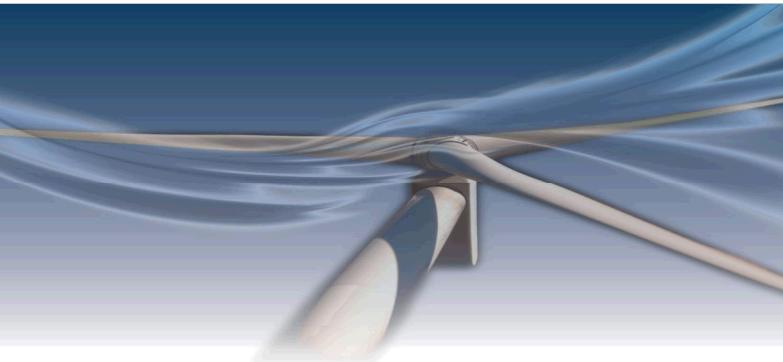


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# Availability and Reliability Standards

Standardizing Definitions for Wind Turbine Availability and  
Reliability for Operations & Maintenance Analyses

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Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

# Presentation Overview

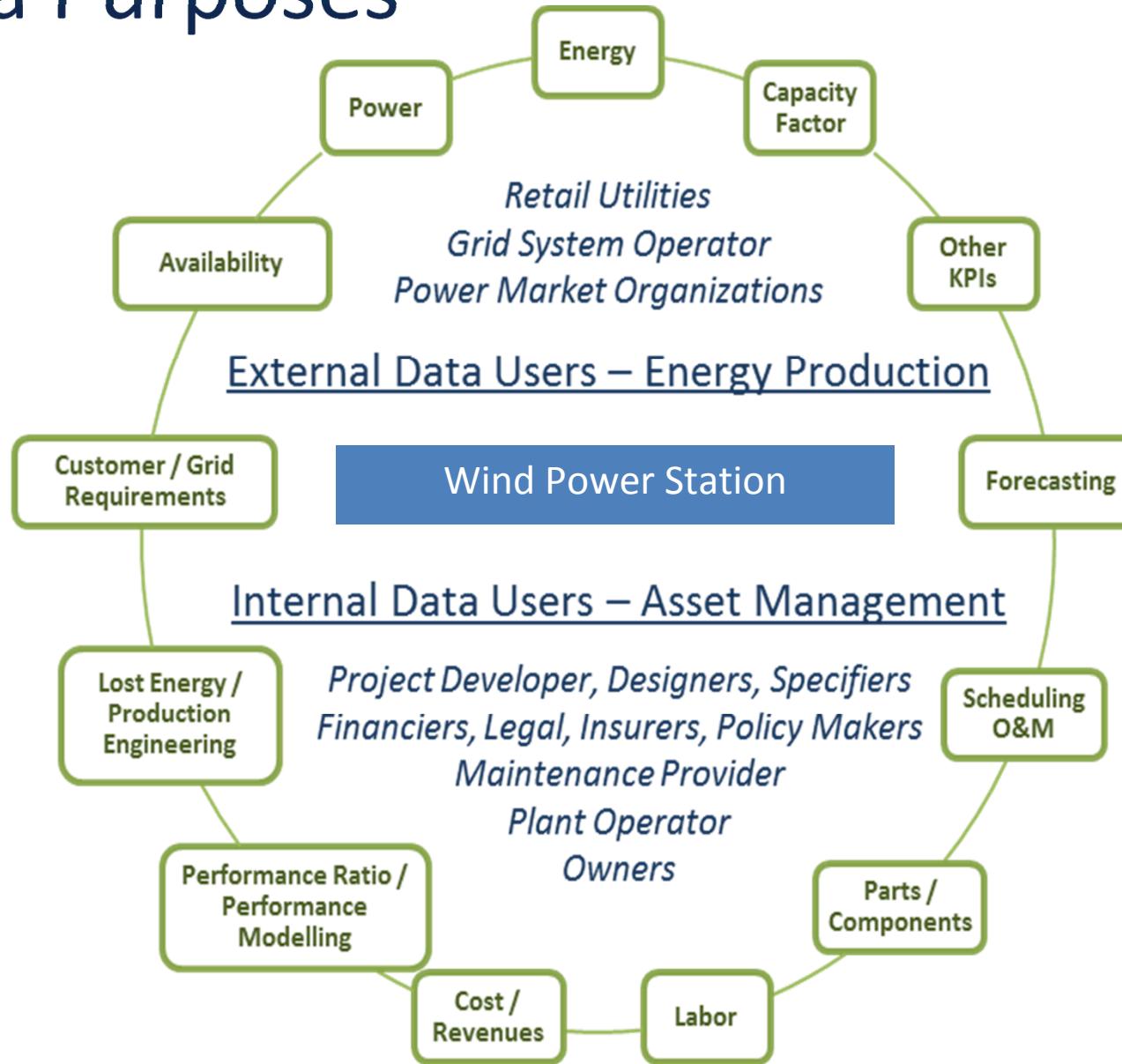
- Background
  - Why are we talking about Availability and Reliability standards?
  - What are the drivers?
- What standards exist?
  - IEC 61400-26
  - IEA Task 33
  - NERC GADS
- What's Next?
  - CREW database example

