BlueScout™ Turbine Control Technology

Bill Fetzer

VP Customer Service & Installations

BlueScout Technologies, Inc.

Topics

- Introductions
- BlueScout Technologies
- Technical Presentation
- R&D Opportunities

Vision

- BlueScout Technologies applies groundbreaking wind sensing to turbine control systems to increase the effectiveness and availability of wind turbines, providing increased energy production and decreased operating costs.
- Website: www.BlueScout.com

OCS-210

Customers and Partners

BlueScout

Customers

Invenergy

enXco An EDF EN Company

BP Wind Energy

BORALEX

TransAlta

Kruger Energy

saturnpower

AXYS TECHNOLOGIES INC.

Partners

AVAILON UNITED WIND SERVICE

Deutsche WindGuard The Wind Professionals

NREL NATIONAL RENEWABLE ENERGY LABORATORY

GL Garrad Hassan

TechnoCentre éolien Wind Energy TechnoCentre

Wind Energy Institute of Canada / Institut de l'énergie éolienne du Canada

NERAK

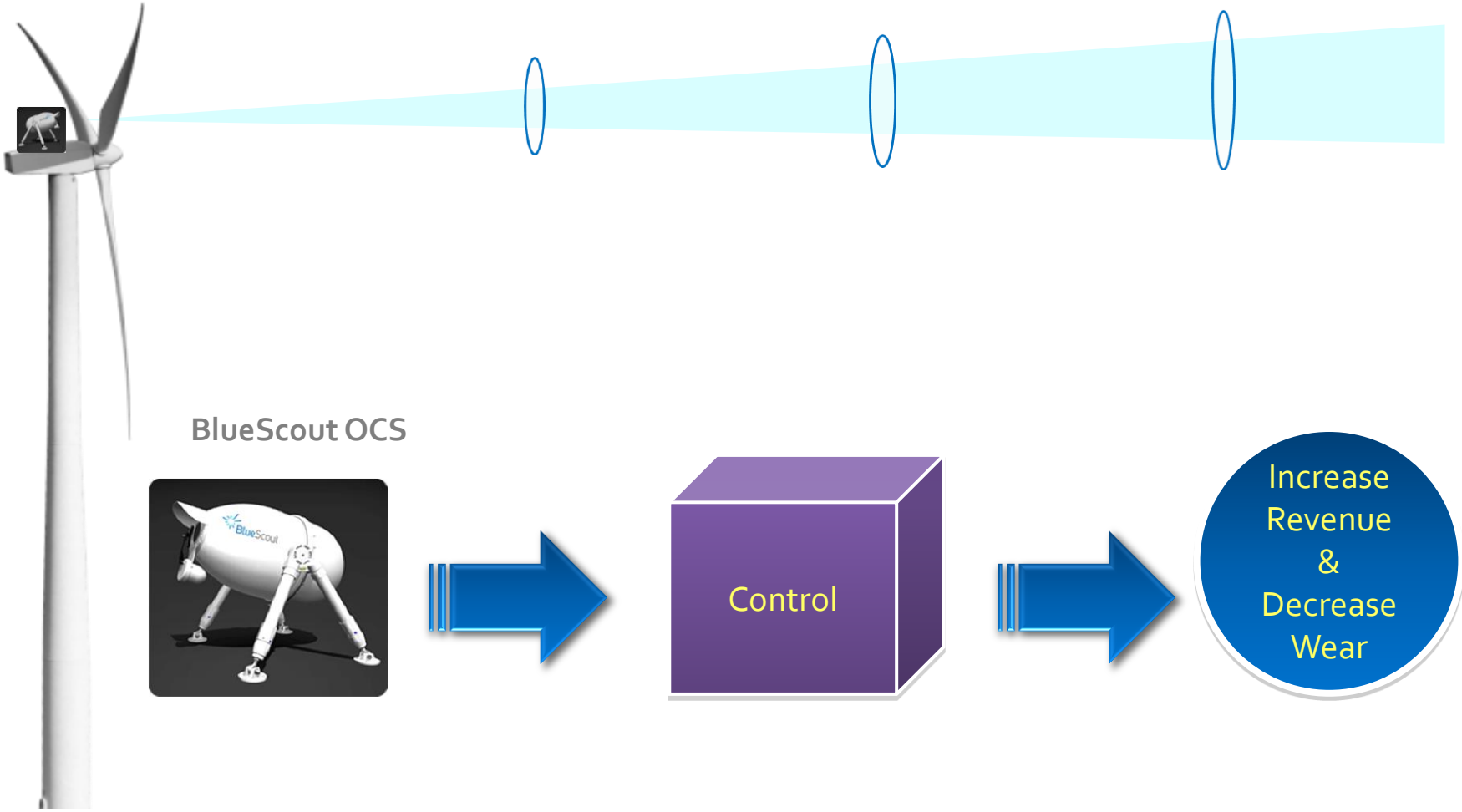
IIT

The Problem

- Problem: Measuring wind behind the world's biggest propeller
- Effect
  - Leads to poor turbine control response
  - Correction of yaw errors is difficult
  - Pitch control is reactive
  - True power performance needs free steam wind data
