Sandia's Wind Turbine Reliability Program

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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**
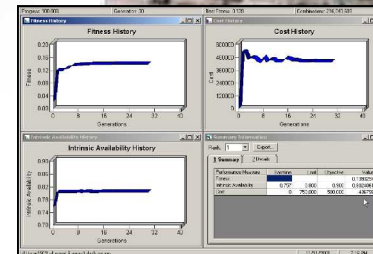
SNL's Pro-Opta reliability software

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Program Goals and Objectives

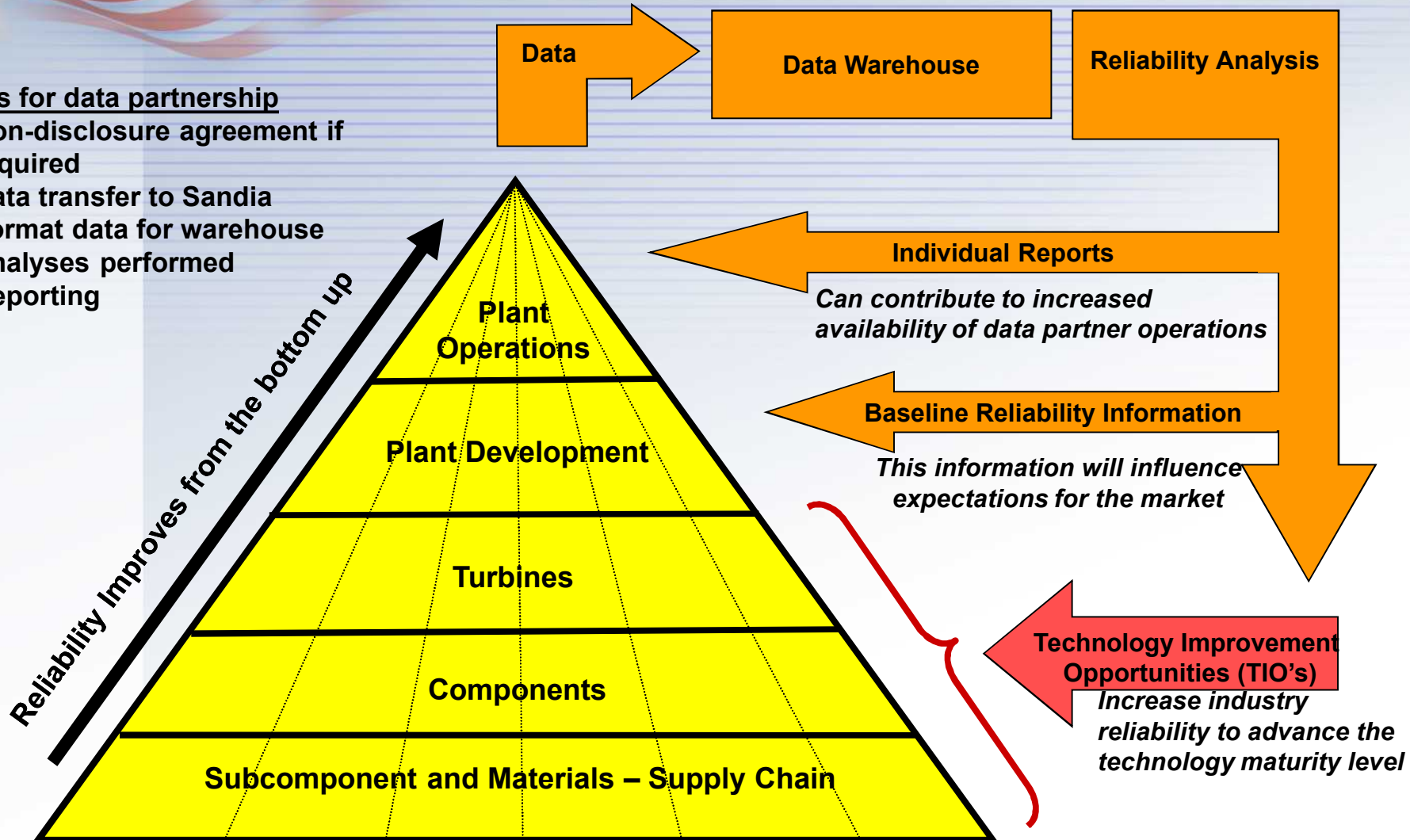## *Working through industry partnerships to:*

- **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)