# Concept of Wind Turbine Availability “not available” not well addressed by industry

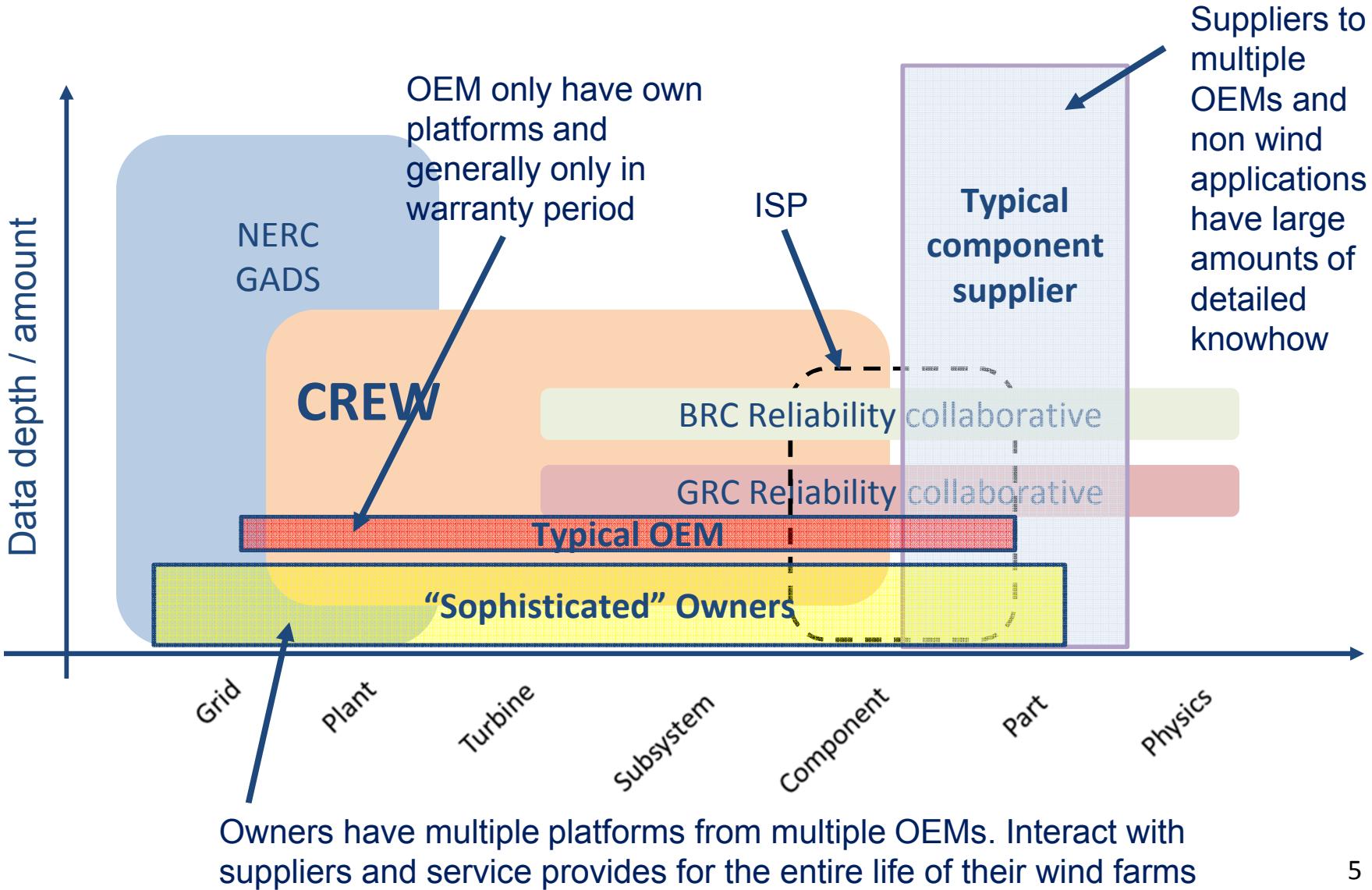
- History
  - Early disagreement for a definition of availability
  - Concept was left open for future discussion during the development of wind turbine design standard (IEC 61400-1)
  - In 2007, IEC TC-88 agreed to begin work towards a standard definition of wind turbine availability
- Drivers of Availability and Reliability Standards
  - Operational optimization
  - Maintenance optimization
  - Purchasing optimization
  - Investor confidence
  - Grid reliability
  - Technology Improvement Opportunities



