Vindicator® Laser Wind Turbine Control System

IIT Wind Energy Consortium – July 2011

State-of-the-Art Wind Turbine Performance Improvement System

Designed and Manufactured by Catch the Wind, Inc.

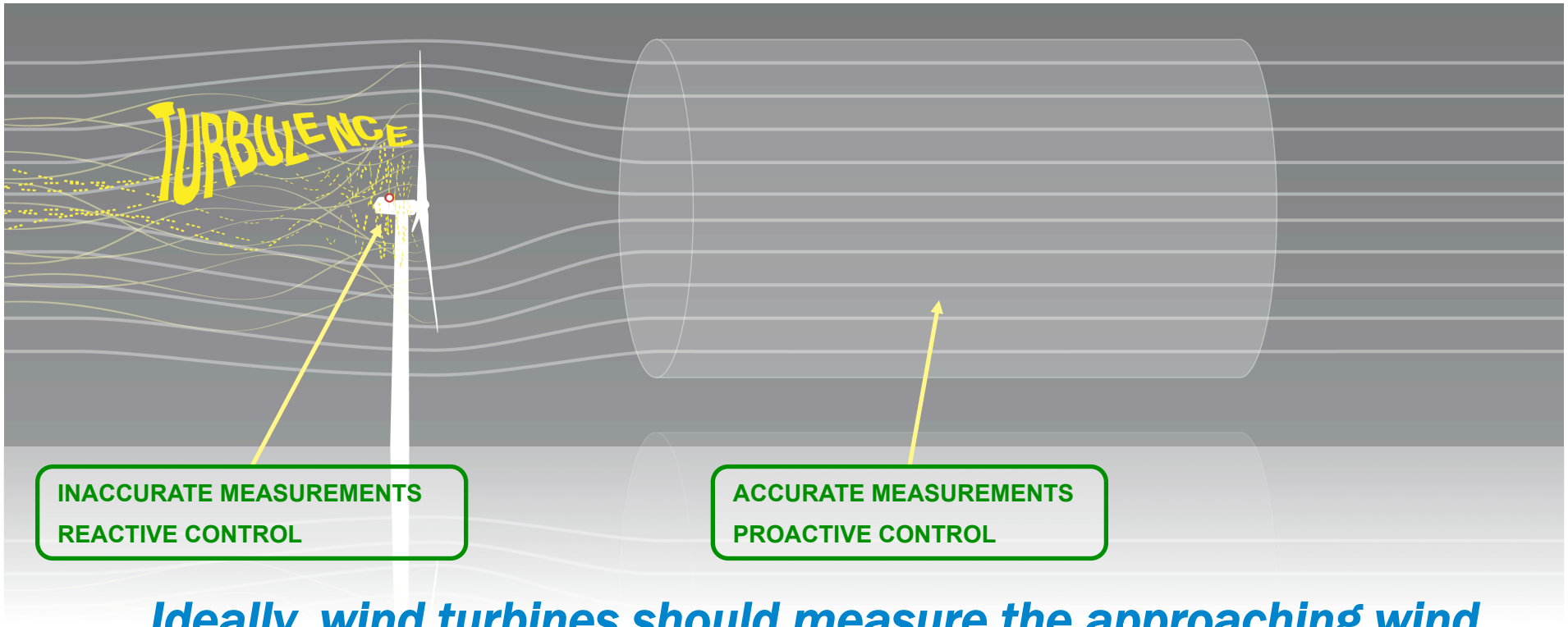
catch the wind inc.

Introduction to Catch the Wind

- *WHO ARE WE?*
  - Catch the Wind is a high-growth technology company headquartered in Manassas, Virginia.
- *WHAT DO WE DO?*
  - Catch the Wind develops and manufactures compact, lightweight and rugged precision laser wind sensor systems.
    - Vindicator® Laser Wind Turbine Control System
  - Our systems are deployed in a variety of applications throughout the wind energy industry
    - Intelligent feed-forward wind turbine control to improve wind turbine performance
    - Onshore and offshore wind resource assessment

What Wind Measurements Provide Optimum Control?

