Welcome

2006 Wind Turbine Reliability Workshop

Roger Hill

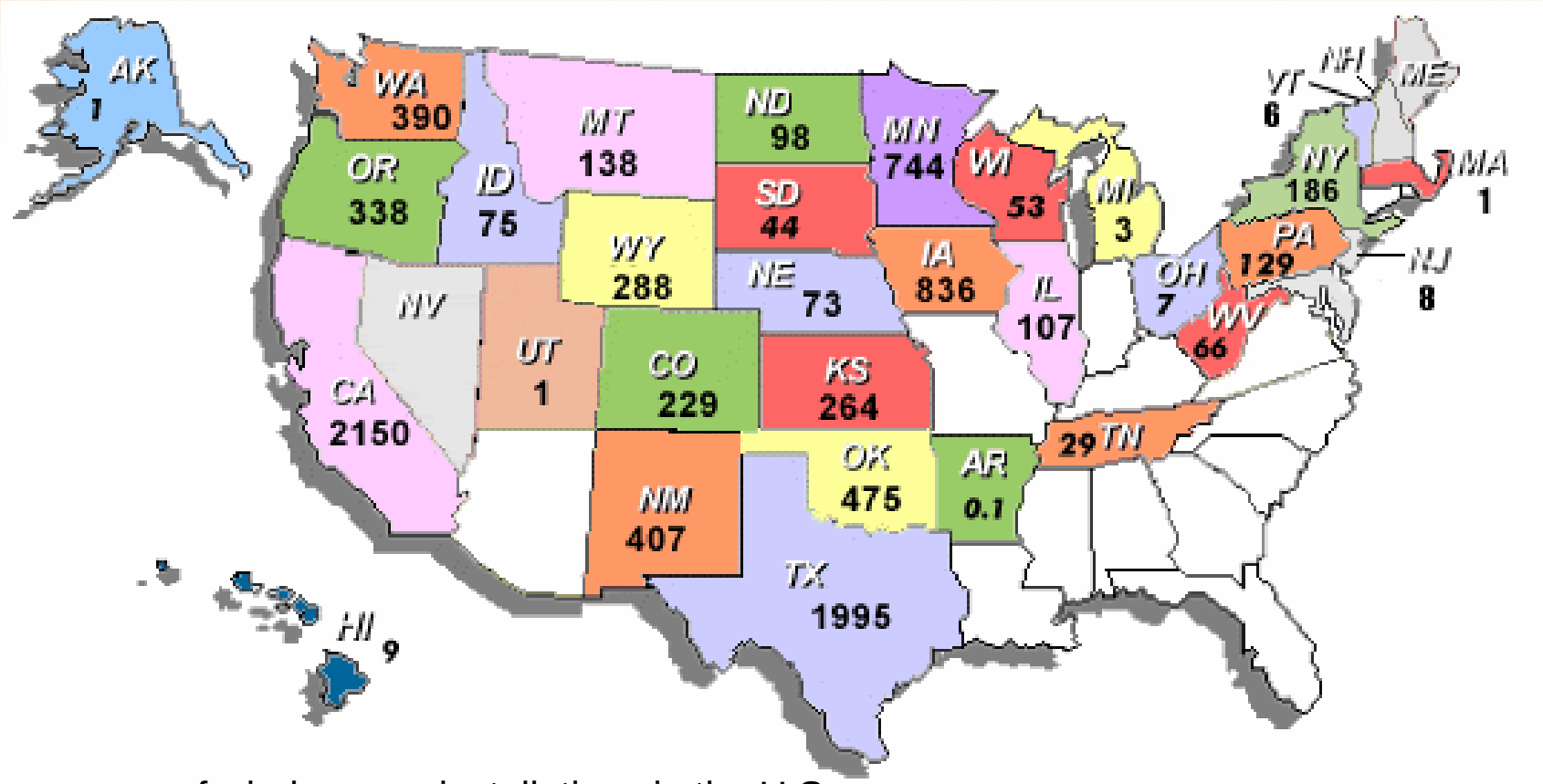
Sandia National Laboratories

rrhill@sandia.gov; 505-844-6111

DOE's Wind Program's mission includes coordination with stakeholders on activities that address barriers to wind energy use.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Status of Wind Power in the US