# Data Purposes



# Insights of Different Stakeholders



# What Standards/Specs Exist?

- IEC 61400-26: Availability for wind turbines and wind turbine plants
- NERC Generating Availability Data System (GADS)
- IEA Task 33: Reliability Data: Standardizing data collection for wind turbine reliability and O&M analyses



## Time based availability for wind turbines

- *“The technical specification shall define generic terms of wind turbine systems and environmental constraints in describing system and component availability, lifetime expectancy, repairs and criteria for determining overhaul intervals. Furthermore the specification shall define terminology and generic terms for reporting wind power based generating unit reliability and availability measurement.”*
- Technical specification is separated into three parts:
  - 61400-26-1 terms for time based availability of a wind turbine
  - 61400-26-2 terms for production based availability of a wind turbine
  - 62400-26-3 terms for time and production based availability of a wind power plant

# Information Model for IEC 61400-26

Information categories				
Mandatory Level 1	Mandatory Level 2	Mandatory Level 3	Mandatory Level 4	Optional - description see Annex A Level 5
INFORMATION AVAILABLE (IA)	OPERATIVE (IAO)	GENERATING (IAOG)	FULL PERFORMANCE (IAOGFP)	
			PARTIAL PERFORMANCE (IAOGPP)	Derated Degraded
		NON-GENERATING (IAONG)	TECHNICAL STANDBY (IAONGTS)	
			OUT OF ENVIRONMENTAL SPECIFICATION (IAONGEN)	Calm winds Other environmental
			REQUESTED SHUTDOWN (IAONGRS)	
			OUT OF ELECTRICAL SPECIFICATION (IAONGEL)	
	NON-OPERATIVE (IANO)	SCHEDULED MAINTENANCE (IANOSM)		
		PLANNED CORRECTIVE ACTION (IANOPCA)	Retrofit Upgrade Other corrective action	
		FORCED OUTAGE (IANOFO)	Response Diagnostic Logistic Failure repair	
		SUSPENDED (IANOS)	Scheduled maintenance Planned corrective action Forced outage	
		FORCE MAJEURE (IAFM)		
INFORMATION UNAVAILABLE (IU)				

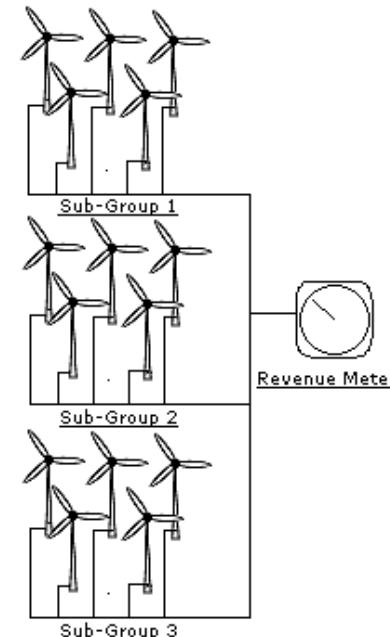
Condition State	Example
Full performance	Function with no limits or restrictions
Partial performance	Functioning with limitations and/or restrictions
Technical standby	Temporarily nonfunctioning due to controlled and/or predefined tasks required - e.g. self-testing, ramp-up
Out of environment spec	Operative but not functioning as the environment is out of design specs
Requested shutdown	Operative but stopped by an external request-i.e. curtailment
Out of electrical spec	Operative but not functioning as the electrical parameters are out of design specs - i.e. grid outage
Scheduled maintenance	Scheduled maintenance prevents system components for performing the intended functions
Planned corrective action	Actions required to retain, restore, or improve the intended functions that are not part of normal scheduled maintenance
Forced outage	Action taken as unforeseen damage, faults, failures or alarms are detected
Suspended	Activities in SCHEDULED MAINTENANCE, PLANNED CORRECTIVE ACTION and FORCED OUTAGE are interrupted or cannot be initiated due personal safety or equipment integrity - e.g. extreme weather
Force Majeure	Extraordinary event or circumstance beyond the control of the parties, prevents the parties from fulfilling their obligations.

