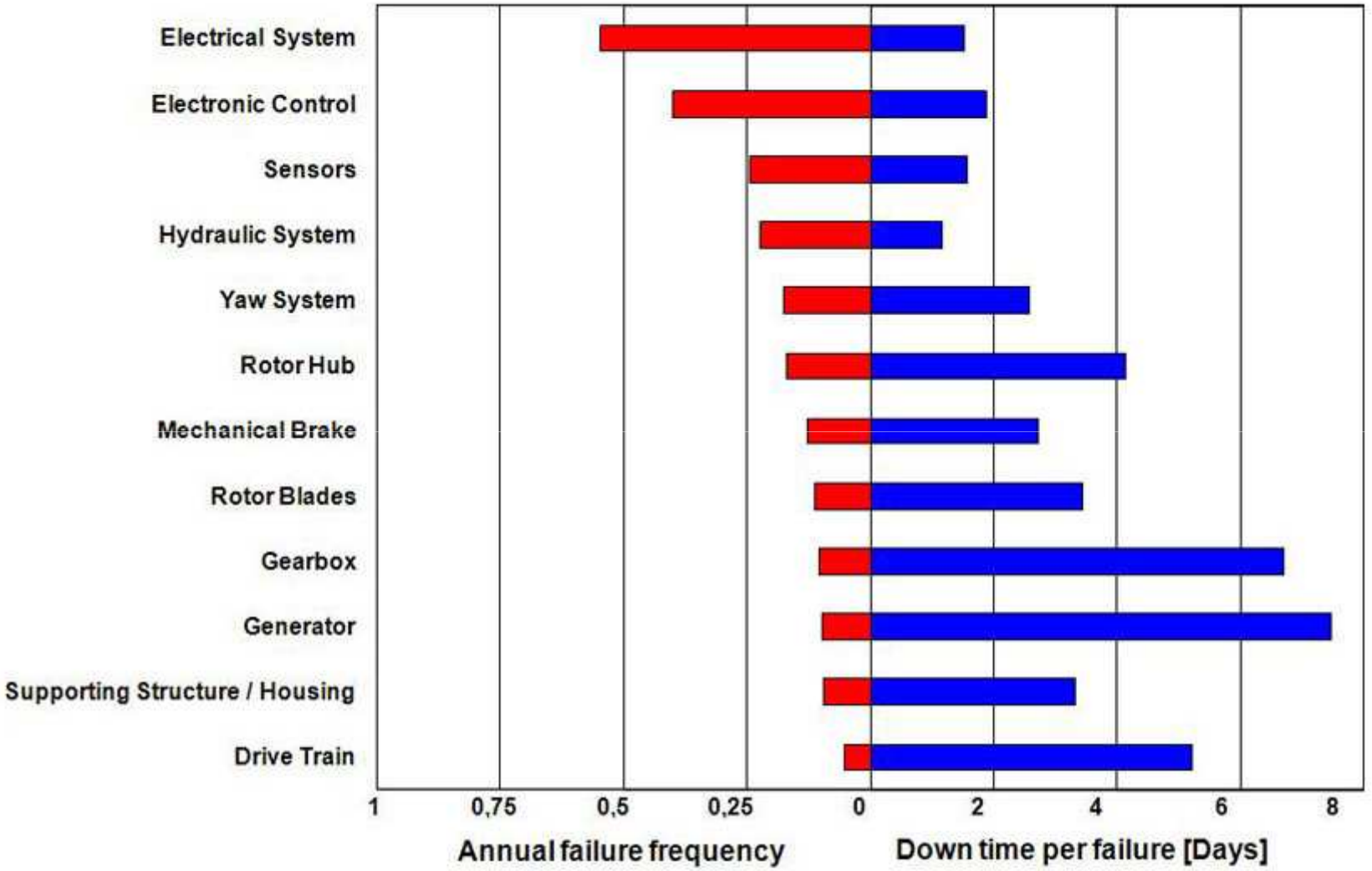
Reliability





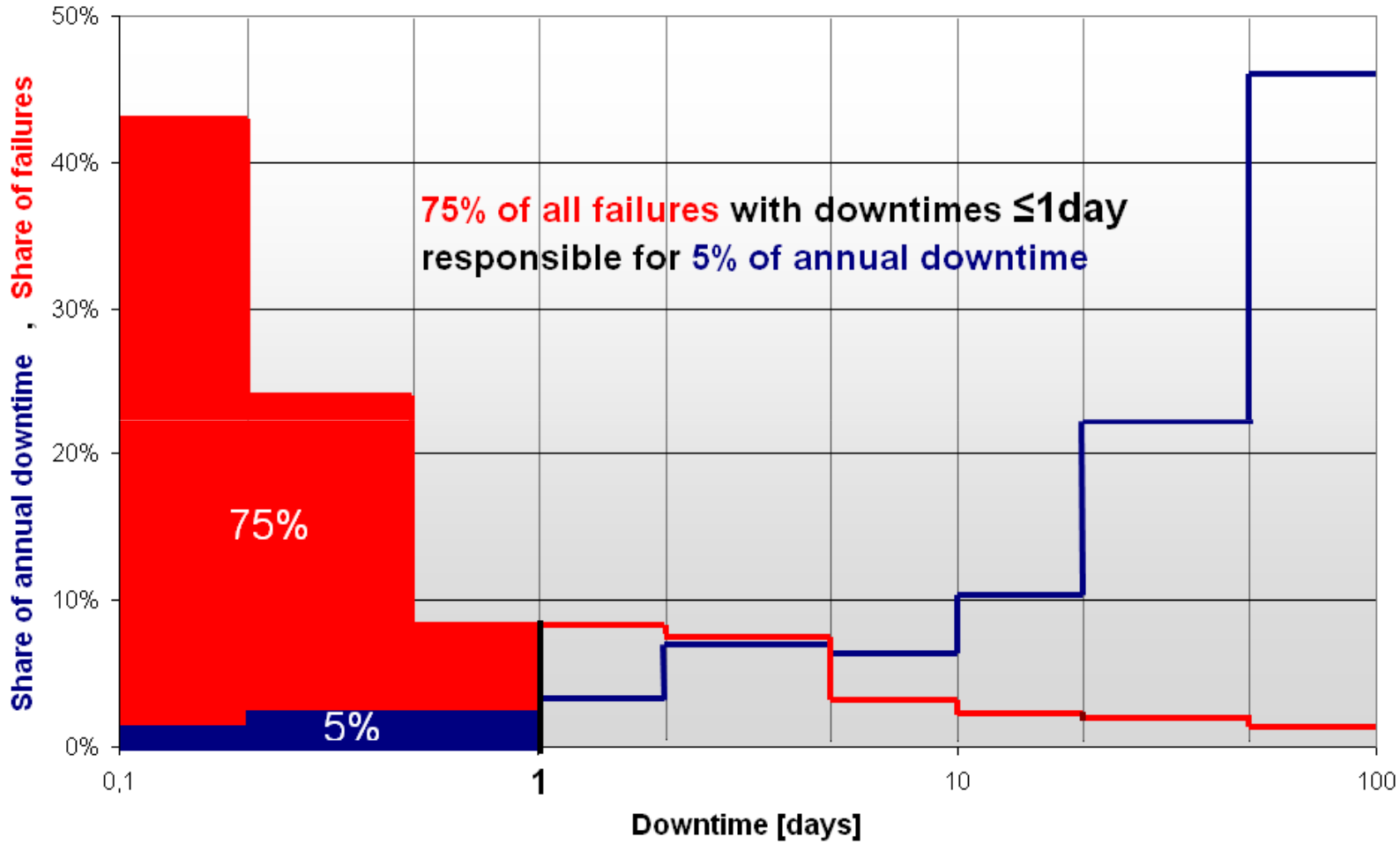
Fraunhofer IWES

Failure Database: WMEP



Fraunhofer IWES

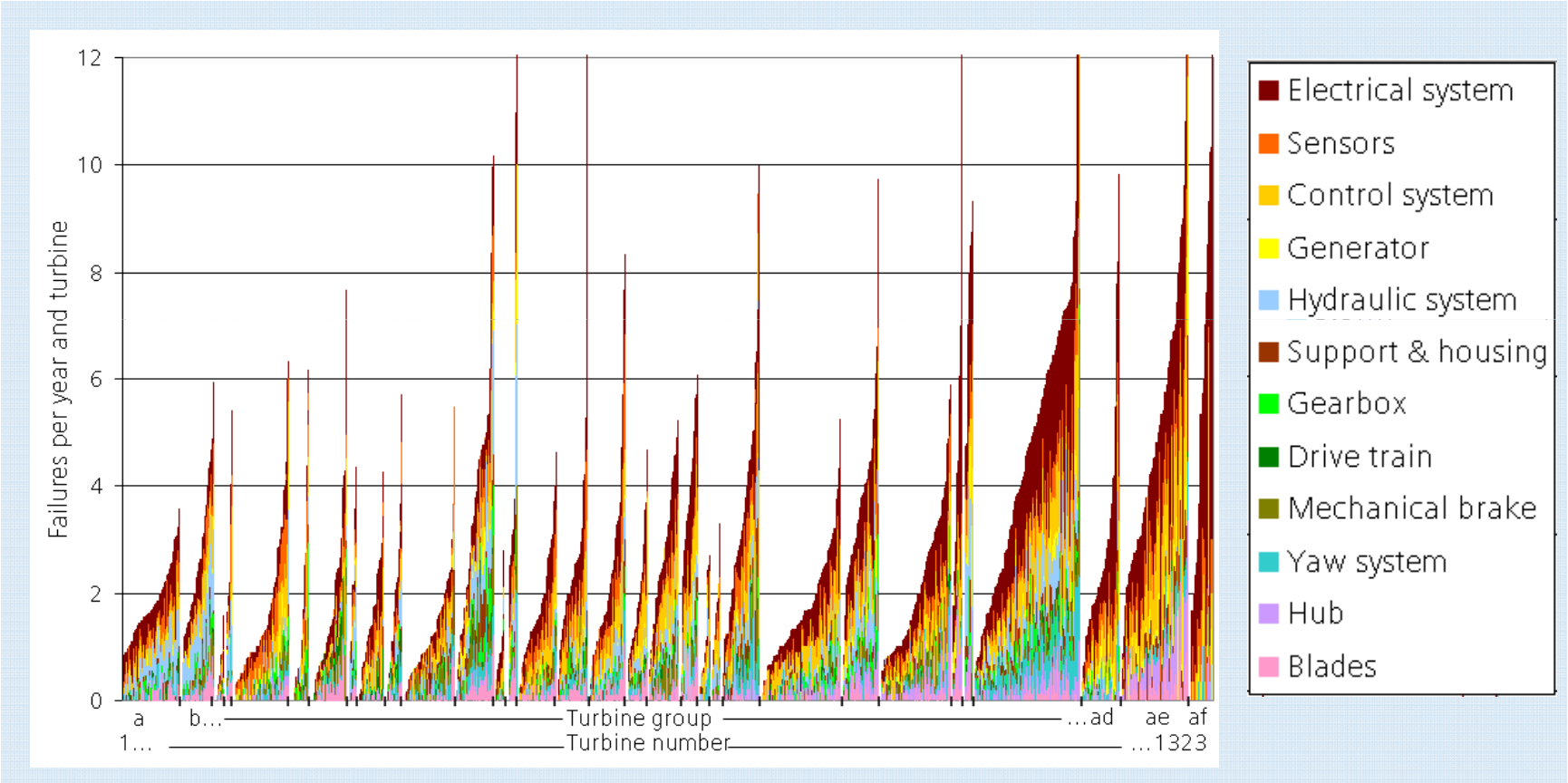
Failure Database: WMEP



Fraunhofer IWES

Failure Database – WMEP

Past



Fraunhofer IWES

Failure Database – Other sources

Past

