SECONDWIND
Measurement. Management. And more.

Reliability Centered Maintenance and SCADA

Patrick Quinlan,P.E.

Second Wind Inc.

Second Annual Wind Turbine Reliability Workshop
Albuquerque, New Mexico
September 17, 2007

Overview

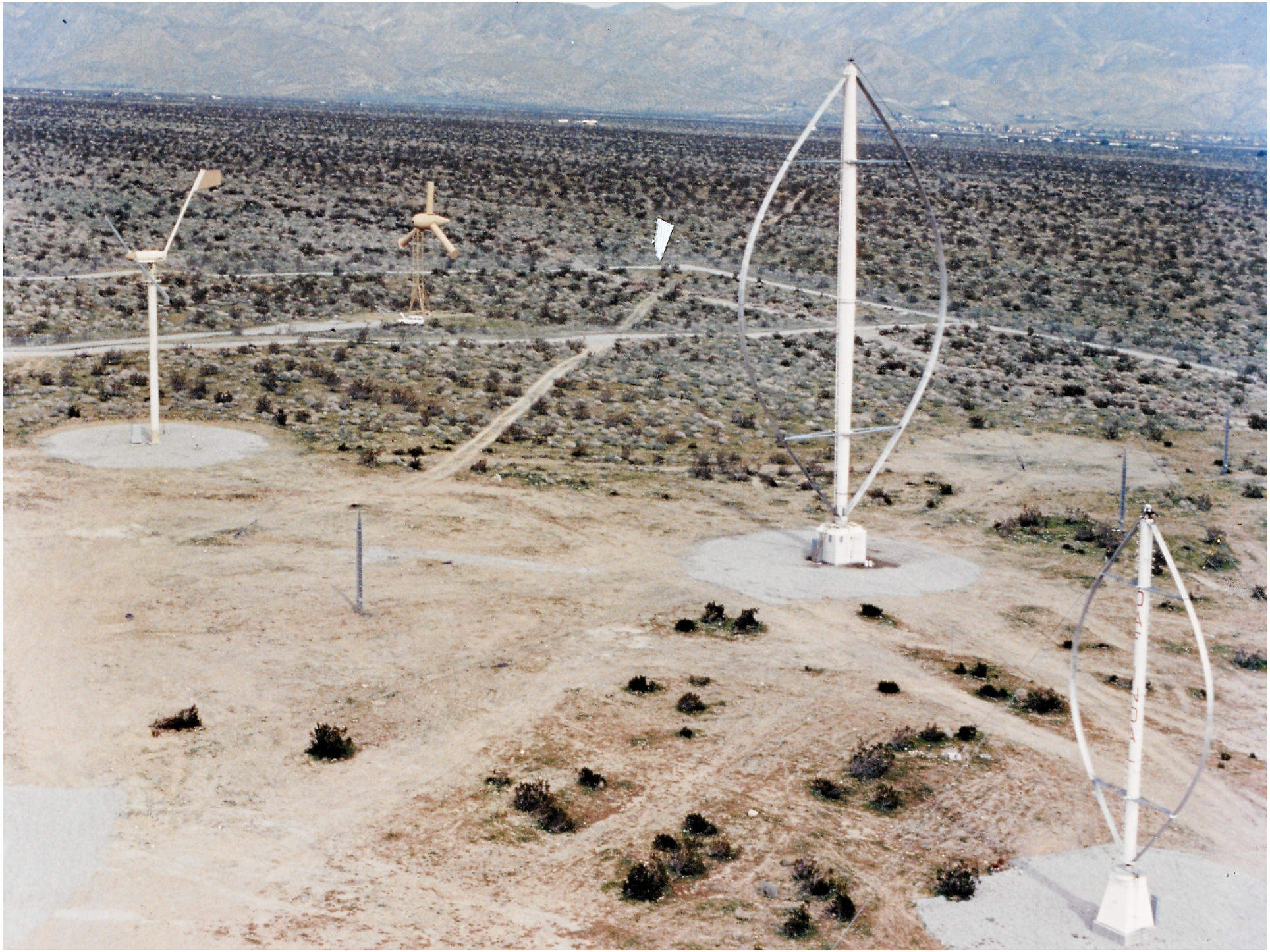
- Reliability Experience
- The Operating Risk/Reward Balance
- RCM 101
- SCADA 101
- Wind Farm SCADA History
- Wind Farm SCADA Today
- Wind Farm SCADA and RCM
- SCADA Issues for a National Wind Farm Reliability Program