# NERC Generation Availability Data System (GADS)

- The industry standard for reporting generator availability performance data
- Uses consistent formulas developed by industry to calculate key availability metrics
- Wind and Solar do not have mandatory reporting requirements
- Only ~4% of wind generation is reporting to GADS
  
- NERC provides free software to allow for easy reporting

Wind Turbine Group  
*Groups report the following site data:*

- Associated Plant ID
- Turbine Group ID
- Turbine Group Name
- NERC Utility Code
- NERC Unit Code
- Installed Capacity in MW
- Auxiliary Capacity
- Commercial Date
- Nearest City, State
- Longitude and Latitude
- Elevation
- Wind Regime (topography)
- SCADA Type
- SCADA Manufacturer
- SCADA Model



# IEA Task 33

Reliability Data: Standardizing data collection for wind turbine reliability and O&M analyses

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## Objectives

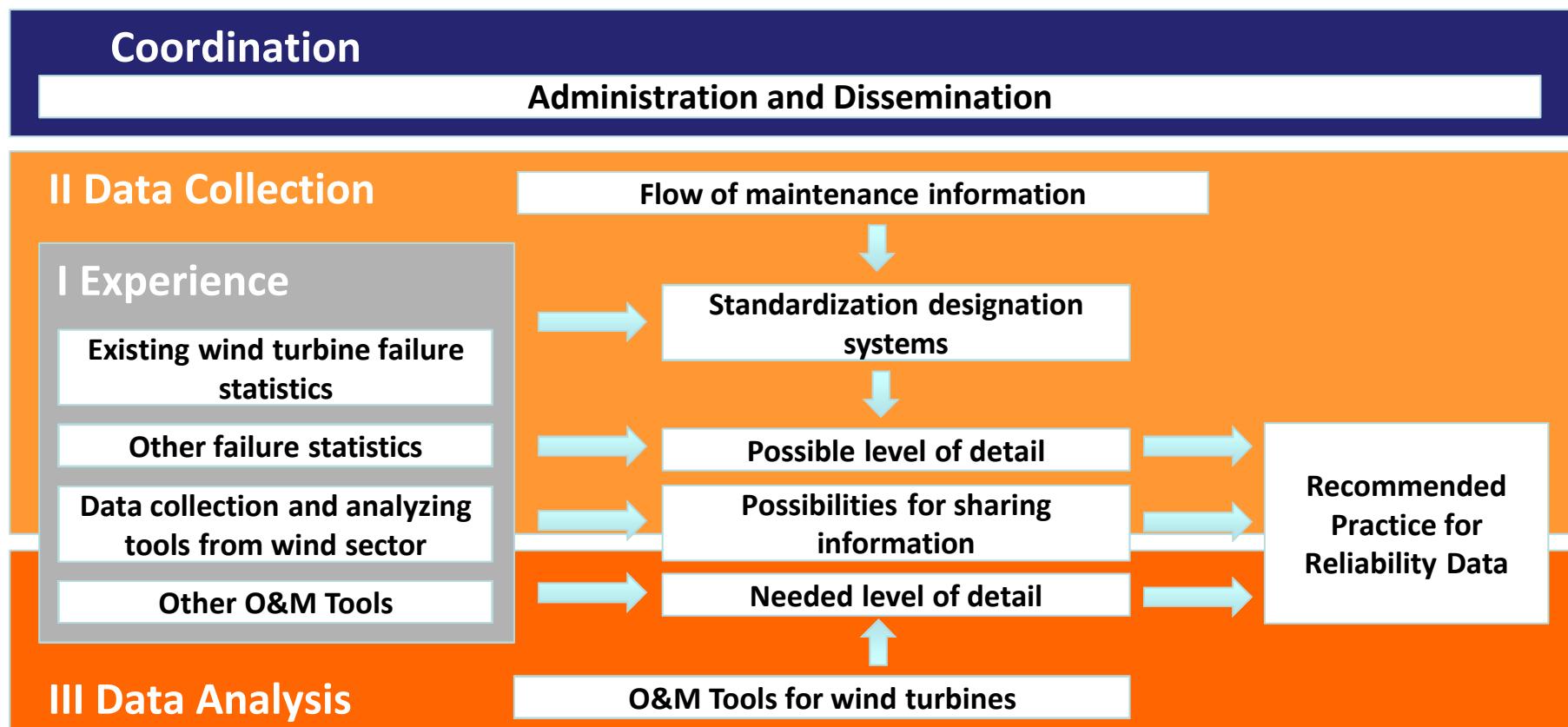
- Provide an international open platform for regular and continuous exchange of experience and progress from research activities and measurement projects on failure statistics on wind turbines.
- Develop “***Recommended Practices for Reliability Data***” during the Task.
- Identify areas for further research and development as well as standardization needs