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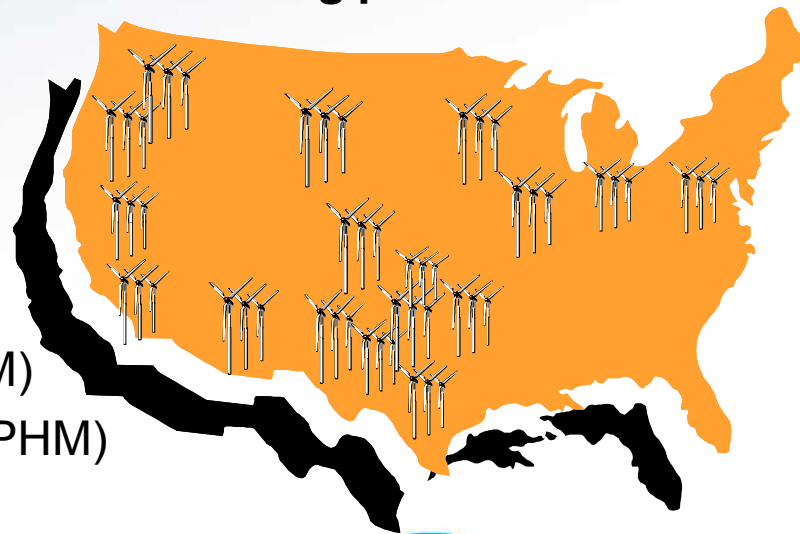
Data Driven Analysis Improves Reliability

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

Data

Data Warehouse

Reliability Analysis

Reliability Improves from the bottom up

Plant Operations

Plant Development

Turbines

Components

Subcomponent and Materials – Supply Chain

Individual Reports

Can contribute to increased availability of data partner operations

Baseline Reliability Information

This information will influence expectations for the market

Technology Improvement Opportunities (TIO's)

Increase industry reliability to advance the technology maturity level

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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.
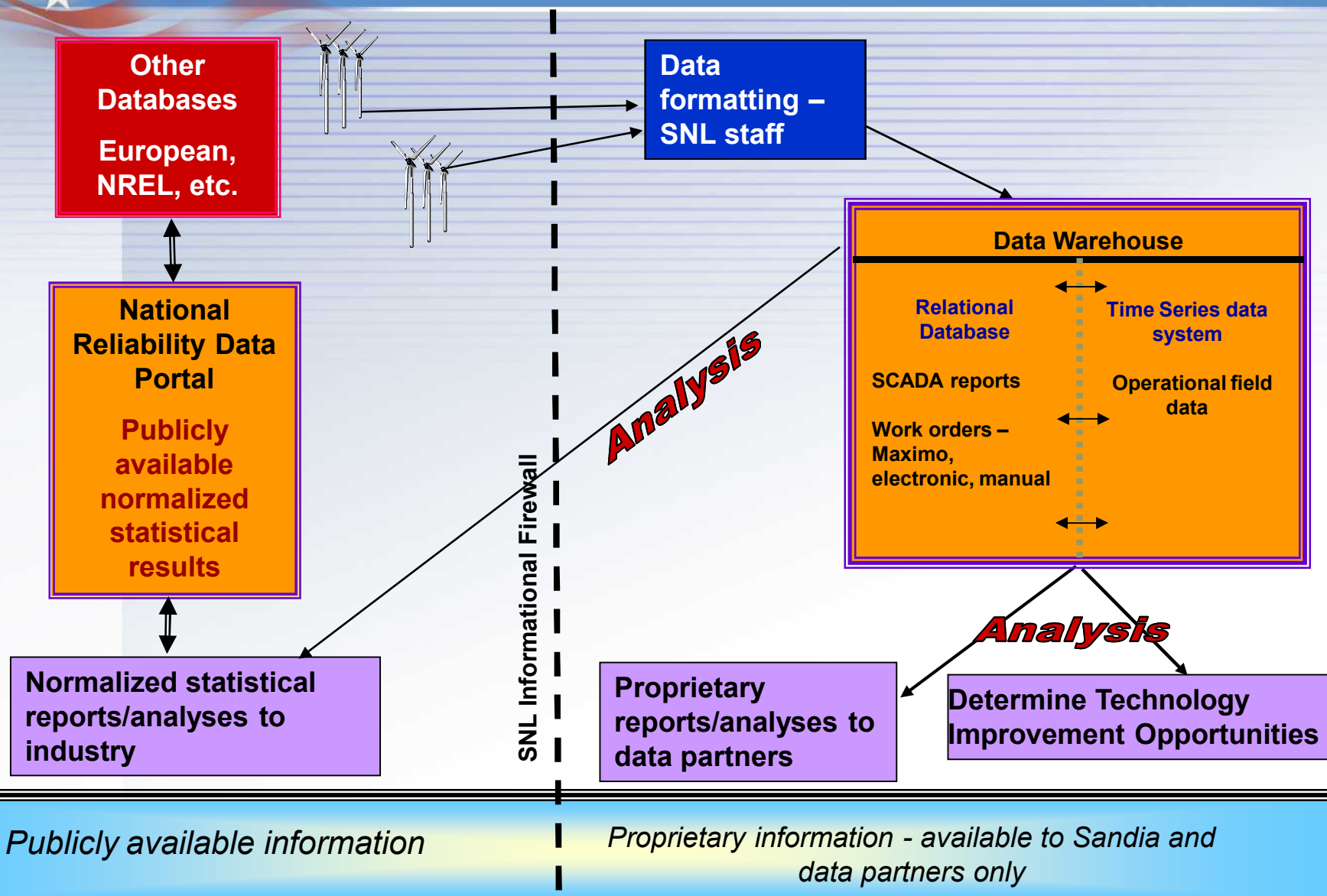
National wind reliability program

