SCADA Data Mining and IT Needs to Improve Plant Operation and Downtime

AWEA Wind Power Asset Management Workshop

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SCADA Defined

- Supervisory Control and Data Acquisition system
- Actual definitions and descriptions can vary – some skip the "supervisory control" part and just handle the data side
- Projects need data analysis, not just acquisition

Three Levels of SCADA Systems

- Systems focused on site operations
  - Primarily systems provided by turbine manufacturers
- Systems focused on project-level analysis
  - Primarily small-scale, third-party systems
- Systems designed for enterprise-level, fleet-wide analysis
  - Almost exclusively third-party systems, especially when handling multiple turbine types

What They're Generally Best At (Although All Systems Vary)

Task	Manufacturer's Project SCADA	Third-party Project SCADA	Enterprise SCADA
Day-to-day project operations	Best ☺	Good 😐	Fair ☹
Month-to-month project performance analysis	Fair ☹	Best ☺	Good 😐
Evaluation and comparison of entire wind portfolio	Poor 💣	Fair ☹	Best ☺

Why Use Third-Party Systems?

- Provides common system and interface when mixing turbine manufacturers
- Generally more customizable for reporting and analysis purposes
- Provides independent measurements and analysis – the system calculating availability will not be designed by the people who have to pay for low availability
- Frequently more functionality and data storage

Why Not Use Third-Party Systems?

- Often redundant to some extent, if turbine manufacturer requires use of their SCADA for O&M/warranty purposes
- Can be more difficult to get full access to systems for data collection purposes
- Value of analysis tools is limited by quality of data going in
- Cost (perceived or actual)

Hardware and Software Needs – On-Site System

- Most manufacturer's systems are turnkey installations
  - Controller/interface at each turbine or other monitoring point
  - Fiber optic cabling or wireless communications across project
  - Centralized server at operations building

Hardware and Software Needs – Telecommunications

- Security important for control: crucial that unauthorized users not control turbines!
- High-speed, reliable Internet access required for efficient data transmittal
  - Typically, T1 speed and reliability necessary
  - DSL/cable problematic due to speed/availability issues
  - May not be cheap to get wiring to remote sites

Telecommunications (Continued)

- Project-specific needs:
  - Data transmittal to utility
  - Data transmittal to forecasting services
  - Internal presentation
  - Public presentation

Hardware and Software Needs – Off-Site/Enterprise Systems

- **Lots of Storage**
  - Data need to be readily available in order to be useful
  - Desktop-type database systems generally inadequate for management of long-term data
  - Large project can generate many GBs of data/year – multiply by several projects and several years
  - Data backup system is (of course) important

What Can be Learned by Mining SCADA Data?

- Verification of turbine and plant performance
- Assessment/prediction of failures
  - Predictive maintenance of large components (including condition monitoring)
  - Evaluation of faults and minor components
- Quantification of effects of problems and prioritization of efforts to solve problems
- Warranty claim support

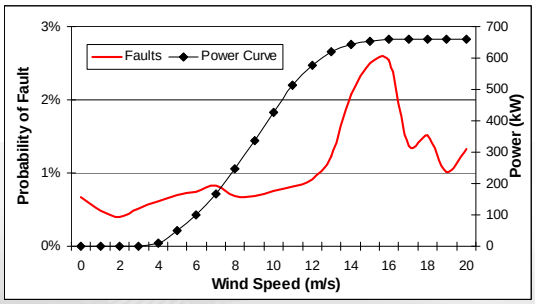
Objective: Optimize Operations to Maximize Profit

- … not turbine availability, energy production, or project revenue, if at the expense of cost or effort
- On-site operations are frequently driven by reactions to short-term problems and may not reflect the best overall strategy