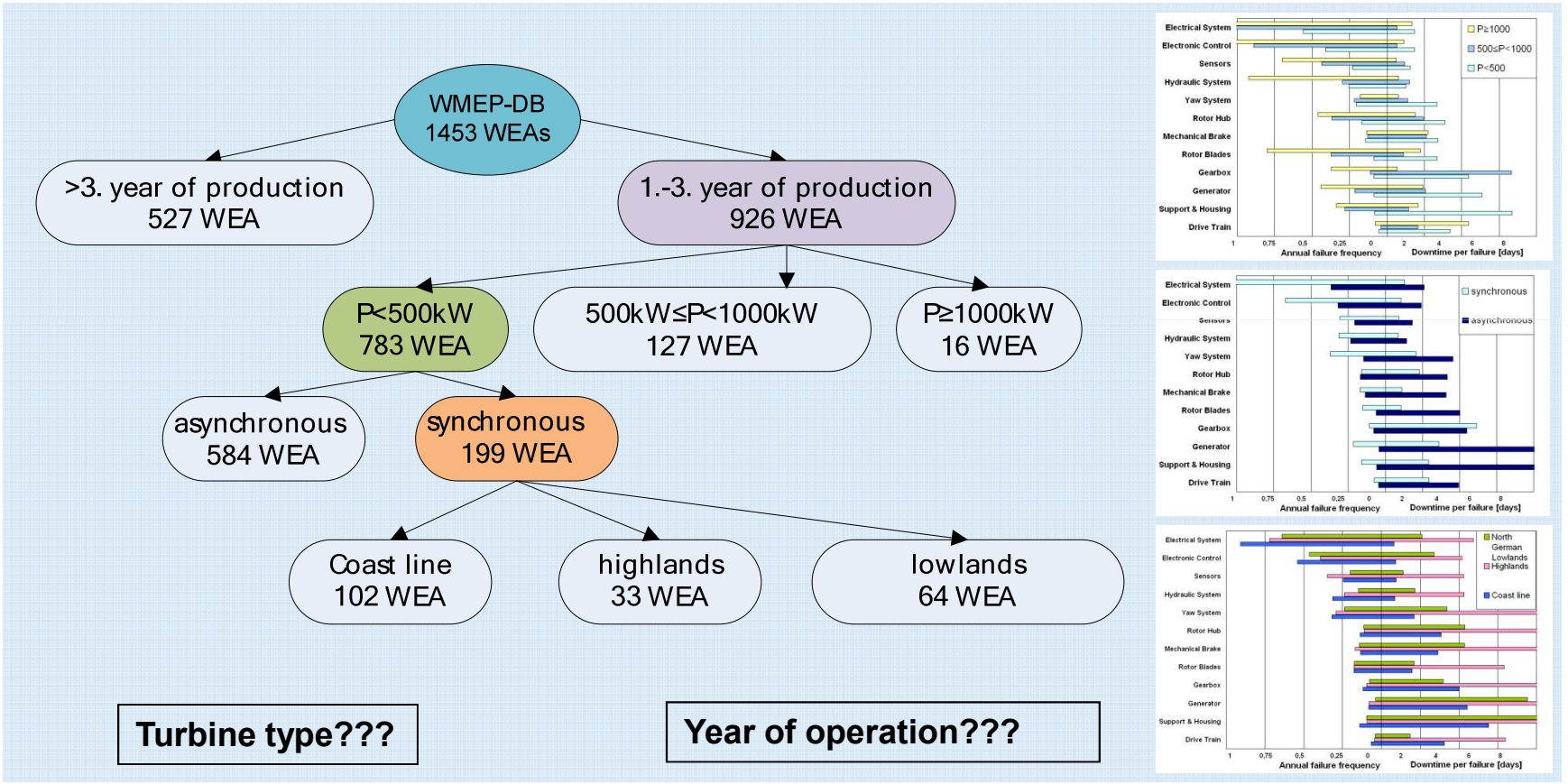
	WMEP	LWK	WIND-STATS	WIND-STATS	VTT	ELFORSK
Country	Ger	Ger	Ger	Dk	Fin	Swe
Time span	1989 – 2006	1993 – 2006	1995 – 2004	1994 – 2003	2000 – 2004	1997 – 2004
Number of turbines	1468	241	4285	904	92	723
Years of experience	~15.000	5.719	27.700	18.700	356	4.378
Average failure rate *[failures/turbine/year] over whole survey period*	2,4	1,9	1,8	0,7	1,5	0,9
Annual downtime *[hours/turbine/year] over whole survey period*	156	27	93	-	237	58
Highest failure rate	Electric Control Sensors	Electric Blades Control	Blades Electric Sensors	Control Blades Yaw-Syst.	Hydraulic Blades Gearbox	Electric Hydraulic Sensors
Longest downtime per failure	Gearbox Drive train Generator	Gearbox Blades Electric	Gearbox Blades Drive Train	–	Gearbox Blades Structure	Drive train Yaw-Syst. Gearbox

Fraunhofer IWES

Failure Database – Appropriate failure statistics

Past

- For differential analysis distinctions regarding size, technical concepts, site conditions, etc. must be made