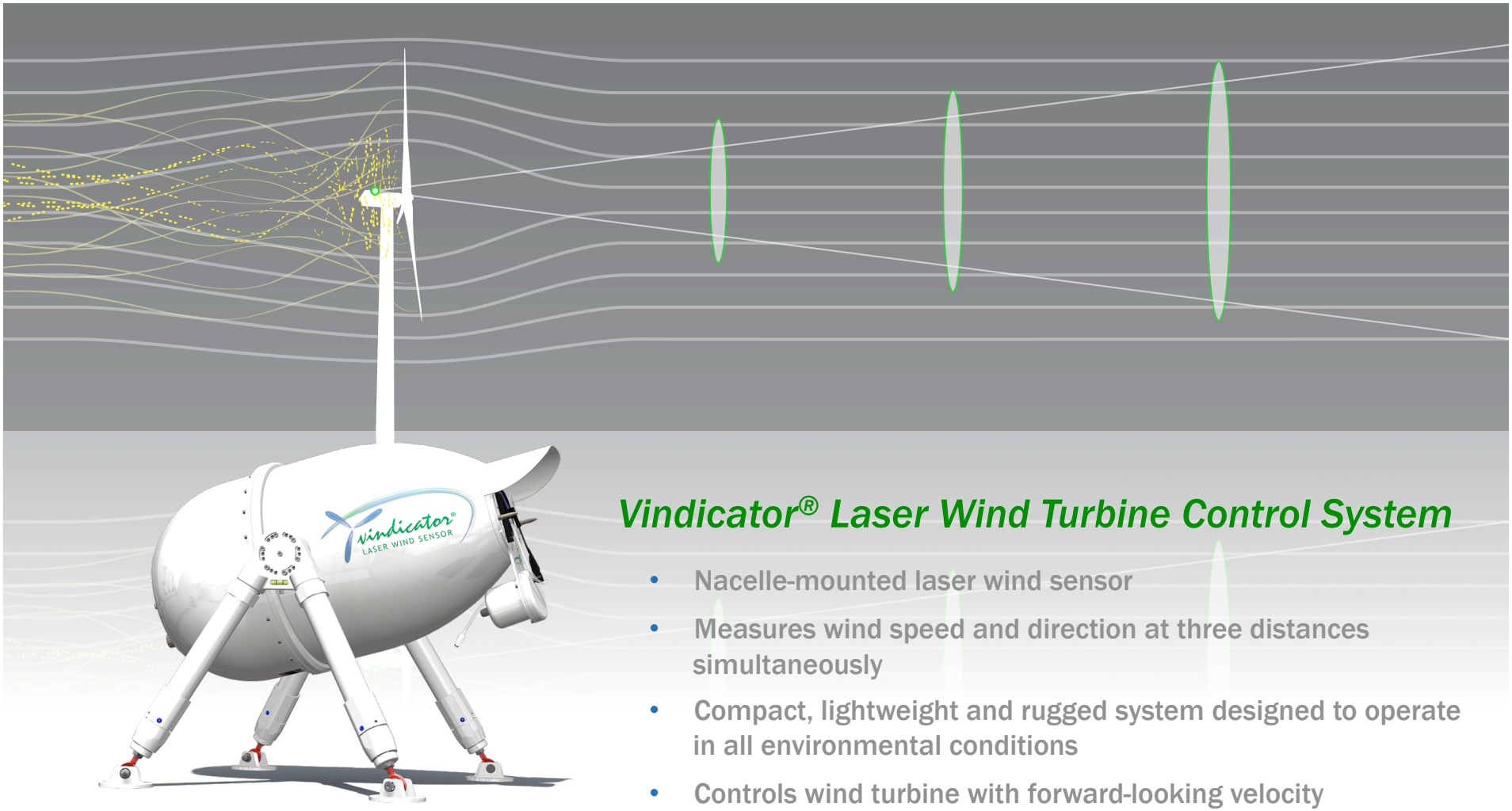
Standard Anemometry vs. Feed-Forward Measurements



Ideally, wind turbines should measure the approaching wind

- More accurate wind data from undisturbed inflow
- Intelligent control system adjusts turbine proactively
- Anticipate changes in wind and make adjustments as they occur

