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Sandia's Wind Turbine Reliability Program

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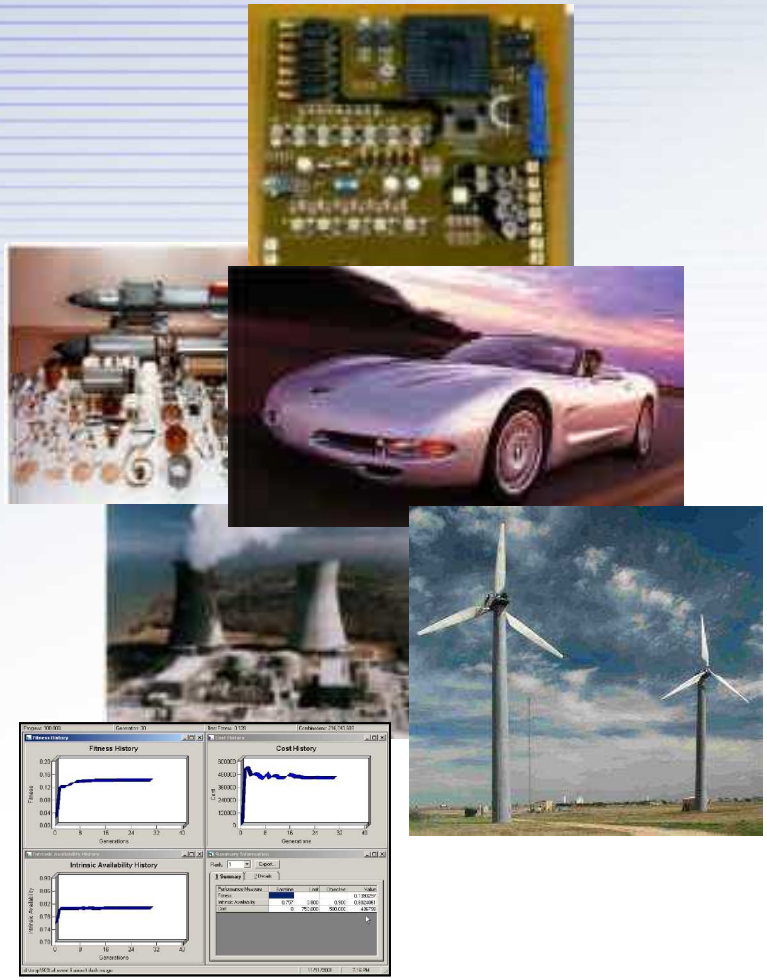
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories

Sandia's Reliability Capabilities

- Sandia Labs is leading the National Wind Reliability effort
- The Center for System Reliability (CSR) started in 1998
  - Developed and uses a reliability software tool (Pro-Opta) that addresses a wide range of reliability issues
  - Application areas are wide ranging
- Sandia's reliability expertise is focused on technology research and development

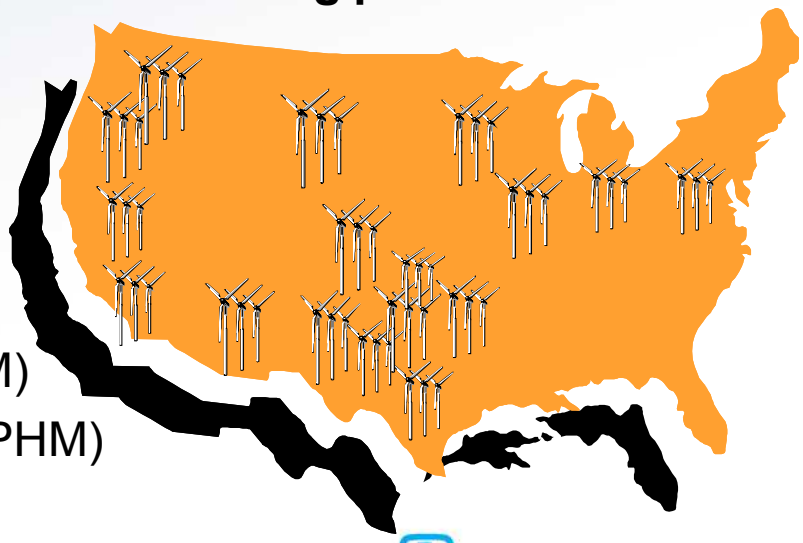


SNL's Pro-Opta reliability software

Program Goals and Objectives

Working through industry partnerships to:

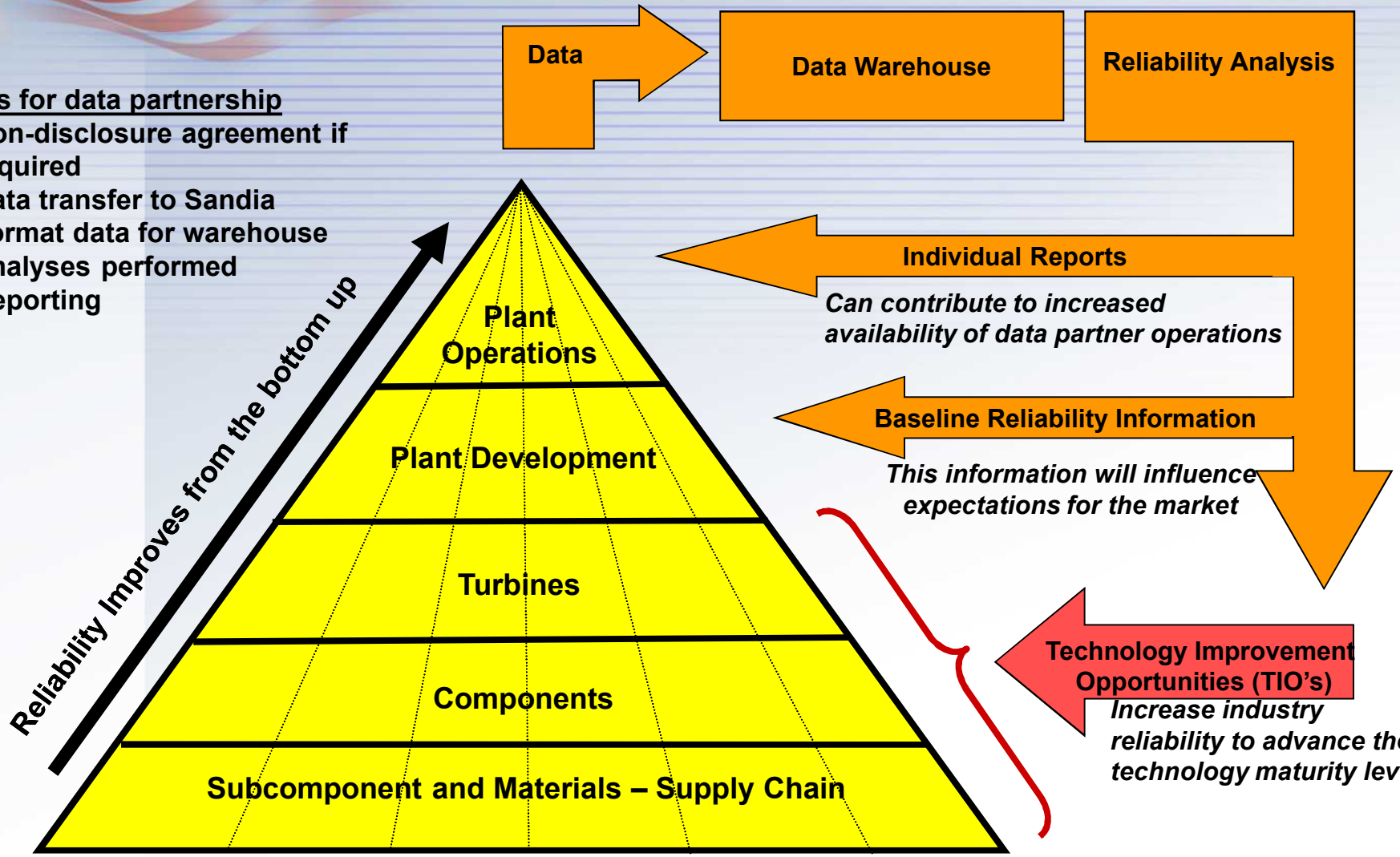
- **Develop National reliability baseline statistics for the US wind energy industry**
  - **Turbine component failure rates are higher than expected by some**
  - **This is the first long-term, data based, national effort to quantify and track these failures**
- **Guide efforts to address important component reliability problems**
- **Provide feedback for improving design and manufacturing practices**
- **Help wind plants:**
  - **Improve asset management for**
  - **Optimize O&M practices**
    - Preventive maintenance
    - Parts inventory optimization
    - Condition-Based Maintenance (CBM)
    - Prognostic & Health Management (PHM)



Data Driven Analysis Improves Reliability

5 Steps for data partnership

- Non-disclosure agreement if required
- Data transfer to Sandia
- Format data for warehouse
- Analyses performed
- Reporting



Reliability Program is Unique

Typical corporate reliability program

- **GOAL** – Profit
- Analyses done before deployment to field
- Focus on a single product
- More control over data
- Results kept in house
- Less incentive to improve industry as a whole
- Detail oriented – down to the nuts and bolts level
- Work directly with design and engineering
- Profit oriented

The result of any reliability program should be continuous product, system or process improvement.