Fraunhofer IWES

Interim Conclusions

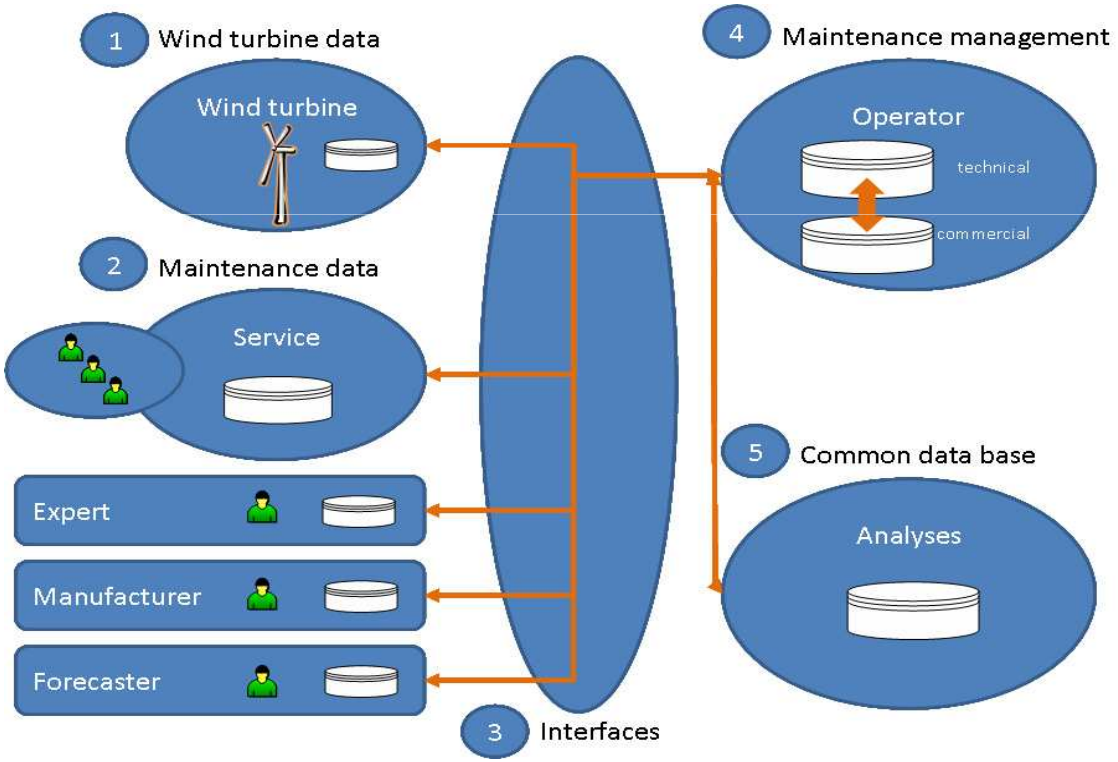
- Potential for reliability improvement and for reducing maintenance effort exists
- Data collections from the past show similar results but are not able to consolidate
- Common database needed due to parameter diversity
- Different concepts are necessary
  - Overall data structure
  - Standards and definitions
  - Accessibility of information

Failure Database – EVW (Increasing availability of WTs)

Present

- Funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

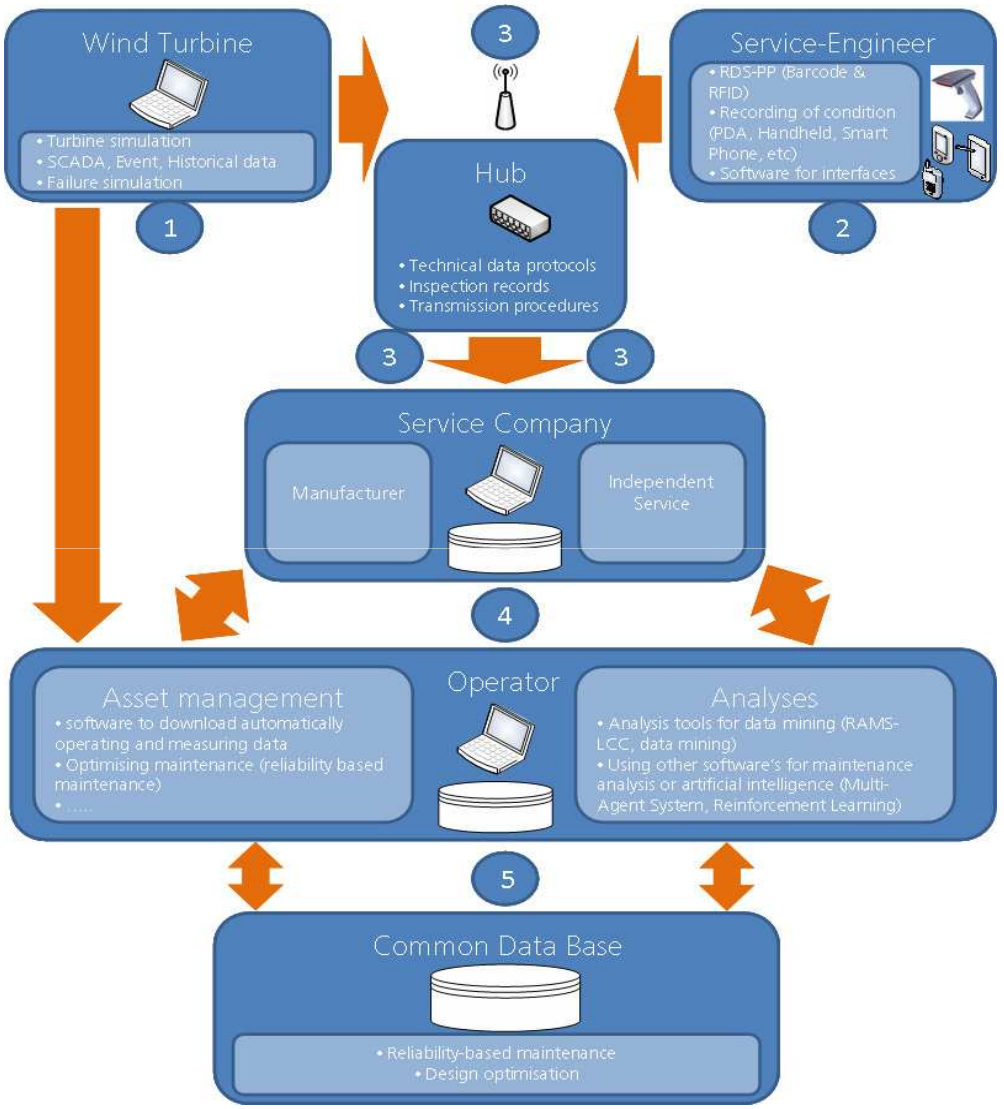
- Task: Knowledge management and maintenance optimization as methodical base for increasing the availability of wind power plants