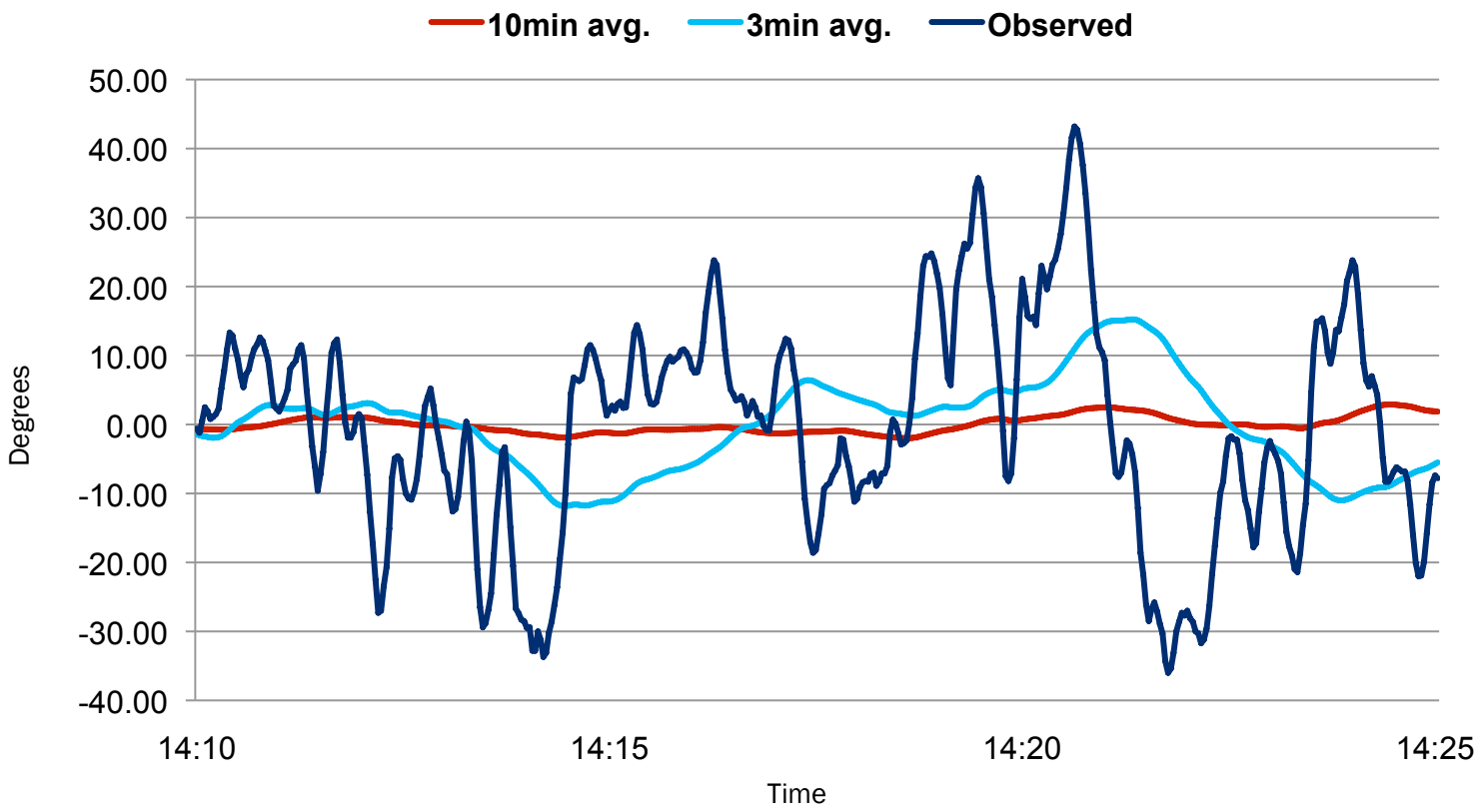
Intelligent Feed-Forward Wind Turbine Control



Vindicator® Laser Wind Turbine Control System

- Nacelle-mounted laser wind sensor
- Measures wind speed and direction at three distances simultaneously
- Compact, lightweight and rugged system designed to operate in all environmental conditions
- Controls wind turbine with forward-looking velocity measurements

The Effect of Wind Data Averaging



Aug. 14, 2009, NPPD-Ainsworth, T22, Laser measurement

Real-time wind data shows the dynamic and variable nature of wind

- Great opportunity for optimization, much larger than industry assumes

How Much of Difference Does Misalignment Make?

