GARRAD HASSAN

Reliawind Field Study

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2009 Wind Turbine Reliability Workshop
Albuquerque, NM, 17-18 June 2009

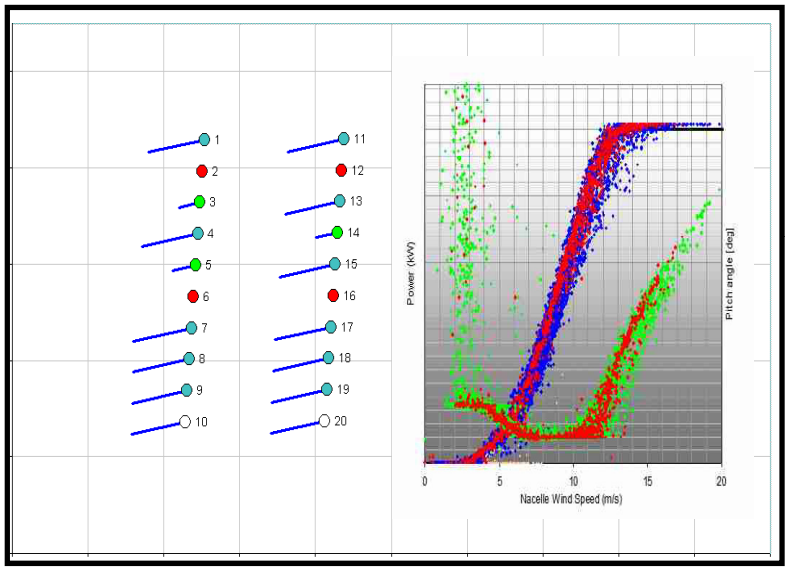
Renewable Energy Experts
worldwide

Garrad Hassan Around the World

- Founded in 1984 in UK
- Now have offices worldwide
- Local understanding informs global perspective

Asset Management and Optimisation Services (AMOS)

- ✓ Performance Monitoring
- ✓ Fault diagnostics and forensic analysis of SCADA data
- ✓ Post-construction energy forecasts
- ✓ O&M advice
- ✓ Warranty calculations
- ✓ End of warranty inspections



20 GW of operating plant assessed worldwide

Introduction to Reliawind

Summary of Reliawind

- EC funded R&D project
- €7.7M total funding
- €5.5M EC funding
- 10 organisations involved
- 3 years

Aims:

- Improve general understanding of wind turbine and farm reliability
- Develop reliability models specific to wind turbines