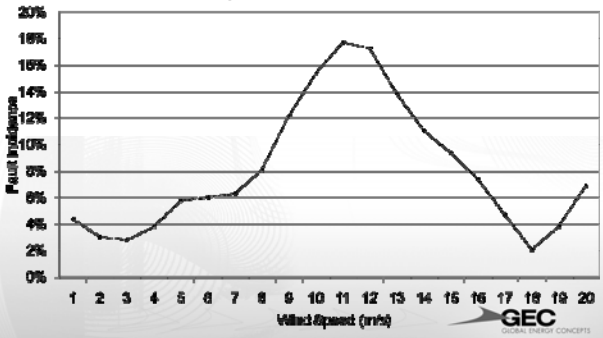
Condition Monitoring

- The more data you have, the easier it is to discover impending problems
  - Comparison of measurements across a turbine fleet
  - Comparison of measurements over time
- Modern turbines have huge numbers of sensors for trend analysis
- Interpretation can be tricky! Weighing indications of potential failure vs. replacement cost is tricky
- Use of full condition monitoring systems (e.g., vibration analysis)

Fault Analysis: Overheating/Power Regulation

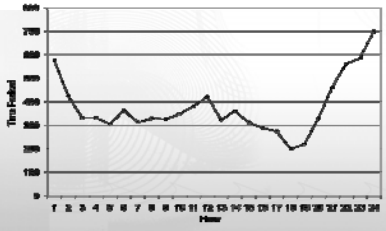


Fault Analysis: Pitch System Problems

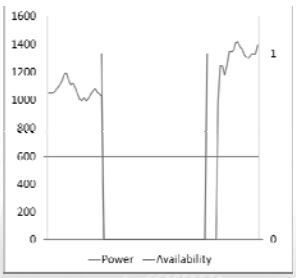


Downtime vs. Time of Day

- Cost-effectiveness of nighttime and weekend fault response plans
- Better assessment of lost revenue, considering time-of-day pricing



Fault Recovery Time



- Are 30-minute faults more realistically 60-minute faults?
- Is this being accurately considered in availability calculations?
- Would it be more cost-effective to "ride through" faults with lower power output?

Environmental Considerations (Examples)

- Blade soiling assessment
  - Cost of reduced power output vs. cost of blade washing
- Site access restrictions
  - Cost of lost power vs. cost of snow removal
- Heated control anemometry
  - Cost of downtime due to frozen sensors vs. cost of changes to sensor types

Component Failure Rate Analysis

- SCADA can provide supporting data for component failure predictions and/or serial defect analysis
  - Tie SCADA to site maintenance logs/parts inventory (e.g., CMMS = Computerized Maintenance Mgt System)
  - Comparative studies of subcomponents from different vendors
- Long data history is (again) very important
  - Major components should have zero failures until late in project life
  - By the time there are enough failures to make predictions, it may be too late

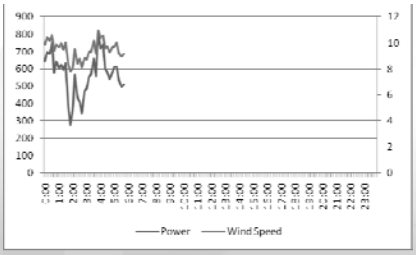
Warranty Claims

- Is availability being calculated accurately?
  - Turbines "paused" or otherwise incorrectly included?
  - Wrong numerator or denominator in availability calculations?
  - If warranty is energy-based, not time-based, is the lost energy being correctly accounted for?

Turbine	kWh	Availability
T01	10908	100.0%
T02	10584	99.8%
T03	0	100.0%
T04	11304	100.0%
T05	540	92.4%
T06	10728	100.0%

Warranty Claims (Continued)

- Analysis of catastrophic failures
  - If anything unusual happened prior to failure, what?
  - If nothing happened, that can be even more valuable



Conclusions

- Turbines generate both energy and data – don't waste either
- Relying only on turbine manufacturer's SCADA can give a limited view
- Getting the best value from the data requires real analysis – no SCADA hands you all of the answers