Significant yaw misalignment affects the entire wind energy industry

Turbine Model	Avg. Integrated Yaw Error	RMS Error
Vestas V-82	15°	21°
Nordex N60	13°	16°
Vestas V-82	15°	19°
Other 2.0 MW	15°	19°
Other >2.0 MW	12°	17°

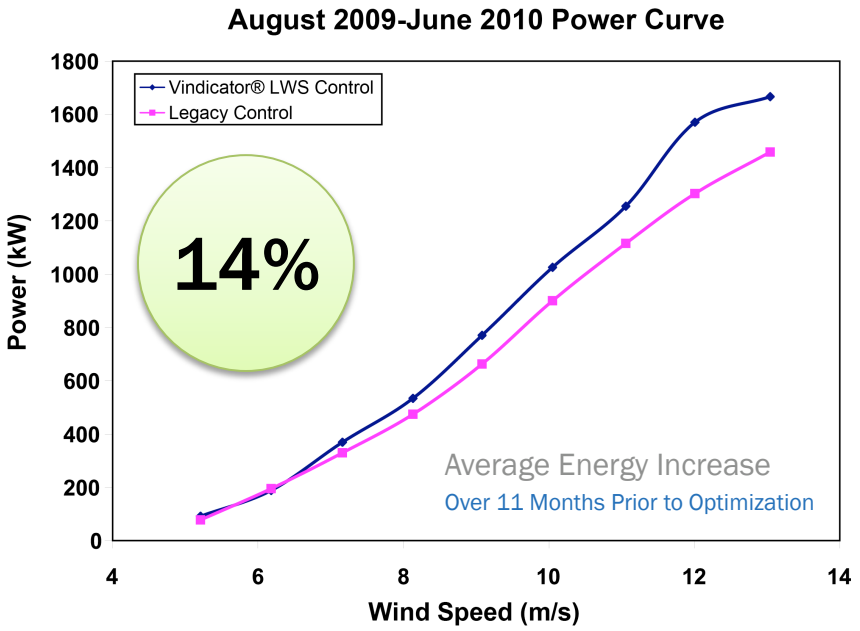
- CTW data indicates that wind turbine controls using standard nacelle located anemometry and other sensing techniques are consistently misaligned:
  - Various wind turbine makes and models
  - Various locations, environments and wind conditions
  - Complex terrain and flat terrain
- Yaw misalignment translates directly into decreased performance and reduced revenue