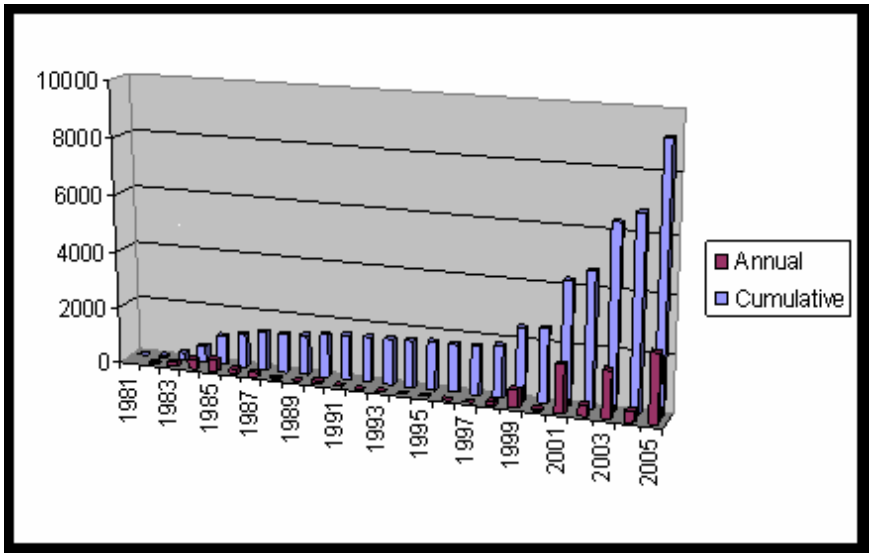
Leading owners of wind energy installations in the U.S.

Source: AWEA

#1 FPL Energy – 3,192 MW
#2 PPM Energy – 518 MW
#3 MidAmerican Energy – 360.5 MW
#4 Caithness Energy - 346 MV
#5 Edison Mission Group – 316 MW
#6 Shell Wind Energy - 315 MW

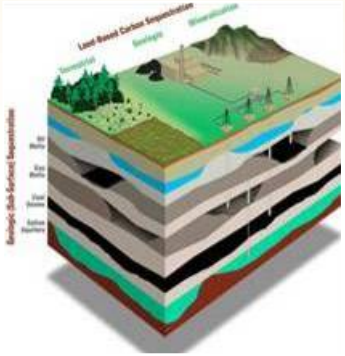
Manufacturers' Installed Capacity for the Past Five Years

2005	GE Energy 1,433 MW	Vestas 700 MW	Mitsubishi 190 MW	Suzlon 55 MW	Gamesa 50 MW
2004	GE Energy 171 MW	Mitsubishi 120 MW	Vestas 97 MW		
2003	GE Energy 903 MW	Vestas 359 MW	Mitsubishi 201 MW	NEG Micon* 129 MW	Gamesa 56 MW
2002	Vestas 175	NEG Micon* 98 MW	GE Energy 62 MW	Mitsubishi 61 MW	Bonus* 48 MW
2001	Vestas 653 MW	Enron Wind* 418 MW	Bonus* 278 MW	Mitsubishi 221 MW	NEG Micon* 119 MW



Source: AWEA

Sandia Energy Programs



Technologies include Concentrating Solar Power, Photovoltaics, *Wind,* Geothermal, Energy Storage, Well Construction, Reservoir Evaluation and Production, Storage and Transmission, Energy and Water, Fuel Utilization