- Increase MTBF
- Decrease MTTR
- Increase availability
- Decrease CoE

Important Onshore → Critical Offshore

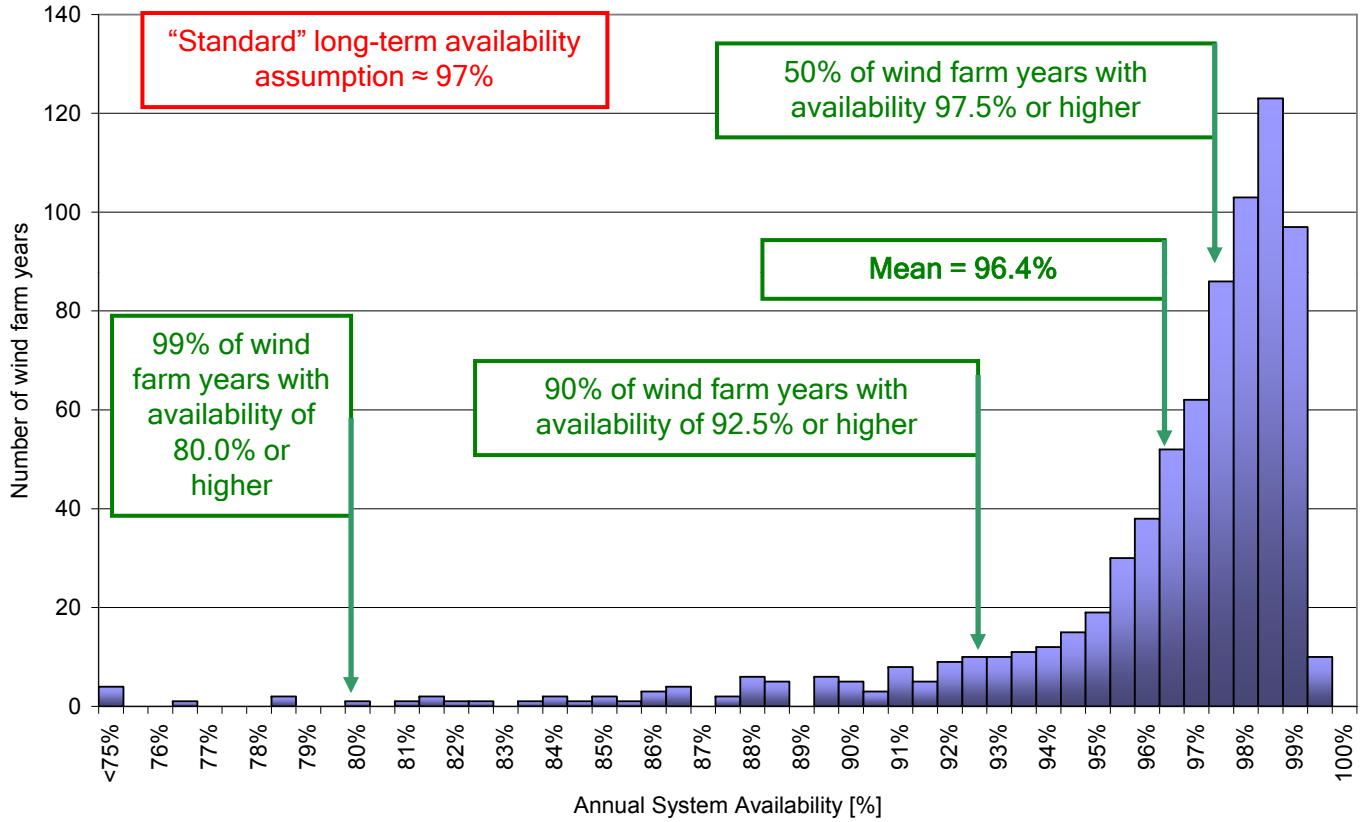
Summary of Reliawind

Main project work packages:

1. Field data reliability analysis
2. Design for reliability
3. Algorithms for condition monitoring
4. Proof of concept

Previous Work – Availability

Distribution of annual availability

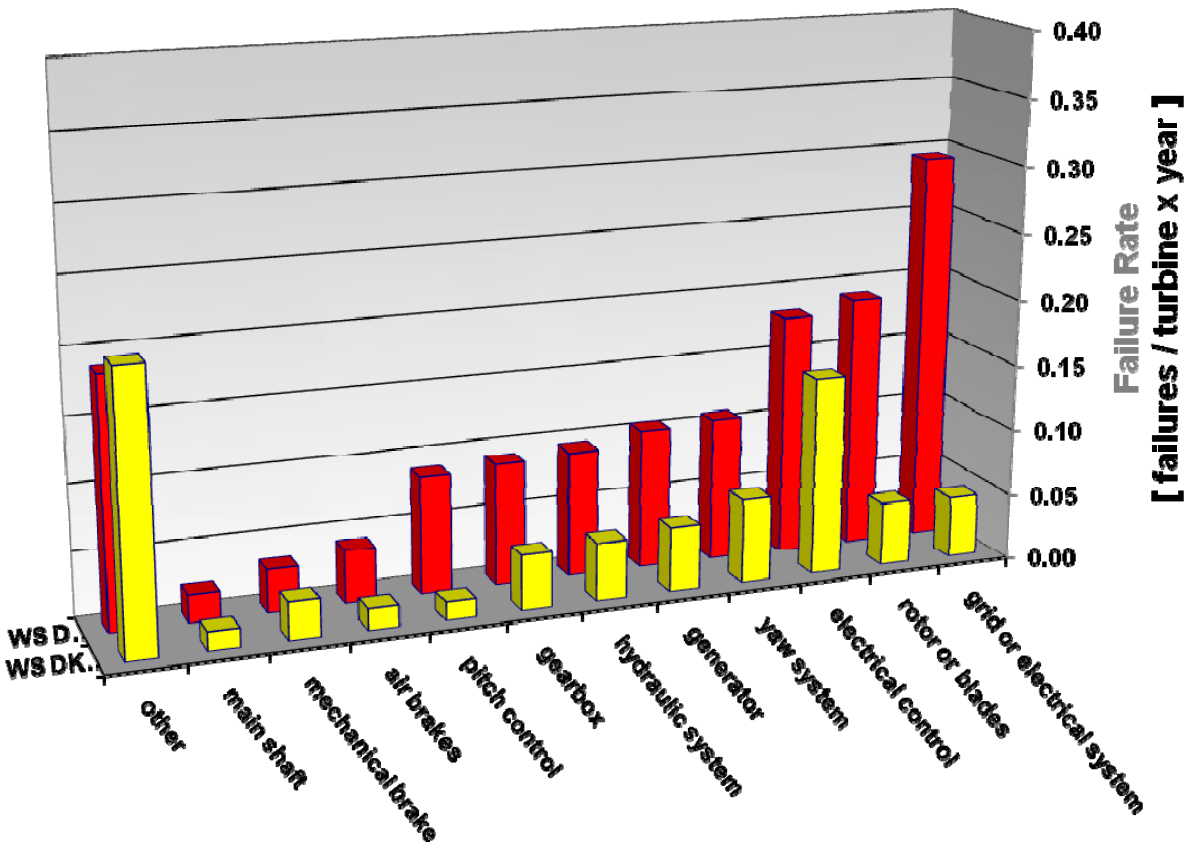


Database:

- **Over 250 wind farms worldwide**
- **All major manufacturers**
- **Over 1000 wind farm operating years**
- **Operating from 1 to 15 years**

Source GH, presented at EWEC 2008

Previous Work – Reliability



Courtesy of Durham University

Previous Work

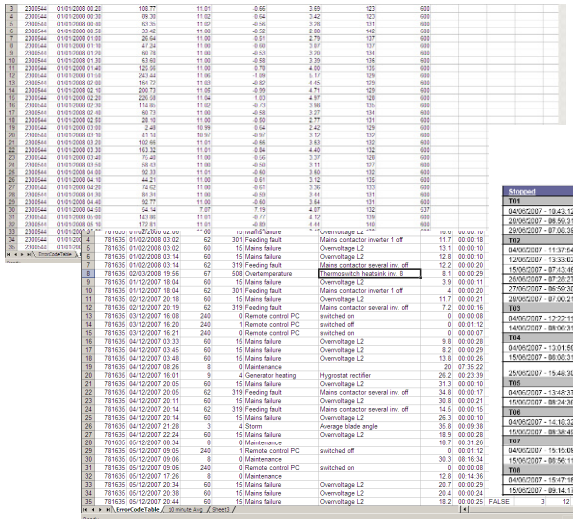
- Previous availability work limited to high level availability and fault information
- Previous reliability work limited by quality of data
- Need better quality data to get better results…