Reliability Experience

- Harvard Six Cities Air Quality Study-QC Team
- University of Mass Wind Program
- OSHA, EPA QC, and SPC training
- Southern California Edison Wind Turbine Test Center--test program staff
- Insurance Contractor, Tehachapi and San Gorgonio Pass, California
- Second Wind Inc.—SCADA Business Development

Southern California Edison Wind Turbine Test Program

- Seven Turbines, Three Catastrophic Failures*, One Fatality[T]
  - Bendix Schachle 3 MW Turbine
  - Alcoa 500 kW VAWT Wind Turbine*
  - DAF Indal 50 kW VAWT Wind Turbine
  - DAF Indal 500 kW VAWT Wind Turbine* [T]
  - Wenco 100 kW Wind Turbine
  - Hansen MAT Wind Turbine*
  - Howden 330-kW Wind Turbine

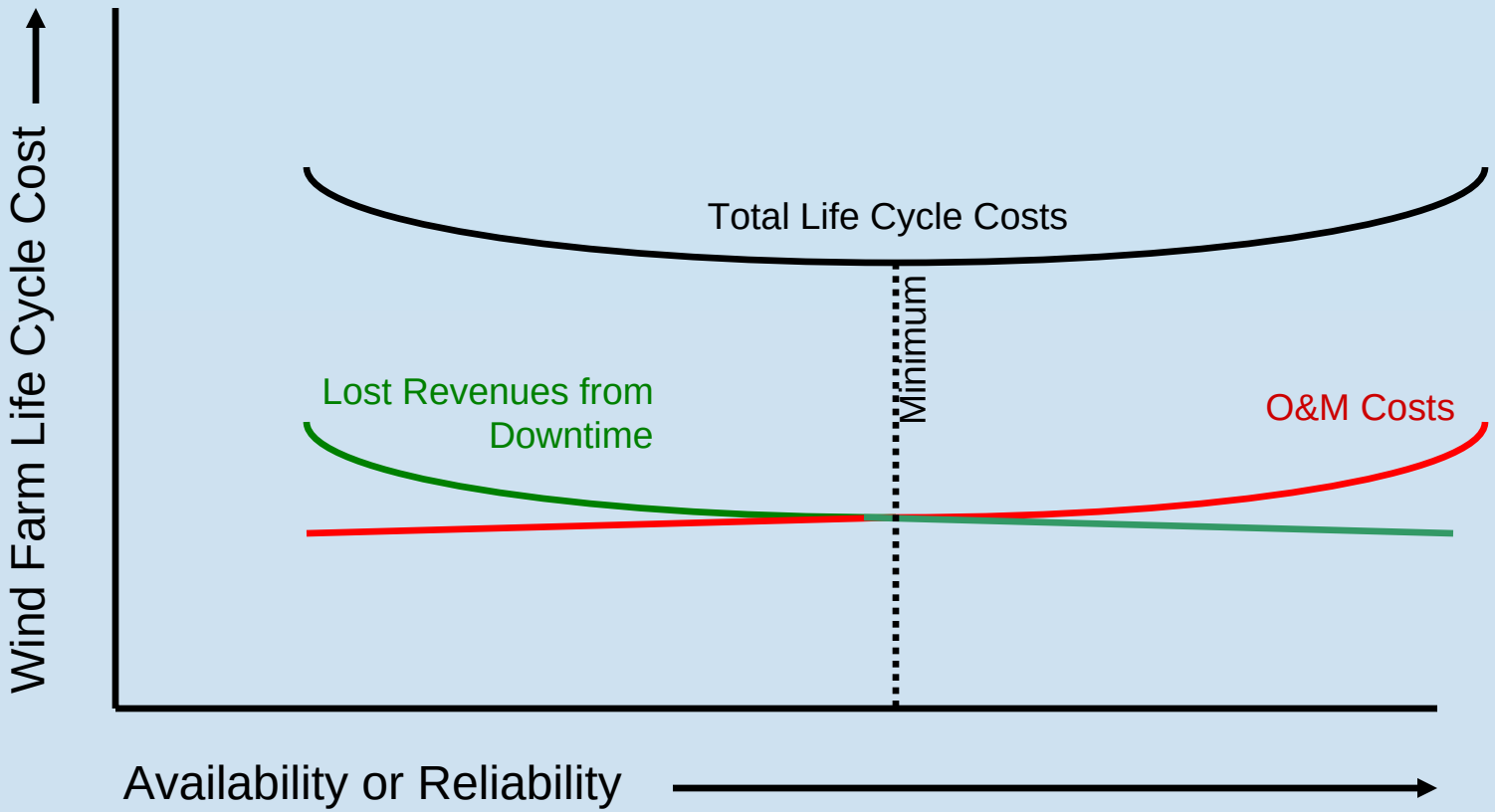


SECONDWIND

The Operating Risk/Reward Balance

- The Risk/Reward Balance:
  - Highest Present Value of Wind Farm Production and Avoided Maintenance and Repair Costs.
- Maintenance Strategies:
  - Easy and Inefficient: Hard Time.
  - Harder and More Efficient: Operating Hours.
  - Hardest and Most Efficient: On Condition—When it Needs it!
- What's the Optimum Operating /Reward Balance Point?
  - Need Perfect Information.
  - Real Time Data is Key--Condition Monitoring.
  - Failure Mechanisms and Rates Need to be Well Understood.
  - Fault Tree Diagnostics Need to be Well Understood.
  - Reliability Centered Maintenance: Approaching the Optimum.

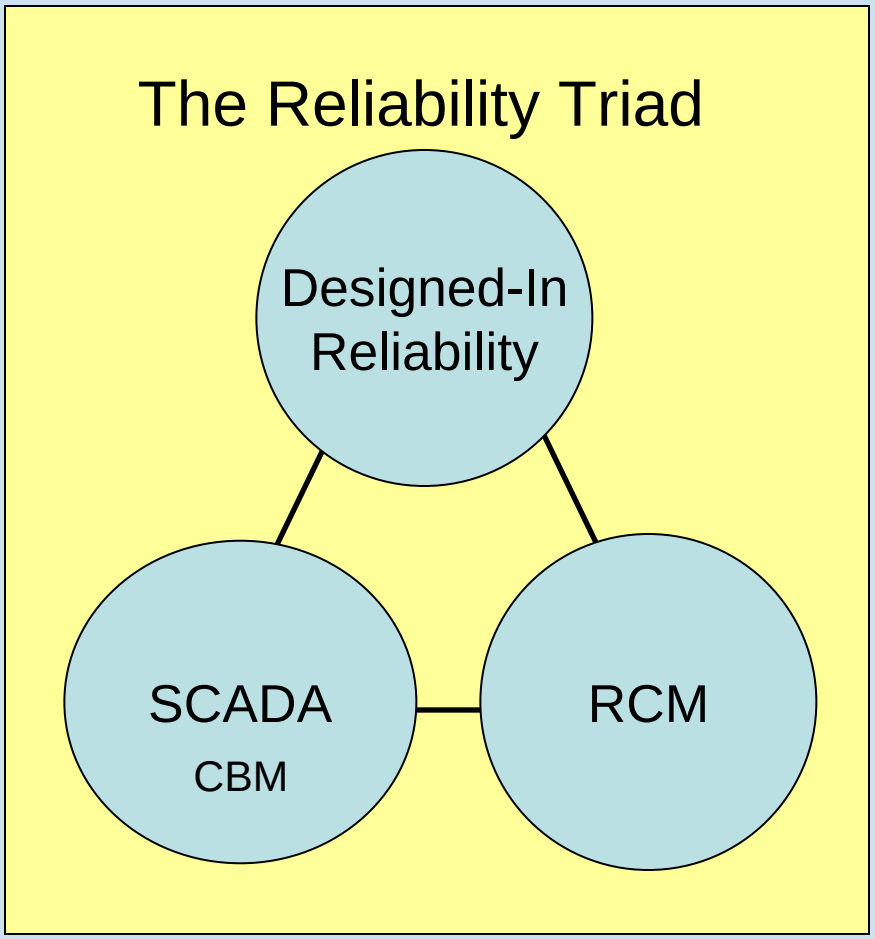
O&M Spending and Lost Revenue Balance Point



SECONDWIND

Reliability Centered Maintenance 101

- Definition: RCM is a logic-based system for maintaining equipment based on identification of failure modes and failure mechanisms.
- Early Work--US Military and Aircraft Industry.
- Cannot improve “designed-in” reliability of equipment.
- Relies on SCADA for actionable information.
- Condition-Based Monitoring (CBM) will grow in importance.