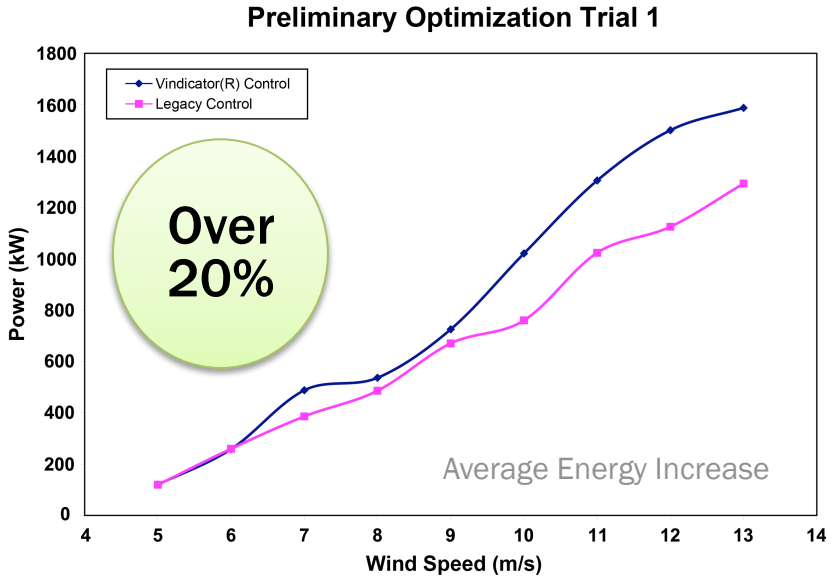
Industry Validation

- Technical & Environmental Testing
  - Wind Energy Institute of Canada (WEICan)
  - National Renewable Energy Laboratory, CRADA
  - Helimax (Germanischer Lloyd)
  - Deutsche Windguard
  - ***Illinois Institute of Technology***
- Customer Validation Trials and Sales
  - Nebraska Public Power District
  - TransAlta
  - BP Wind Energy
  - enXco EDF – EN
  - ***Invenergy***
  - Kruger
  - Boralex
- OEM Validation
  - Multiple OEMs Engaged
  - (Anonymous – Unit purchased by first-tier manufacturer)
- AXYS Technologies
  - WindSentinel™ - Offshore Resource Assessment
  - WindSentinel™ LS - Terrestrial Resource Assessment

Vindicator® System Installation Photos

Power Production Increase





July 2009:

- Vindicator® LWS System Installed on Vestas V-82 (Turbine #T22) at Nebraska Public Power District (NPPD)
- Deployed and in Control for 24 Months

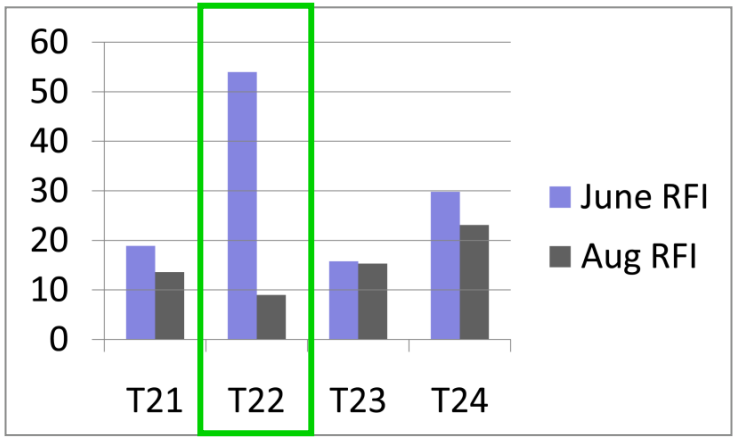
July 2010:

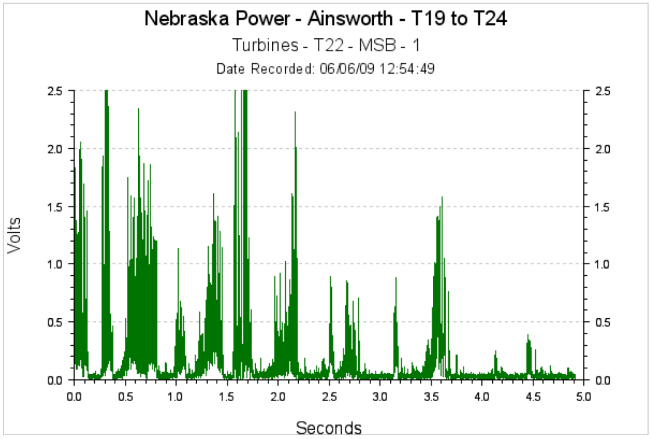
- Control Algorithm Optimization Program Initiated

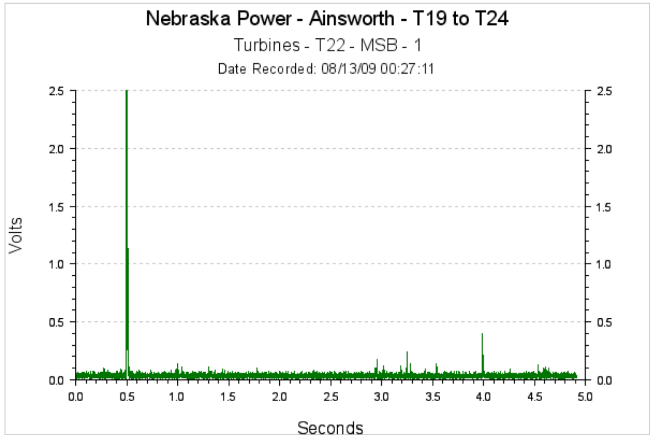
Stress Load Reduction

NPPD

- SWANTech report
  - Independent third party
- Test turbine went ***from worst to best*** with Vindicator® LWS control