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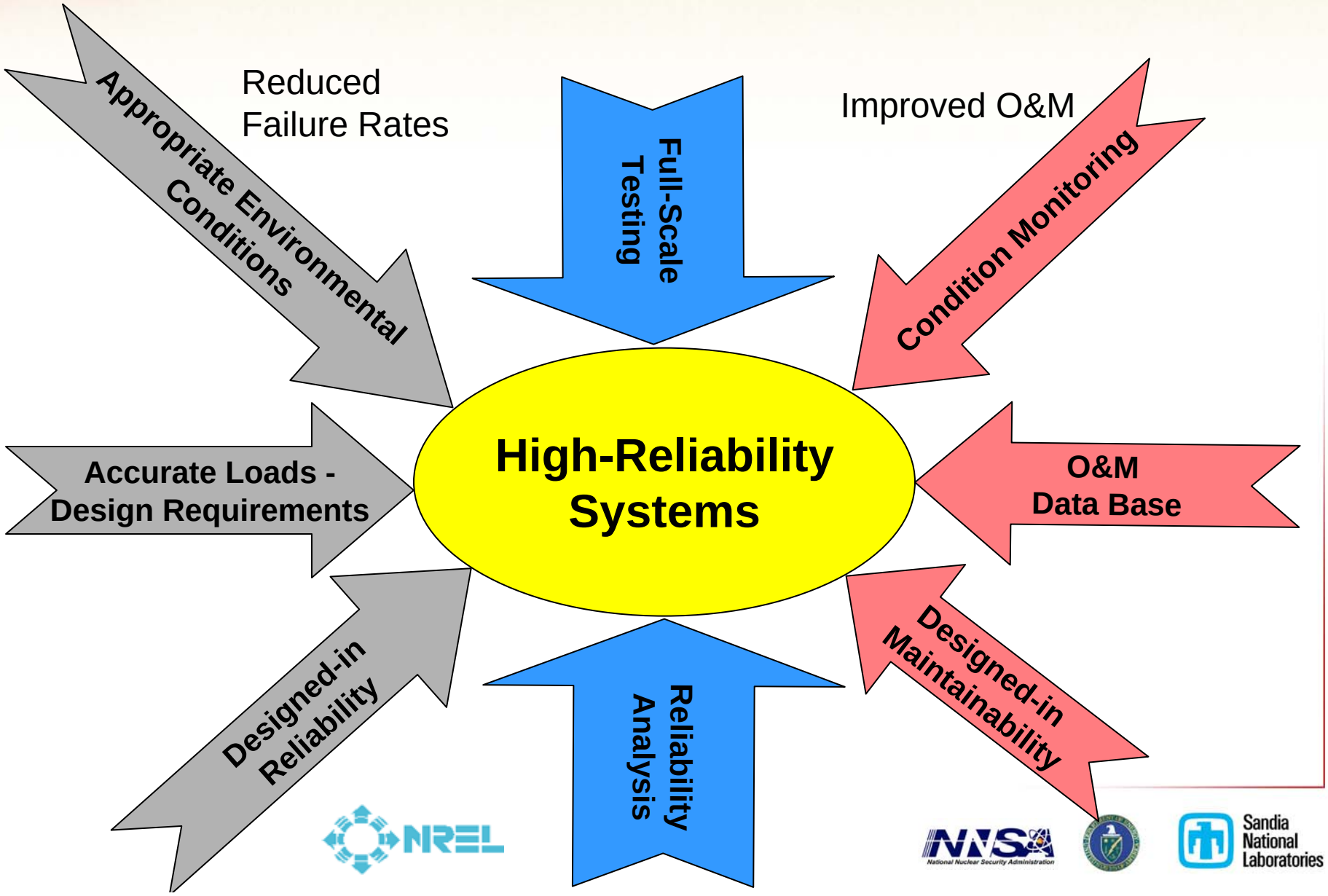
Purpose of the Reliability Workshop

Recognized Need for Improved Reliability

- **Industry and others have acknowledged the importance of reliability in the continued growth and expansion of markets for wind turbine technology**
- **Critical for increasingly hostile environments and the impacts are broad, ranging from economics to advancement of designs.**
- **Looking at increased efforts in reliability research and resultant R&D improvements to wind turbine design, operations, and maintenance**
- **Here to have a forum to learn better define, increase the fidelity of knowledge relating to unreliability, and develop paths to move forward.**

The value comes in having the opportunity to do something to prevent the failure from occurring…Thus prediction becomes part of the process of "designing the future"

What is Required to Develop High-Reliability Systems?