SECONDWIND

RCM and Wind Generation

- Early Wind-Related Work (Quinlan):
  - 1986--*Risk Assessment Methods Applied to Wind Park Operations*, AWEA Wind Energy Expo '86.
  - 1987--*Reliability-Centered-Maintenance Applied to Wind Park Operations*, ASME Wind Energy Symposium.

- Renewed Interest in RCM:
  - Larger Turbines—bigger consequences of cascading failures (lesson learned from MOD-X programs).
  - Components—bigger blades, higher gearbox torque loads, more complicated electrical systems.
  - *A Survey of Failures in Wind Power Systems*. Master Thesis by J. Ribrant. KTH School of Electrical Engineering, Sweden, 2006.

SCADA 101

- SCADA: Supervisory Control and Data Acquisition.
- Initially, wind turbine SCADA was almost all provided by independent vendors (e.g., Second Wind).
- Today, most wind turbine SCADA is provided by the turbine manufacturers, as well as independent vendors
- Early use: predominately fiscal and administrative.
- Later use: engineering post hoc analyses.
- SCADA systems vary widely: 10-minute systems predominate, but 1-second systems gaining popularity for data *historians*.

SECONDWIND

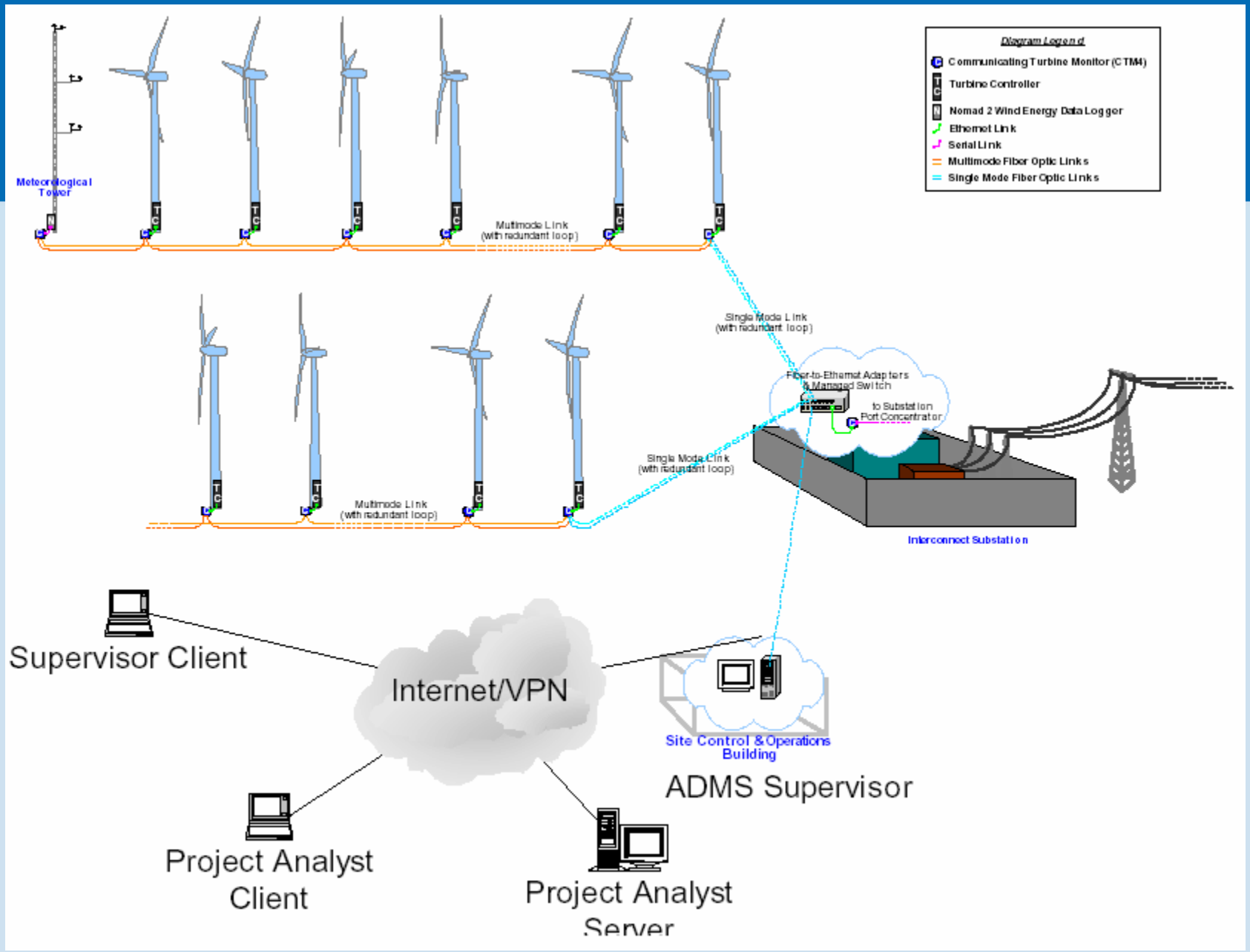
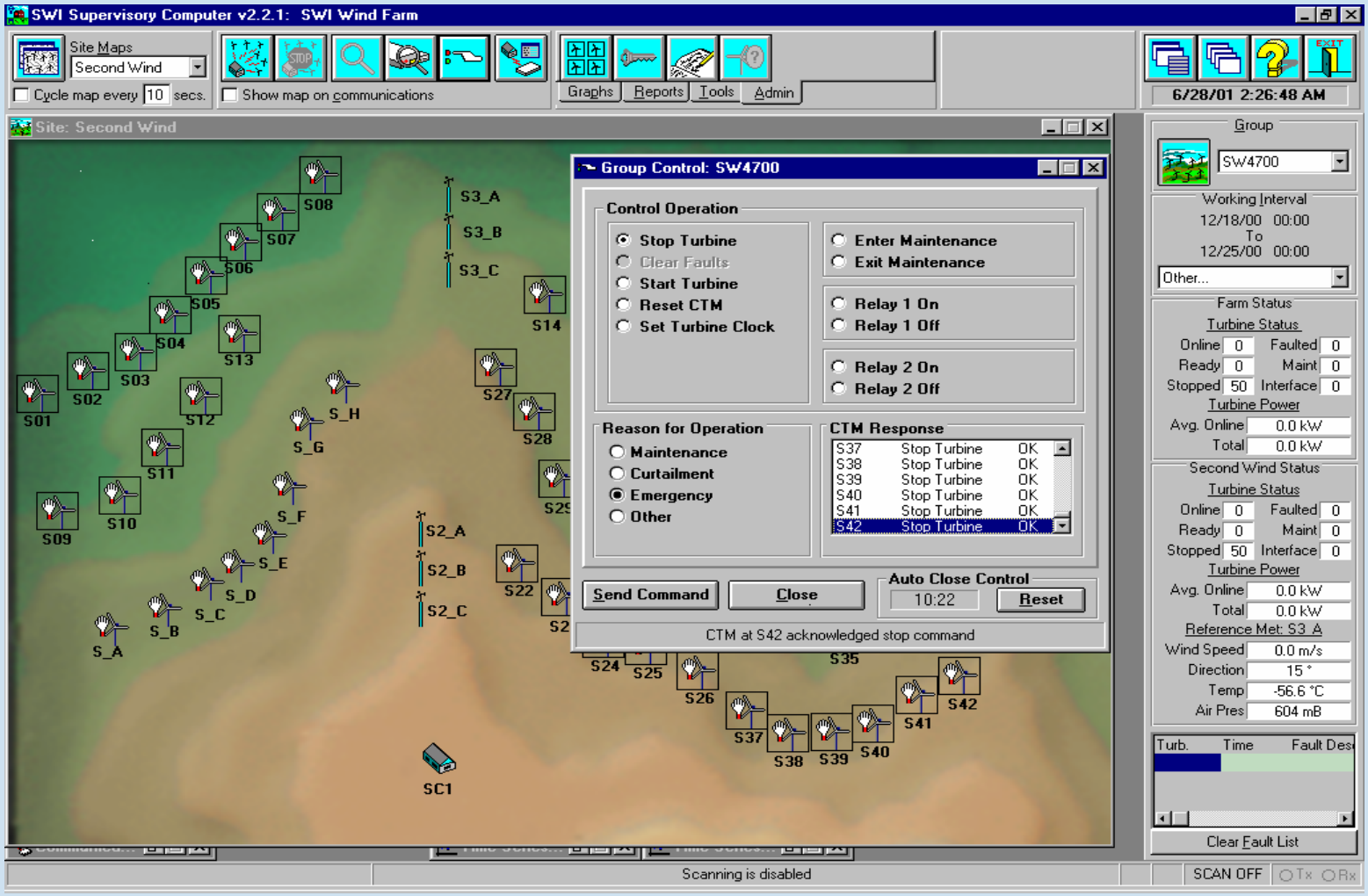