## Industry Value:

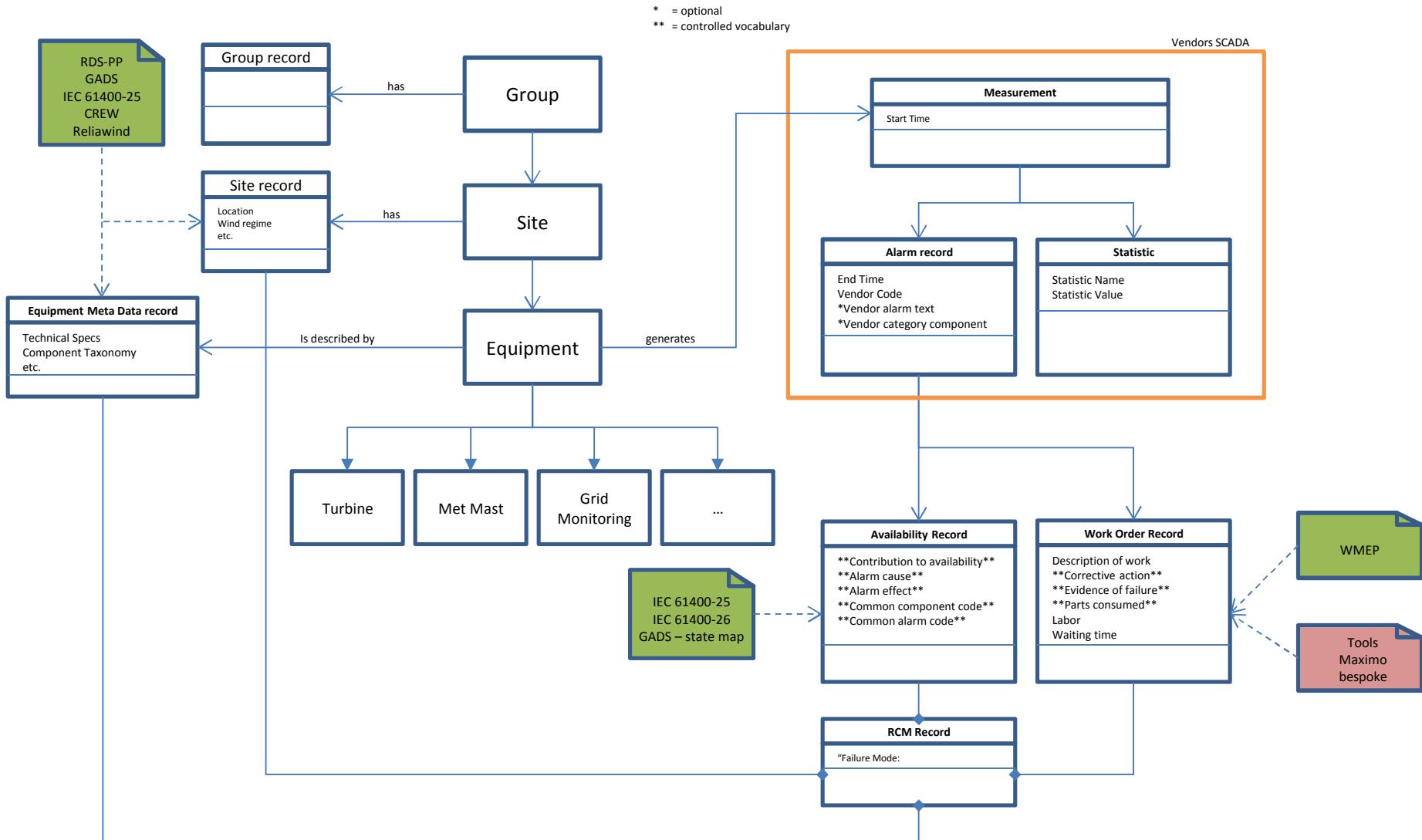
- Increased implementation of appropriate, standardized, data-based decision making techniques and tools to optimize wind plant O&M and thereby increase turbine reliability and plant availability while decreasing O&M costs