- ***"Analysis of Traditional Yaw Measurement"***
- ***"Wind Measurements and Power"***

The Solution

Measure Wind Before the Turbine

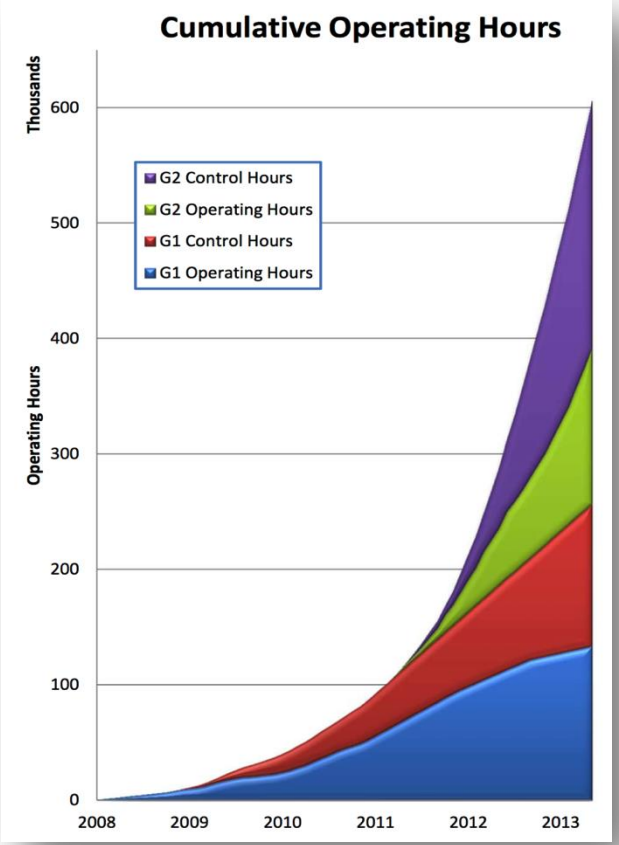


BlueScout Experience

- “Nothing ever becomes real 'til it is experienced.”

  — John Keats

- Over 30 installs done or planned
- ~250,000 operating hours
- Strong corporate focus on getting large scale deployments to accelerate operating hours



GE 1.5sle Experience

- Installations - 10 deployments
  - 66,984 hours
- Turbines controlled - 8
  - 35,856 hours
- By early Q4
  - 9 turbines will be under OCS control
- "*Controller Description GE 1.5SLE*"

Turbine Control Example

- Test Period – May 2011 through July 2012
- Control logic switches at intervals between legacy and OCS control for comparisons
- Total control hours: 10,733
- Total hours analyzed: 6,562
- Data analyzed
  - Turbine status = 2 (No faults)
  - Load operation = 1
  - OCS not in state = 0

Power Gains

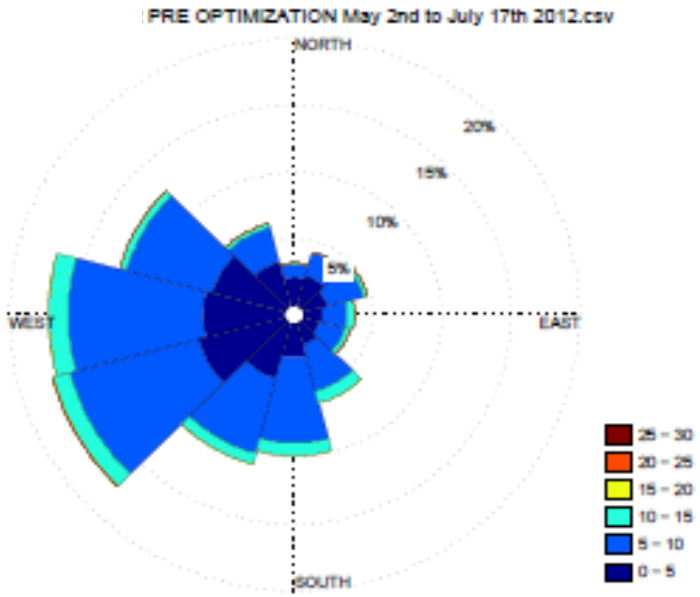
- 4 Customer turbines under study
- Control Method V1.0 power gain is 4%
  - Optimization will add 2-4% to power increase
- Power NF factor *decreases* 12%
  - Power NF = STD (Power) / MEAN (Power)