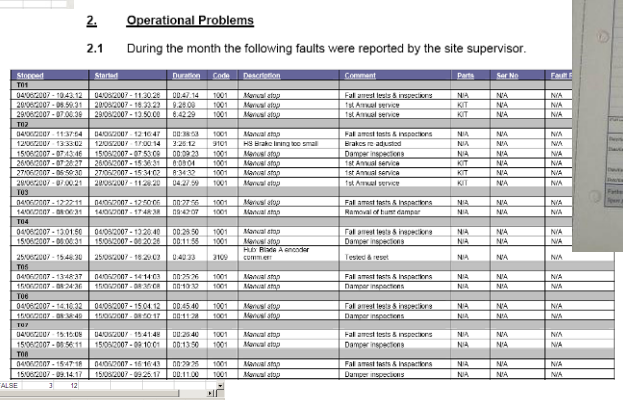
Reliawind Field Study

Reliawind Field Study Methods

Data Available from a Wind Farm

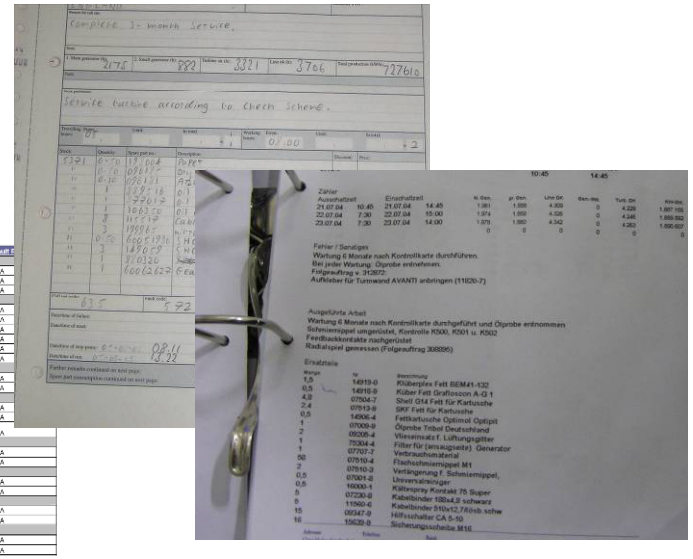
- 10 minute average turbine and substation SCADA databases
- Fault logs per turbine and substation
- Manual records
- Work orders
- Monthly operational reports compiled by the operator and or manufacturer





2. **Operational Problems**

2.1 During the month the following faults were reported by the site supervisor.



Reliawind Common Formats

Turbine taxonomy

A common approach to describe wind turbines from different manufacturers

ROTOR MODULE		
	PITCH SYSTEM	
		PITCH HYDRAULIC SUBSYSTEM
		BLADE PITCH ACTUATORS
		ROTATING JOINT
		POSITION SENSOR (BALLUFF)
		BLADE LOCKING SYSTEM
	HUB	
	BLADES	
		TC
	BLADE BEARINGS	
		GENERAL BLADE BEARINGS
		LUBRICATION SYSTEM
	HUB COVER	
DRIVE TRAIN MODULE		
	MAIN SHAFT	
		MAIN SHAFT
	GEARBOX ASSEMBLY	
		GEARBOX
		TORQUE ARMS
		GEARBOX COOLING SYSTEM
		GEARBOX LUBRICATION SYSTEM
		GEARBOX SENSORS
	MECHANICAL BRAKE	
		MECHANICAL BRAKE HYDRAULIC SUBSYSTEM
		BRAKE CALLIPERS

TABLE 1 EVENTS

Wind Farm	Turbine ID	Date & Time of Event	Time to Repair TTR (hours)	Actual Repair Time ART (hours)	Sub-System	Assembly	Sub-Assembly	Part	Failure Mode	Root Cause	Maintenance Category	Severity Category	Additional information
A	1	2008-04-01 11:28:01	54.2	N/A	Drive train	Gearbox assembly	Gearbox	N/A	N/A	N/A	4	3	N/A

TABLE 2 FAILURE RATES

Wind Farm	Turbine	Sub-System	Assembly
A	1	Drive Train	Gearbox
A	1	Power	Generator
A	1	R	

TABLE 3 DOWNTIME

Wind Farm	Turbine	Sub-
A	1	Drive
A	1	Power
A	1	Rotor
…	…	

TABLE 4 WIND FARM CONFIGURATION

arm	s	ower	/ind n.s^{-1})	nce y	ight	r (m)	Terrain Type	Control Type	…
							Offshore	A	…
							Onshore Exposed	B	…
							…	…	…

TABLE 5 ADDITIONAL TURBINE INFORMATION

Wind Farm	Month	Energy Generated (GW.h)	Revolutions	…
A	2008-01	50	1.544×10^5	…
A	2008-02	70	2.422×10^5	…
…	…	…	…	…