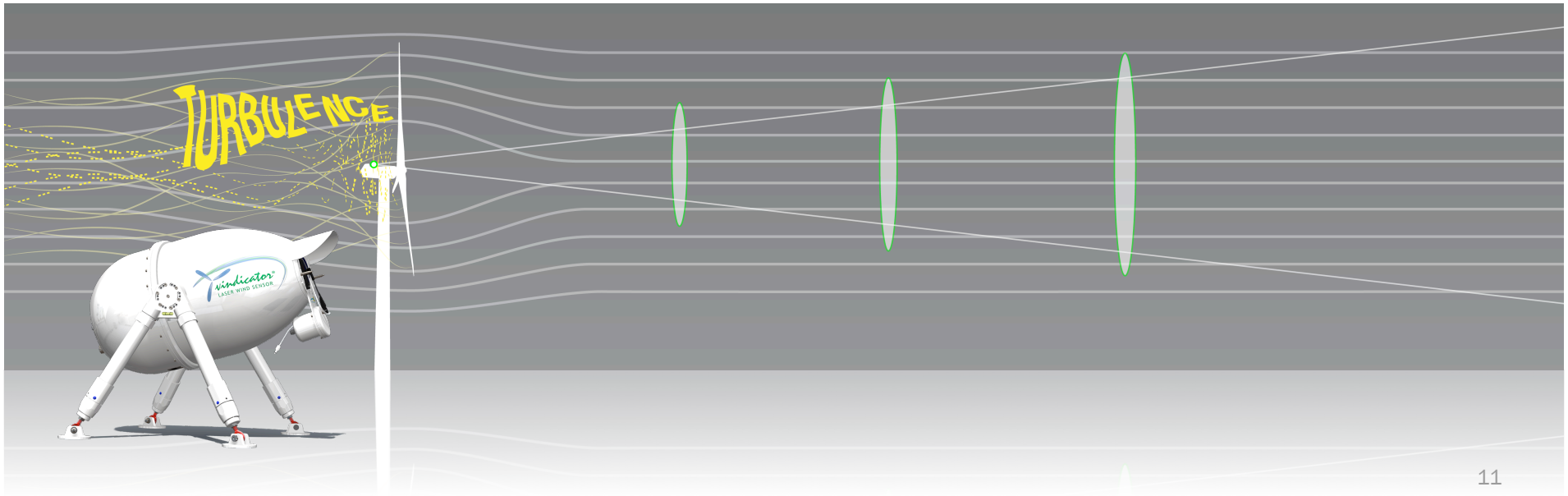






Summary

- Existing methodologies in turbine control do not measure real wind inflow:
  - Use disturbed and turbulent measurements from sub-optimal location
  - Use time-averaging, transfer functions and torque sensors to compensate for location of measurement instruments
  - Results in significant average yaw misalignment = loss of power/energy and increased stress loading
- All large wind turbines need forward-looking control systems to increase efficiency and reduce stress loading
  - Accurate and timely speed and direction of undisturbed inflow to turbine
  - Proactive yaw control and blade pitch regulation



IIT Consortium Project Opportunities

- Measure stress loading effects of yaw misalignment
- Investigate optimum stress load reduction methodologies
- Investigate algorithms for feed forward yaw control
- Investigate optimized control solutions for pitch and yaw
  - “Dancing with the wind!”

Contact

Bill Fetzer
VP, Business Development
+1 703-393-0754
wfetzer@catchthewindinc.com

Mireille Focquet
Director Sales and Marketing
+1 450-578-3545
mfocquet@catchthewindinc.com