# IEA Task 33

- Addresses the data collection and failure statistics in the wind energy sector to standardize reliability data will facilitate effective analysis and the wide applicability of results.
- Aims to use reliability data to support improving reliability and optimizing O&M procedures of wind turbines through the use of reliability data.



# General Framework for Wind Farm Data

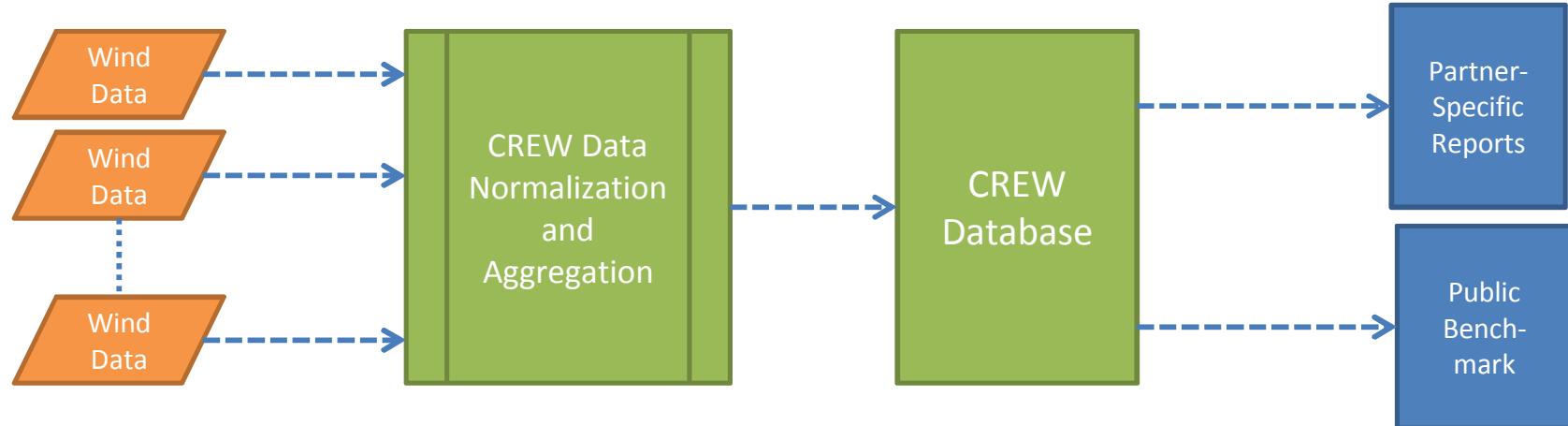


# Sandia's CREW Project

Continuous Reliability Enhancement for Wind (CREW)