- **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
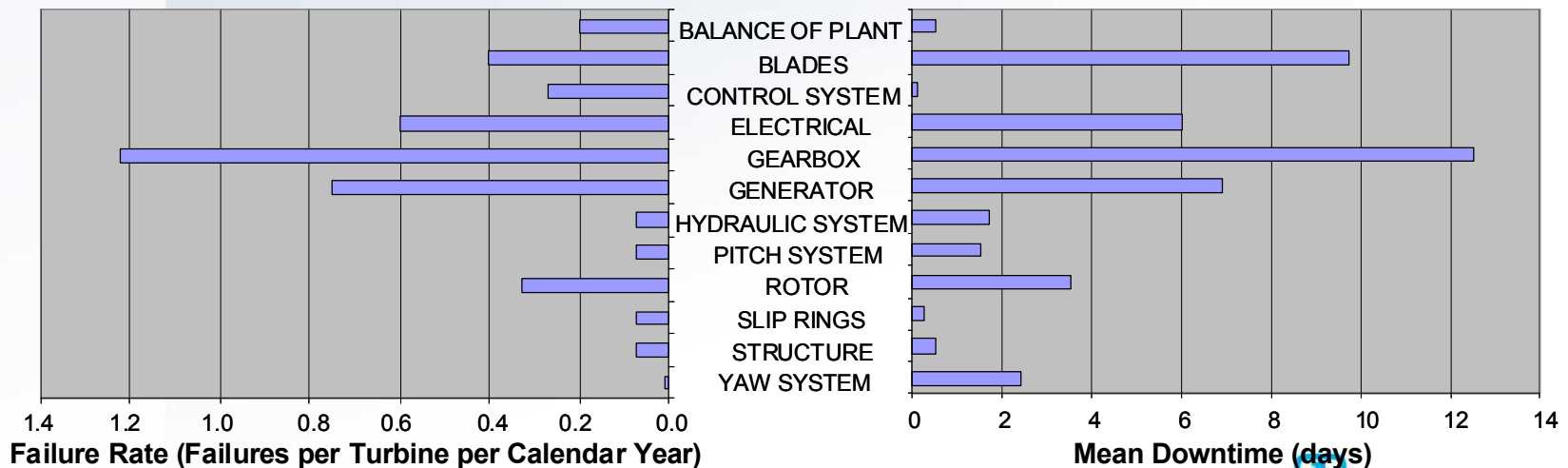- Strategically oriented to mitigate reliability problems

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National Reliability Database

Other Databases

European, NREL, etc.