Failure Database – EVW (Increasing availability of WTs)

Present

- Developing a test and demonstration system
- Preparing recommended practices for reliability based maintenance
- Technical guidelines / standards (Federation of German Windpower)

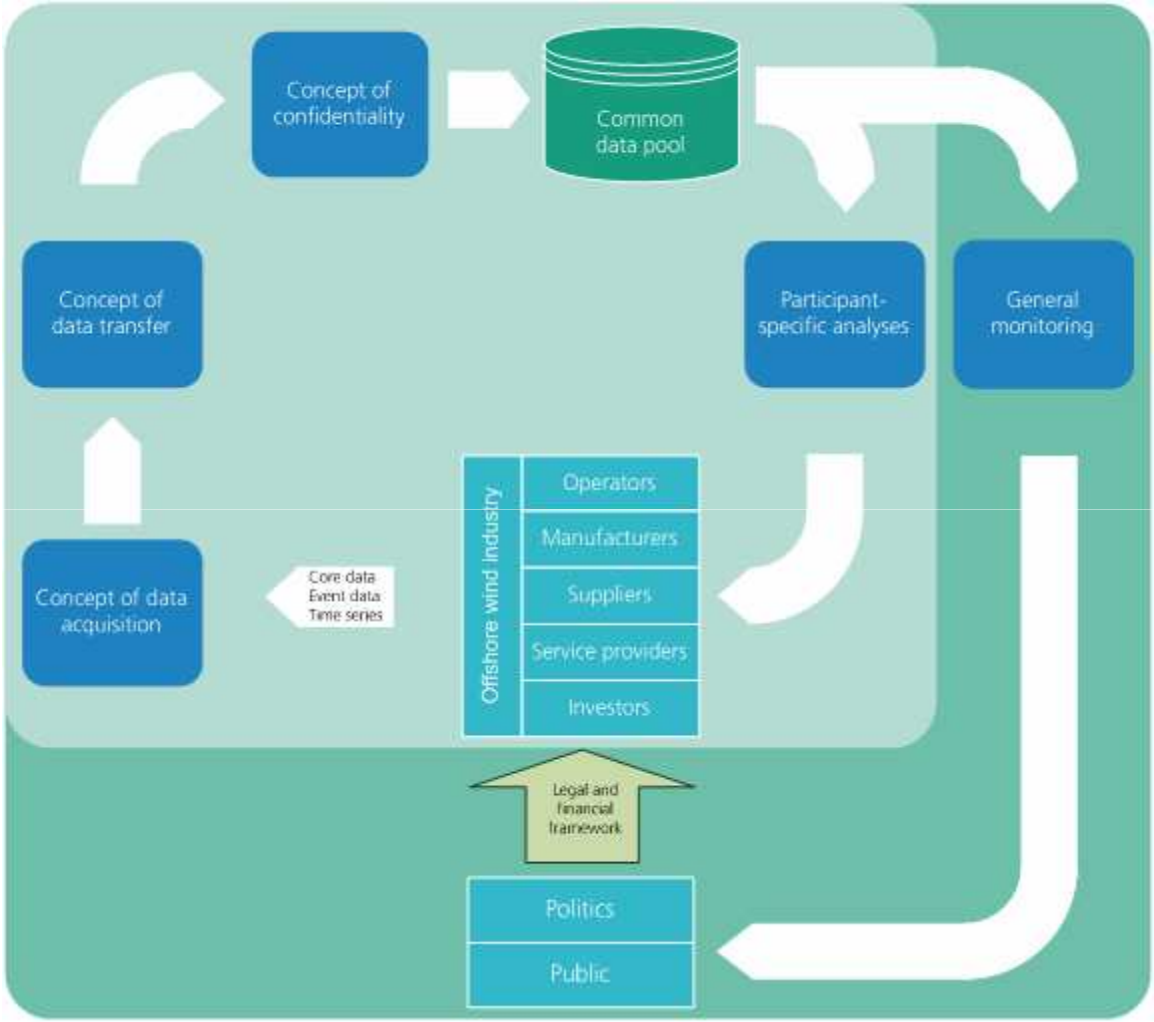


Fraunhofer IWES

Failure Database – Offshore~WMEP

Future

- The project is a follow-up project to the onshore wind energy monitoring program ‘Scientific Measurement and Evaluation Program’ (WMEP) and accompanies the offshore wind energy deployment in Germany
- Funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety