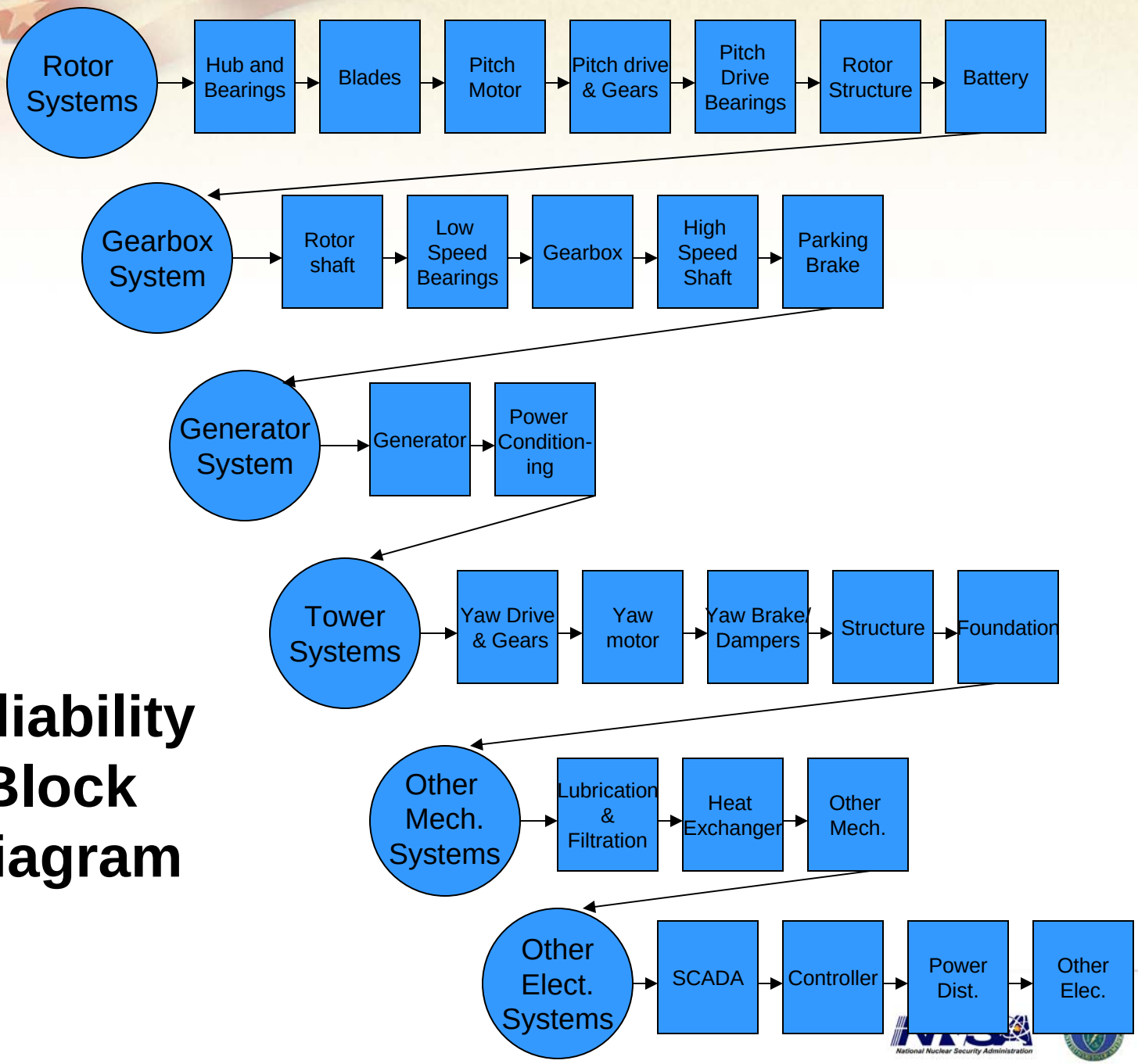


Reliability Analysis

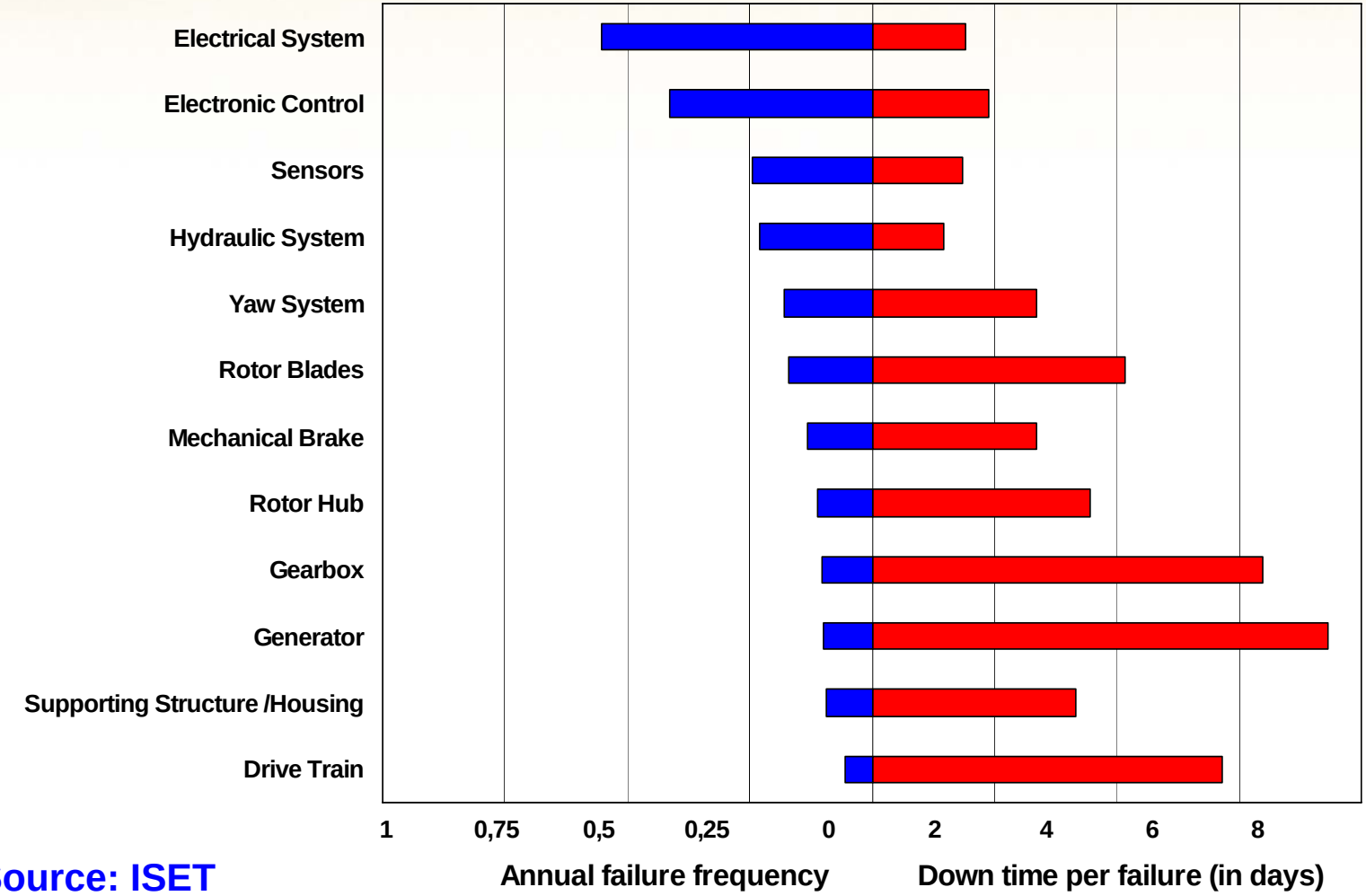
Reliability assessments will have interfaces with all aspects of design, as well as O&M requirements and limitations, and life cycle costs

- **Initially, the system will be broken down into components, failures and understanding of failure modes and effects**
- **System reliability results are calculated using failures populated with real data, to do this….**
  - **Recruit partners**
  - **Obtain data**
    - SCADA
    - Work Orders
    - Interviews
    - Maintenance steps/training
- **Results of model analysis will be system mean time between failures, (MTBF), system mean time to repair (MTTR), availability**
- **Create models and estimate costs, identify key areas for attention**

Reliability Block Diagram



Affected Components and Downtime



Source: ISET
Paul Kühn 04/2006

Failure Rates and Downtimes

Workshop Program

- Managing Costs of Unreliability
- Perspectives for Reliability Improvements
- Gearbox Issues
- Controls, Power Electronics, and Generator
- Reliability Review
- Pitch Systems
- Blades, Larger and Lighter, How Reliable
- Reduced Turbine Costs in the Life Cycle
- Operators' Remark
- Group Discussion