Data formatting – SNL staff

National Reliability Data Portal

Publicly available normalized statistical results

Analysis

Data Warehouse

Relational Database

Time Series data system

SCADA reports

Work orders – Maximo, electronic, manual

Operational field data

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
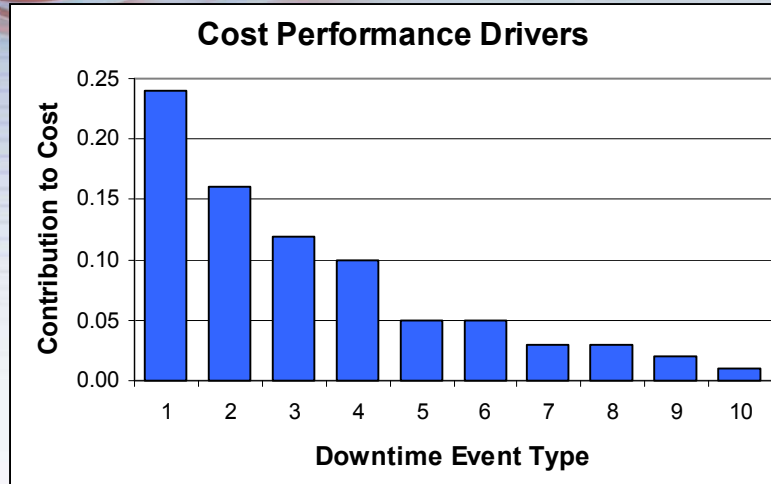
Major Parts Replacements

- **Frequency ("Failure Rate"), Duration ("Mean Downtime") for major failures causing parts replacement**
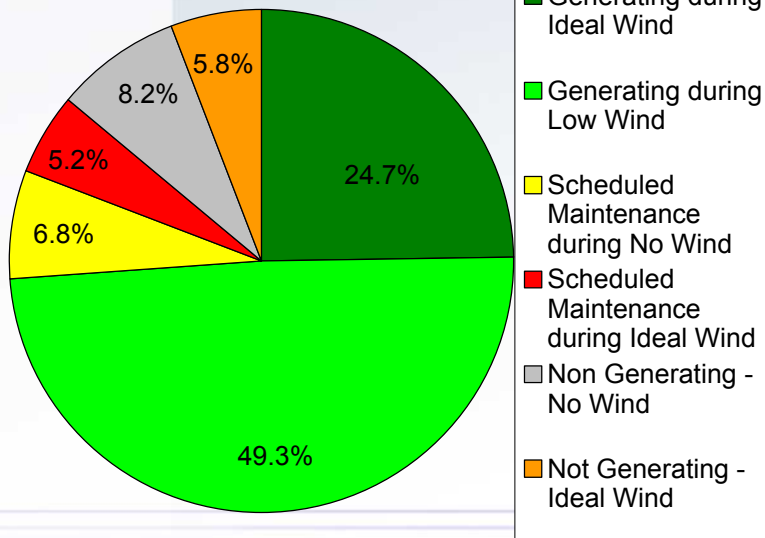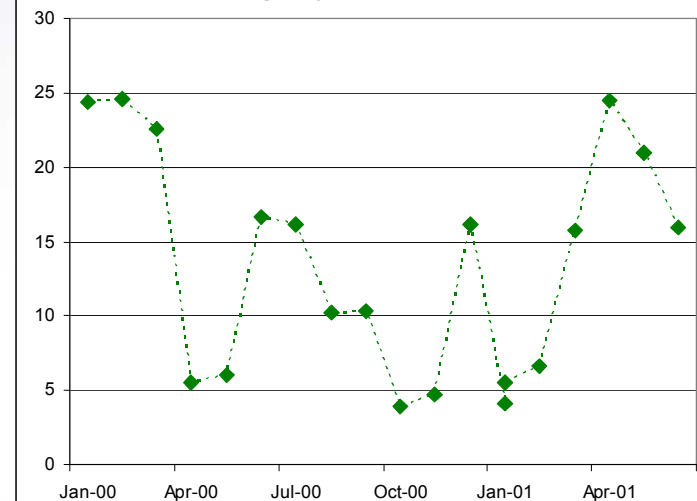
Major Parts Replacements

Failure Rate (Failures per Turbine per Calendar Year) — Mean Downtime (days)

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Reporting Examples

Cost Performance Drivers

	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

Typical Turbine: Time Allocation

- Generating during Ideal Wind — 24.7%
- Generating during Low Wind — 49.3%
- Scheduled Maintenance during No Wind — 6.8%
- Scheduled Maintenance during Ideal Wind — 5.2%
- Non Generating - No Wind — 8.2%
- Not Generating - Ideal Wind — 5.8%

Emergency Stops Per Turbine

■ **Customer checklist (Word document):**

- **Data transfer**

- **Data management**

- **IT issues**

- **Reporting**

- **Meetings**

- **Contacts**

- **Etc.**

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