National wind reliability program

- **GOAL** – Improve industry as a whole (i.e. blade collaborative)
- Analyses done with field data (owned by others)
- Many manufacturers, sizes, and types of turbines – systems engineering
- Data acquisition is complex
  - **Security – anonymity**
  - **Many data sources – electronic, SCADA, paper work orders, - data must be normalized**
  - **Large amounts of data**
- Results shared with industry and individual data partners
- Provide basis to guide standards and technology improvement opportunities (TIO's) for manufacturing, operations, and engineering
- Strategically oriented to mitigate reliability problems

National Reliability Database

Other Databases

European, NREL, etc.

Data formatting – SNL staff

Data Warehouse

Relational Database

Time Series data system

SCADA reports

Operational field data

Work orders – Maximo, electronic, manual

National Reliability Data Portal

Publicly available normalized statistical results

Analysis

SNL Informational Firewall

Analysis

Normalized statistical reports/analyses to industry

Proprietary reports/analyses to data partners

Determine Technology Improvement Opportunities

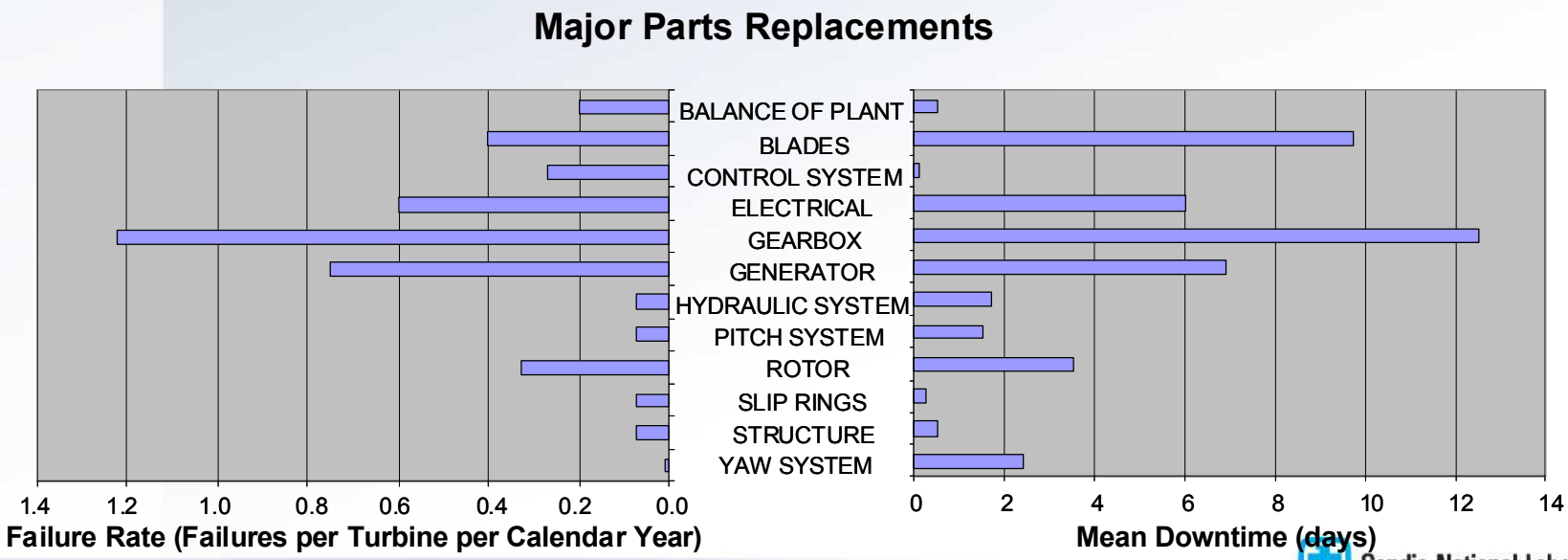
Publicly available information

Proprietary information - available to Sandia and data partners only

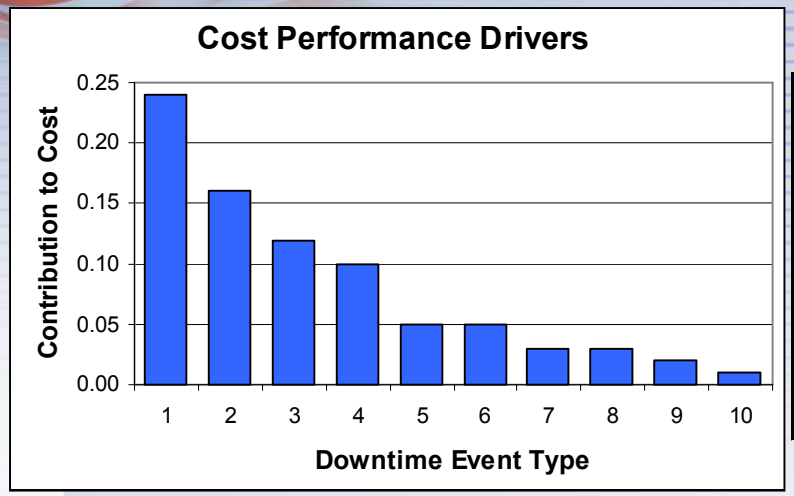
Reporting Examples

Major Parts Replacements

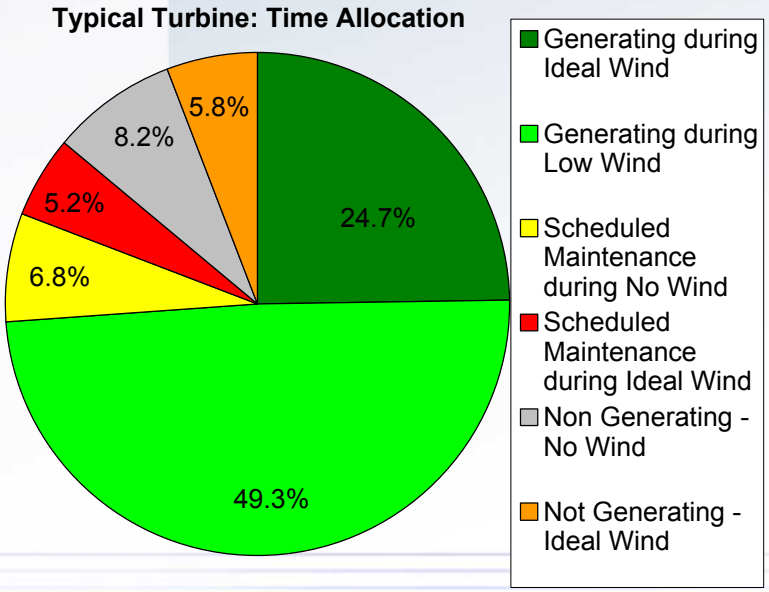
- **Frequency (“Failure Rate”), Duration (“Mean Downtime”) for major failures causing parts replacement**

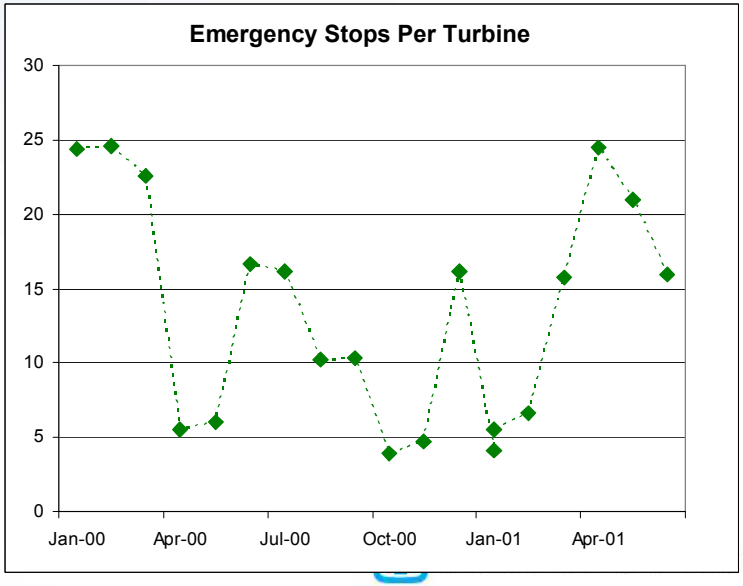


Reporting Examples



Downtime Event Type	
1	Generator
2	Unidentified Failure
3	Rotor::Blade
4	Maintenance::Testing-Mx
5	Electrical::Power converters-Mx
6	Generator::Converter
7	Pitch system-Mx
8	Control system-Mx
9	Yaw System::Yaw control system-Mx
10	Electrical::Circuit breakers and switches





Next Steps

- Customer checklist (Word document):
  - Data transfer
  - Data management
  - IT issues
  - Reporting
  - Meetings
  - Contacts
  - Etc.