IZP

FGW renewable energies

Fraunhofer IWES

Failure Database – Offshore~WMEP

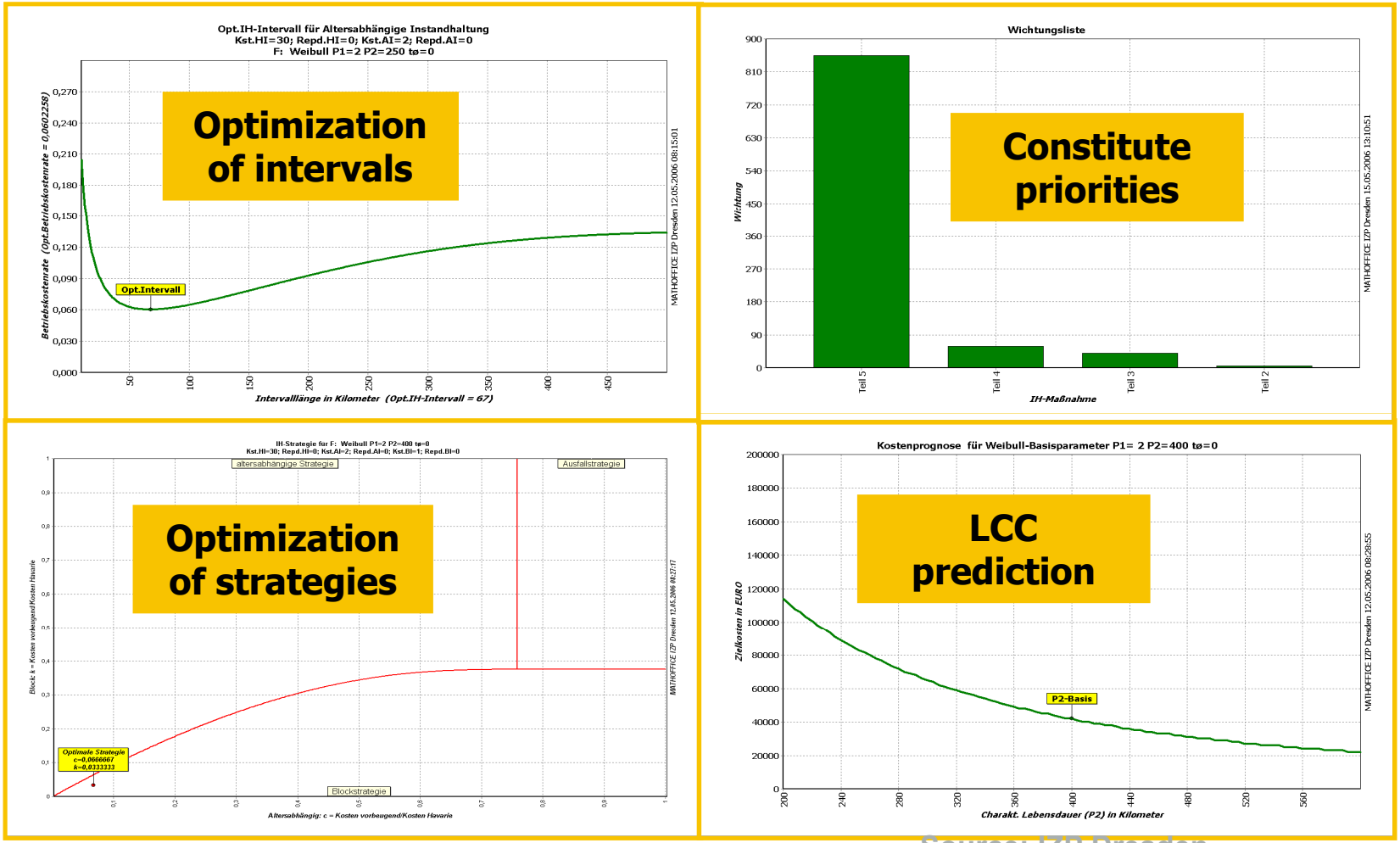
Future – General monitoring

- Core issues
  - Site-specific offshore conditions
  - Installation
  - Energy output
  - Reliability
  - Availability
  - Facility concepts
  - Operation and maintenance concepts
  - Investment and operating costs