Diagram Legend
Communicating Turbine Monitor (CTM4)
Turbine Controller
Nomad 2 Wind Energy Data Logger
Ethernet Link
Serial Link
Multimode Fiber Optic Links
Single Mode Fiber Optic Links
Meteorological Tower
Multimode Link (with redundant loop)
Single Mode Link (with redundant loop)
Fiber-to-Ethernet Adapters & Managed Switch
to Substation Port Concentrator
Interconnect Substation
Supervisor Client
Internet/VPN
Site Control & Operations Building
ADMS Supervisor
Project Analyst Client
Project Analyst Server

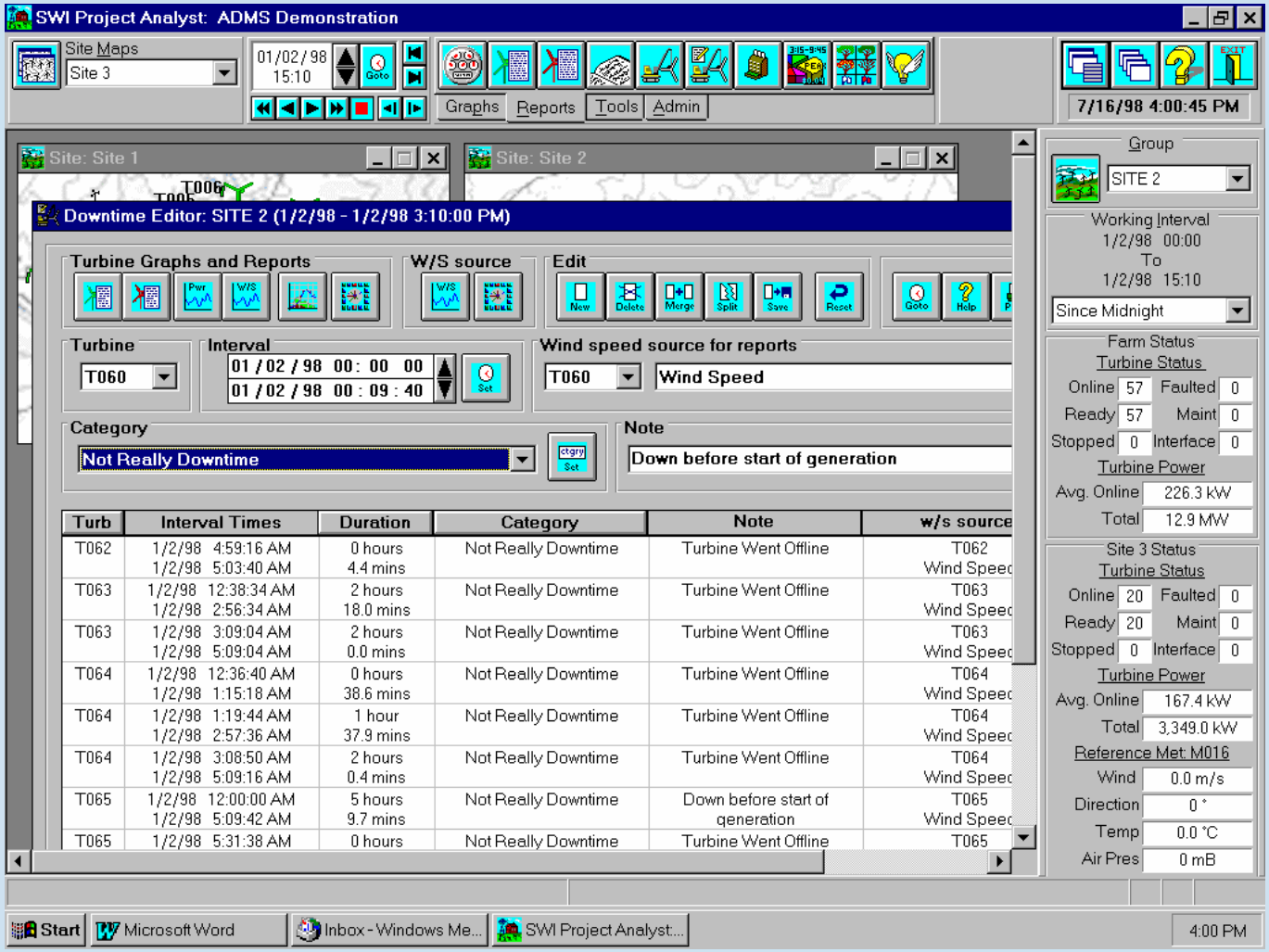
SECONDWIND

Typical SCADA Supervisor



SECONDWIND

Typical SCADA Project Analysis

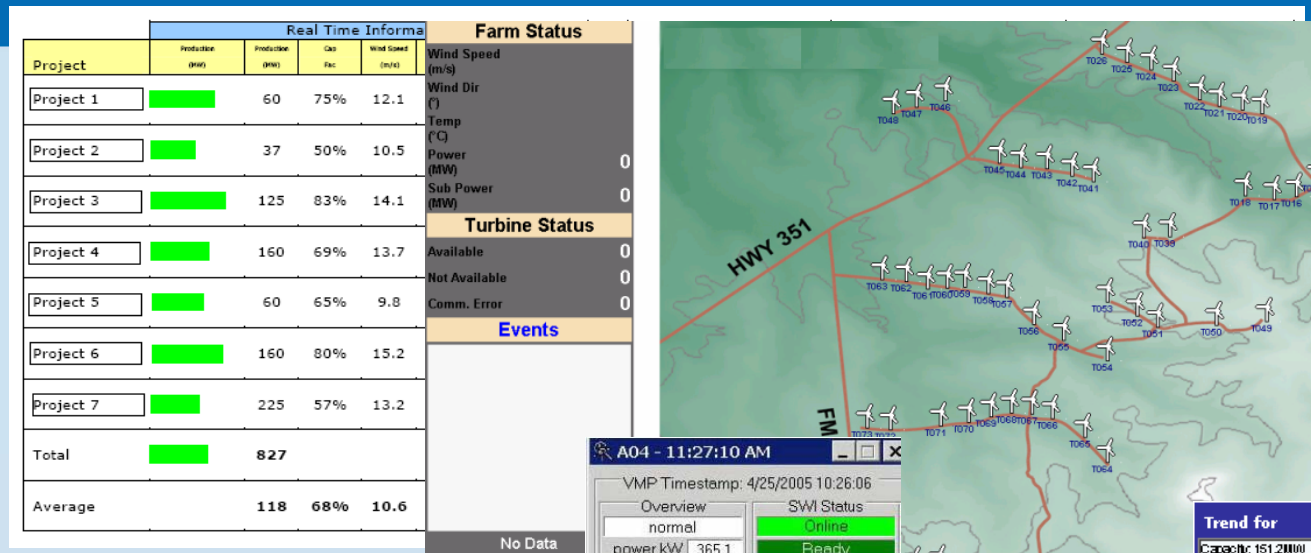


SECONDWIND

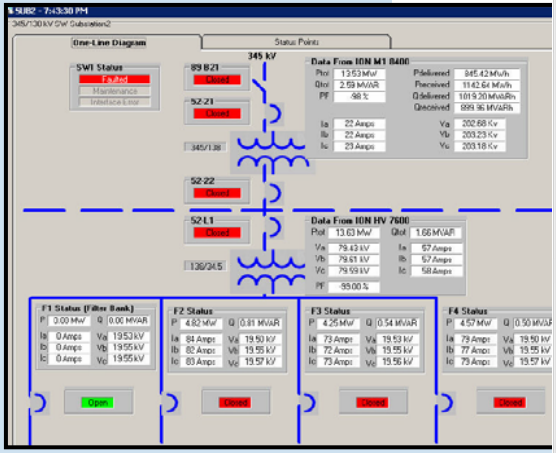
The Wind Farm EMS Option

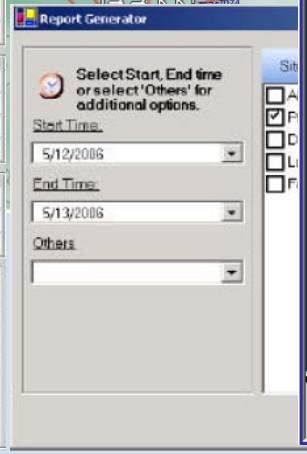
Enterprise Management Systems