Database

A common method to store downtime events and their origin

Reliawind Initial Results

Results – The Story so Far

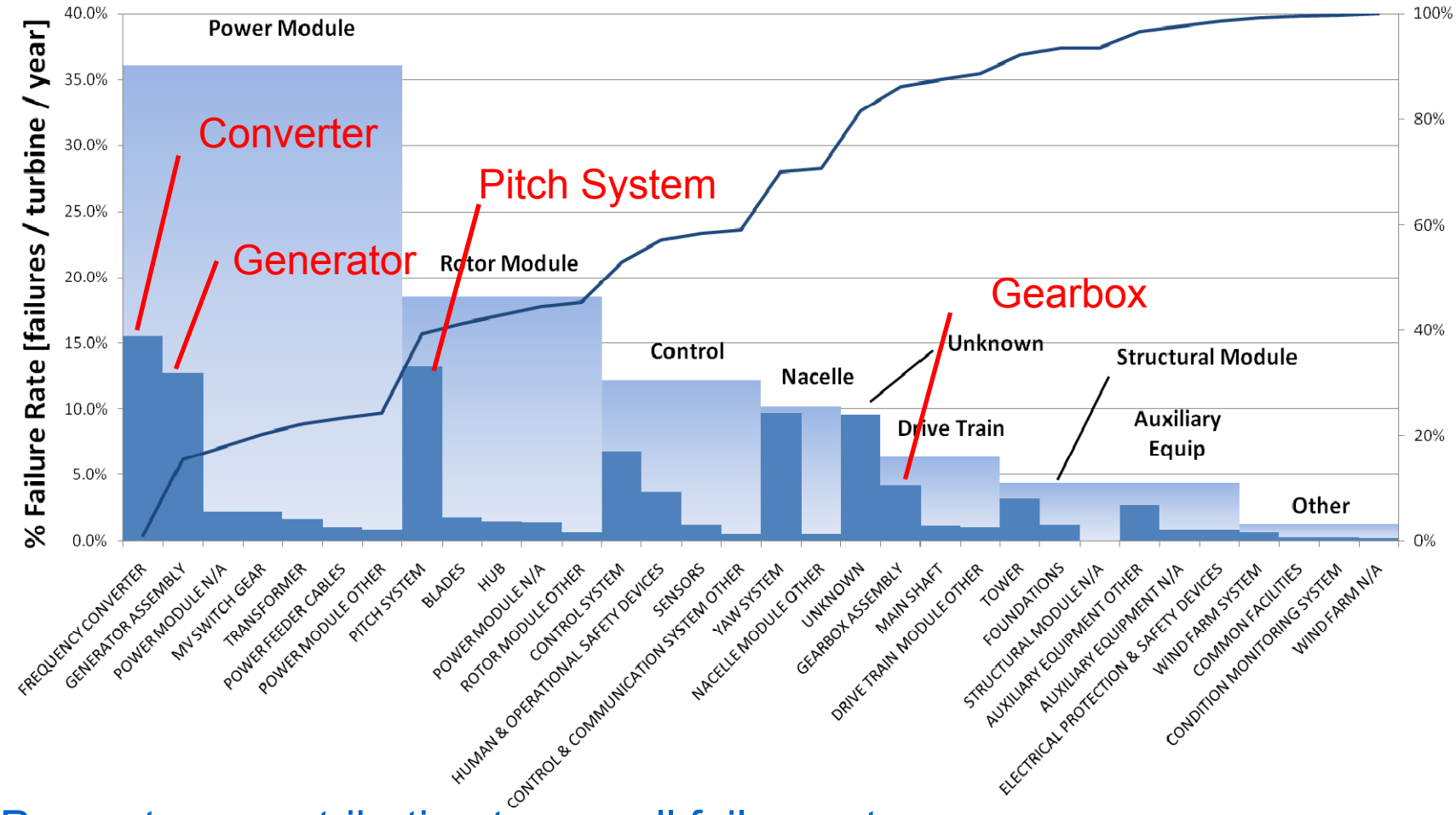
Data sources:

- Manufacturers – Consortium members
- Owners & Operators – Users' Working Group

Data added so far:

- 290 turbines
- 240 wind-farm months

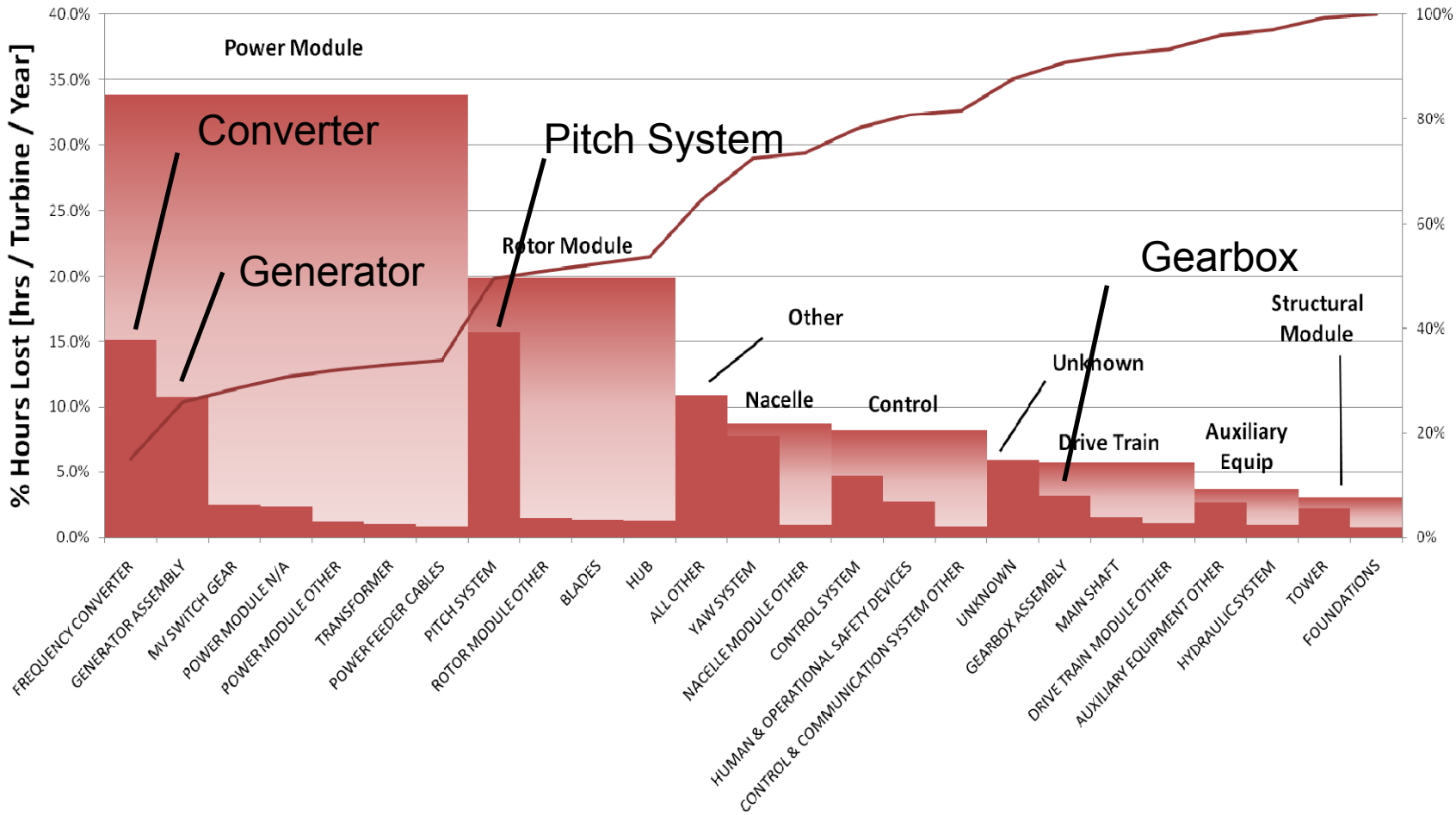
Results – Failure Rate



Percentage contribution to overall failure rate

Data source: turbines from multiple manufacturers

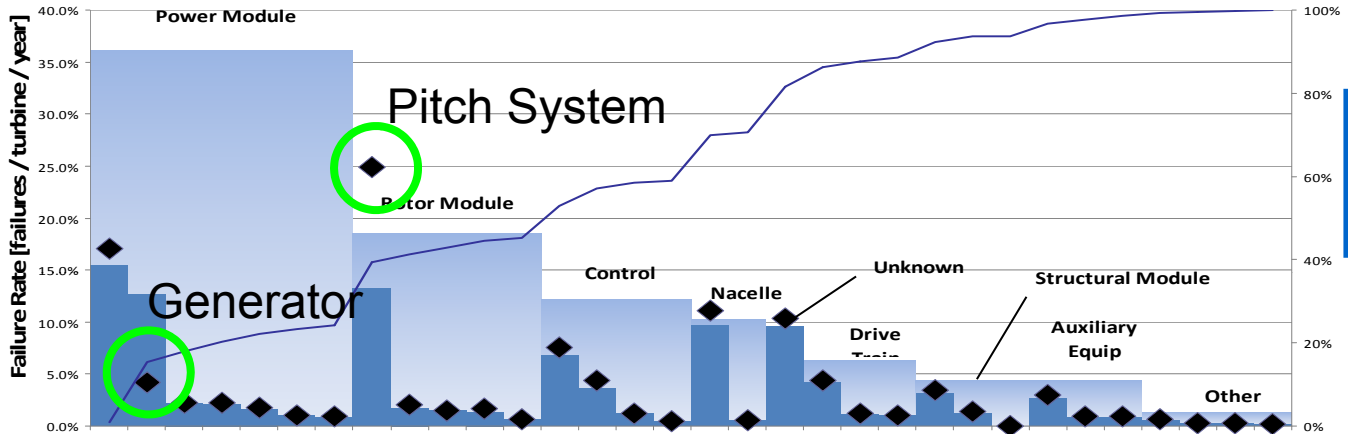
Results – Downtime

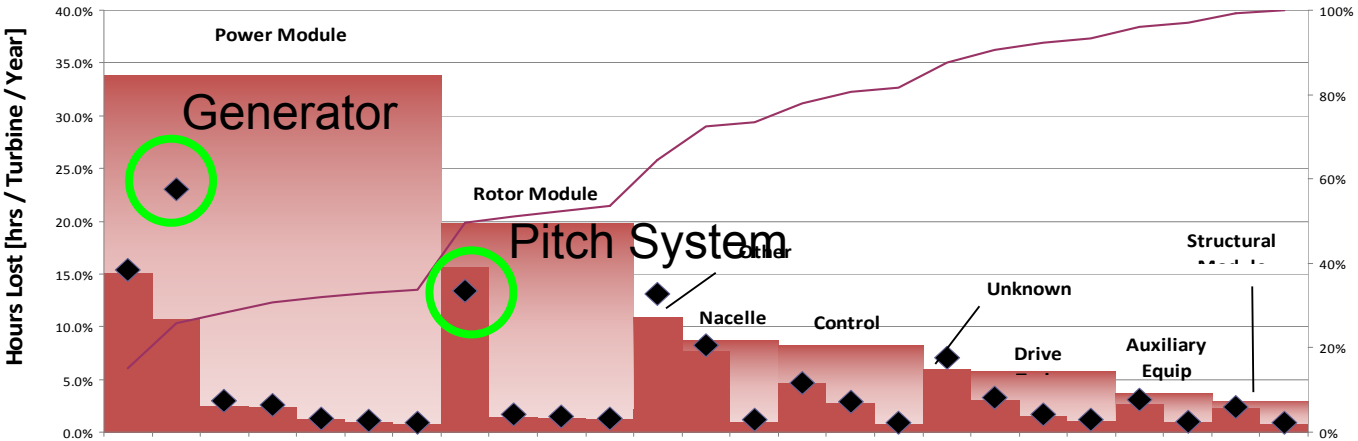


Percentage contribution to overall failure rate

Data source: turbines from multiple manufacturers

Results – Reliability Profile





Your Site

Concluding Remarks

- Reliawind addresses the need for a quantitative measurement and understanding of turbine reliability
- Common standards defined – turbine taxonomy and data structure
- Database populated with data from 290 turbines
- Database growing!

Thank You

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