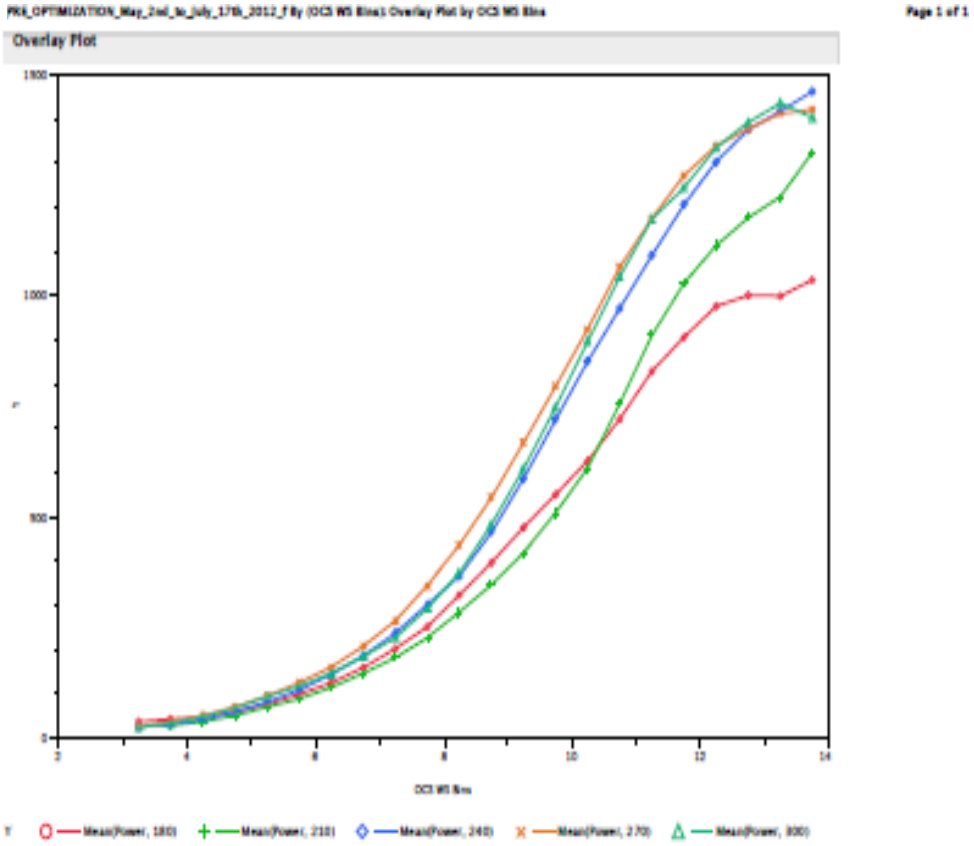
	Time Weighted Average
Power Increase	4.0%
Power Noise Factor – Legacy Control	0.65
Power Noise Factor – OCS Control	0.58

Potential Benefits of Power "Noise" Reduction

- Generator putting out smoother power
  - Converter is not working as hard
- Rotor speed may be more constant
  - Blades pitching less and/or pitch management more effective
  - Less wear

Power Curves By Wind Direction





Future Research Opportunities

- Measuring stress load reduction related to better yaw control
- Acoustic noise reduction analysis
- Generator power noise reduction analysis
  - NREL OCS data: Feed forward controls improve speed and torque controls in Region 3 (Rated Power)
  - To be published in AIAA and IEEE papers in 6 months
- How does combined pitch control and yaw control affect power output in Region 2 (ramp up)?

Questions – Follow-up?

Bill Fetzer
VP Customer Service and Installations
703-956-6554 - wfetzer@bluescout.com