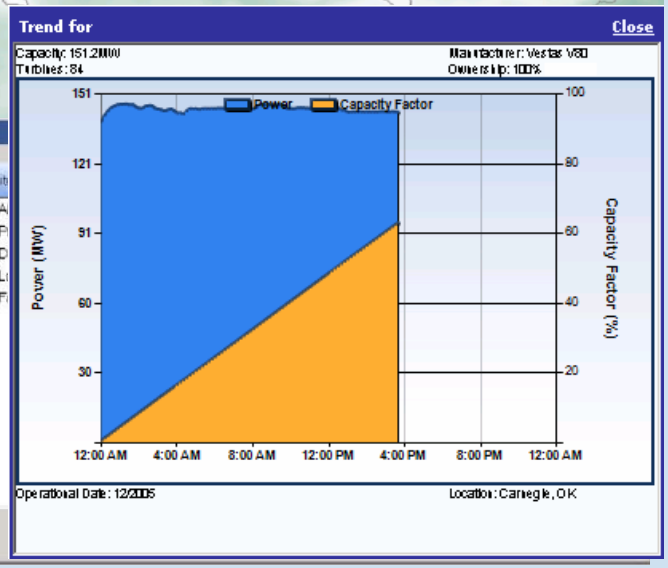
1. Portfolio Overview



2. Real-Time Client (Site View)







3. Real-Time Turbine and Sub Views

4. Report Generator

SECONDWIND

Wind Farm SCADA and RCM

- SCADA is key to RCM through Condition Based Monitoring: provides the data for actionable maintenance.
- CBM will become increasingly common within OEM wind farm SCADA systems.
- Second Wind experience with CalWind Swantech and TVA GasTOPS CBM implementations.
- Data Intensity: Wind Turbine SCADA is special—highest data intensity per MW across generation types.
- Offers data for utility Off-taker and other reporting needs—contributions to grid reliability.
- O&M scheduling, real-time pricing management, and wind forecasting interfaces.

SECONDWIND

SCADA Issues for a National Wind Generation Reliability Assessment

- Technology maturity and relatively youthful equipment age—prospects for serial failure.
- Codes, standards, and nomenclature formalization.
- The “value proposition” for participating operators—big and small operator participation.
- Optional reporting burdens for operators—smaller developers have limited resources.
- Data security and intrinsic source identification
- Upcoming major NERC GADS, ERCOT, and other reporting mandates.

SECONDWIND

Contact Information

Patrick Quinlan
Second Wind Inc.
366 Summer Street
Somerville MA 02144

(617) 776-8520 x21
patrick@secondwind.com
http://www.secondwind.com

TRITON™
SONIC WIND PROFILER

Second Wind ADMS
ADVANCED DATA MANAGEMENT SYSTEM

Satellite Wind Data Service
skySERVE℠

NOMAD® 2
WIND RESOURCE DATA LOGGER

ENTERPRISE MANAGEMENT
SYSTEM *Second Wind EMS*

SECONDWIND