Fraunhofer IWES

Failure Database – Offshore~WMEP

Future – Participant specific analyses



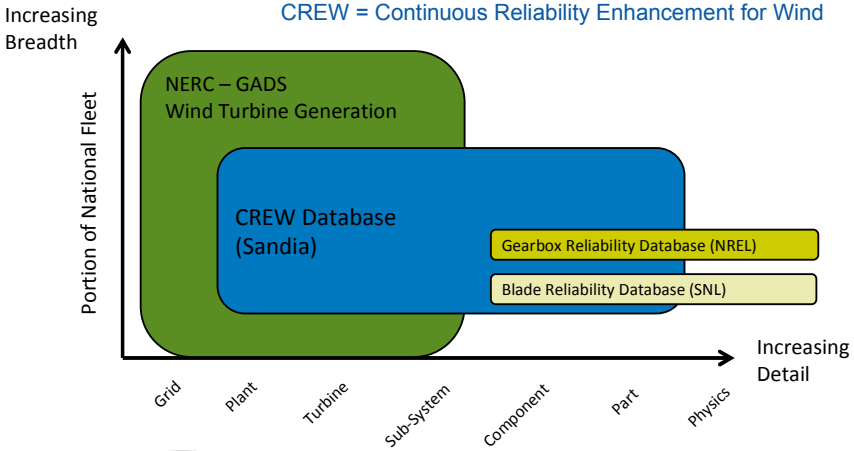
Source: IZP Dresden

Fraunhofer IWES

Failure Database

Present

NERC = North American Electric Reliability Corporation
GADS = Generating Availability Data System
CREW = Continuous Reliability Enhancement for Wind



Sandia National Laboratories

CREW Database Program: Partner Maturity

LESS Mature Data & Analysis ---------- MORE Mature Data & Analysis

Conversations with operators (2007) → Early Partners (2008) → ORAP Pilot Partners (2009) → ORAP Users & CREW Partners (2010) → 2011 → 2012+

Maintenance Data Scheduled & Unscheduled	•No documentation (tribal knowledge) •"I've got my work orders up here" <taps head>	•Paper work orders •Scanning or typing paper forms	•CMMS with true electronic work orders
Failure Data	•Not captured from SCADA	•Data captured; large amounts of time unaccounted (10-15%)	•SCADA data reviewed, and errors addressed
Data Infrastructure	•Flat text files •FTP sites	•Data transfer processes •SCADA & Work Orders disconnected	•SCADA, CMMS, data historian linked •SCADA "events" drive work orders

Manual collection Hard copy → Data historian Automated

ReliaWind

Reliability Engineering Specialised Firm

Relex

Experts in European R&D Project

Interface Europe

Fraunhofer IWES

Final Conclusions

- Potential for reliability improvement and for reducing maintenance effort exists
- Data collections from the past show similar results but are not able to consolidate
- Common database needed due to parameter diversity
- Different concepts are necessary
  - Overall data structure
  - Standards and definitions
  - Accessibility of information

Final Conclusions

- Potential for reliability improvement and for reducing maintenance effort exists
- Data collections from the past show similar results but are not able to consolidate
- Common database needed due to parameter diversity
- Different concepts are necessary
  - Overall data structure
  - Standards and definitions
  - Accessibility of information
- Several groups and projects dealing with the topic of establishing failure database to improve reliability of wind turbines
- Harmonization is needed ➔ focus on **structuring the format for data collection, setting up procedures for analyses and reporting, and developing a central database** that can be accessed by industrial and scientific parties, keeping in mind the **confidentiality aspects**.

Conclusion/Outlook

- Fraunhofer IWES has great experience with reliability databases due to the WMEP and builds up a more sophisticated database within the project EVW
- The Offhore~WMEP establishes a common database to monitor the offshore deployment and support offshore operators
- TASK 11 IEA Wind:

BASE TECHNOLOGY INFORMATION EXCHANGE
Topical Expert Meeting #65 (*March 30-31, 2011)* on

iea wind

"INTERNATIONAL STATISTICAL ANALYSIS ON WIND TURBINE FAILURES"

<u>Result:</u>

Discussion paper for
launching an IEA-Task
"Wind Turbine Failure Statistics"

Fraunhofer
IWES

Dipl.-Wi.-Ing. Philipp Lyding
philipp.lyding@iwes.fraunhofer.de

Reliability & Maintenance strategies
R&D Division Energy Economy and Grid Operation

Fraunhofer Institute for Wind Energy and
Energy System Technology IWES
Königstor 59, 34119 Kassel

Fraunhofer
IWES