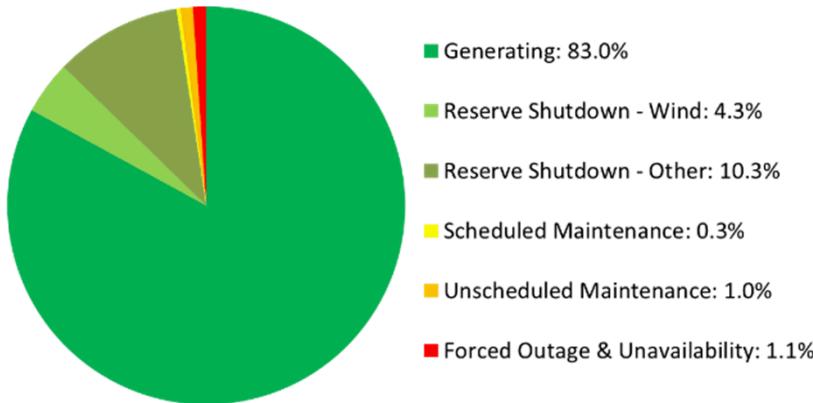
- Improve US wind fleet reliability
- Strategic technology improvements are accomplished by:
  - ***Establishing a US Wind Fleet Benchmark*** that can be used to drive DOE Technology Investments and as a baseline to which owner/operators can identify improvement opportunities.
  - ***Deep technical analysis of a few wind farms*** to provide performance and reliability tools and model validation, root cause analysis of failures and research on operations.
- Past CREW approach
  - SCADA feeds from individual plants to SNL database. Data was aggregated into fleet-level model for reliability benchmarking and analysis
- New approach shifts from low-level SCADA feeds to high-level summarized availability and reliability data dumps

# CREW Data Flow & Process

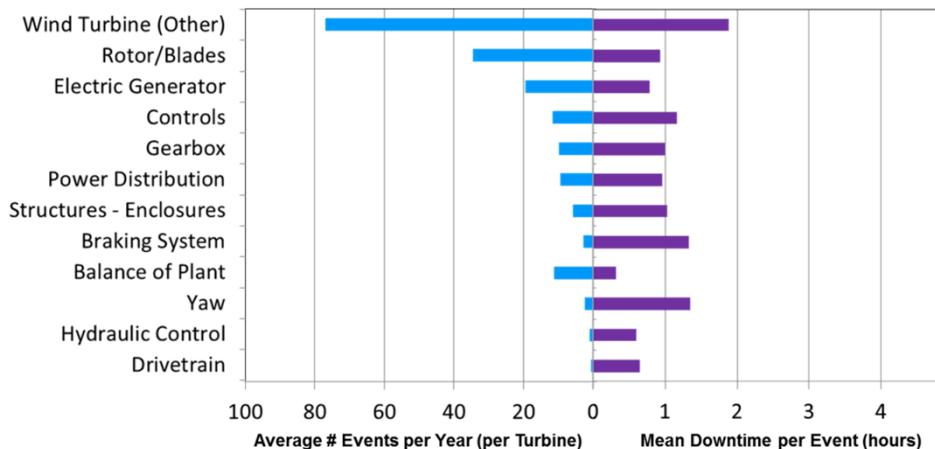


- Wind farm owners provide summarized performance and reliability data in monthly reports
- NDAs define terms for data sharing
- Standardization of data reporting aligned with IEC 61400-26 and IEA Task 33 recommendations
- Data will be scrubbed to remove and protect proprietary information
- Aggregated CREW database will be made available to researchers for analysis
- No proprietary information will be included
- Annual public benchmark will be performed to identify and quantify DOE technology improvement opportunities
- Data partners receive a partner-specific report

# 2013 CREW Benchmark



- Average: 1.6 days of generating before each downtime event
  - Some events automatically reset, others need intervention



- Data represents 327,000 turbine-days
- Key metrics all slightly improved, compared to 2012

	2013 Benchmark	2012 Benchmark
<b>Operational Availability</b>	97.6%	97.0%
<b>Utilization</b>	83.0%	82.7%
<b>Capacity Factor</b>	36.1%	36.0%
<b>MTBE (hrs)</b>	39	36
<b>Mean Downtime (hrs)</b>	1.3	1.6

- Gearbox not in top 5 systems
  - Benchmarking faults and symptoms, at this point
  - Current emphasis on electronic work orders for wind industry

# Conclusion

- Availability and reliability data are needed to create a continuous picture of the power plant's performance over its lifetime.
- Uniform tagging across different datasets is critical
  - IEC and IEA have made great strides towards achieving this
- Meaningful technical benchmarking requires normalization with respect to physical processes (technology, location etc.)
- SCADA data analysis could enhance the relationships and give accurate lifetime performance (power and reliability) estimates
- Data sharing is an important piece to understanding the health of the wind industry and will lead to a lower COE

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# Thank you!

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