Indiana Wind Working Group
December 3, 2010

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Agenda

• Technology & Market Overview

• How We Got Here
  – Fund Raising
  – Technology Development
  – Technology Licensing

• Where We Are Going
Sorian’s Plasma Actuators

- Electrical current causes air to ionize, creating a plasma field (shown in purple above).
- Electrical field manipulates plasma to inject thrust into airflow.
- Trailing edge actuators perform identically to a trailing edge flap – enhancing lift with no increase in drag.
- Leading edge actuators prevent airflow separation.

Retrofit Deployments on a Wind Turbine Blade
Trailing Edge Actuator Test

- Trailing Edge Actuator
- Actuator Location = 0.90 x/c
- 21 m/s
- 7 kV
- Lift Curve and Drag Bucket Shown Below

Experimental Results

Decreasing Lift with a Pressure Side Actuator

S827, $Re_c=350K$, $(x/C)_i=0.95$, $VAC=15kV$

![Graph showing decreasing lift with a pressure side actuator](image-url)
Plasma Actuators Demonstration
Detecting Blade Deflection

- Blade stress detected via accelerometers placed inside each blade
  - Distributed sensors yield high spatial resolution of stress causes

- Separation of blade movement into 3 dimensions
  - Specific identification of stress allows for precision corrective action
Deflection Sensor Data

- Speed drops
- Direction changes

Gravitational Loading

Blade / gearbox stress + lost energy output
Existing Retrofit Opportunity

North American Turbines > 1MW 2009

Worldwide Wind Turbine Installations - 2009

Sources: AWEA / GWEC
Forward Looking Addressable U.S. Market

United States Turbine Installations

Sorian U.S. Market Opportunity

Sources: AWEA / GWEC
Competing Approaches

Output Gains vs Complexity & Weight

- FloDesign Wind Turbine
- SORIAN
- FLEXXSYS WIND ENERGY
- PAXSTREAMLINE
- Frontier Wind
- 3M
V-82 Performance Model

Weibull distribution applied to determine annual performance improvement.

Mean = 7.0 m/s, Shape Factor = 2
V82 Annual Output – Weibull Distribution of Wind ($\mu=7.0 \text{ m/s}$)
Targeting a 2½ Year Payback

Assumptions:
30 Turbines / Installation
Price / kWh = $0.06
Baseline Capacity Factor = 37%

(Typical wind farm financial hurdle post turbine erection)
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Fund Raising

• Initially Targeted “Angel Investors”
• Thrown into VC Market Earlier than Anticipated
  – Too Early, Lots of Good Feedback
• Raised $270k to-date. Plus $200k Grant
• Finalizing Deal with Developer
  – $1.1M in Funding + Field Test Opportunity
• Currently Raising $250k to Augment Deal
Technology Development

- Forced to Develop Without OEM Collaboration
  - Expect Collaboration to Start Next Week
- Plasma Actuators of this Scale Have Never Been Made
  - Lots of Customization
  - Difficult to Find Suppliers
- Installation Plans and Procedures
  - Significant Contributions from Leading Wind O&M’s and Repair Groups
Technology Development

Ground Test at Dr. Adams’ Lab – Purdue University
Technology Licensing

• Plasma Actuators
  – Dr. Thomas Corke: ME & AE - University of Notre Dame
  – Secured Exclusive License to Multiple Fields of Use

• Sensing Technology
  – Dr. Doug Adams: ME - Purdue University
  – Finalizing Exclusive Rights to Multiple Fields of Use
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Go to Market Plans

Generation 3

Gen. 1 Retrofit Kit
- 10% - 20% increased power output in Region II

Gen. 2 Retrofit Kit
- Full active control optimized for wind class and turbine model
- Increase in operating range
- Further improved output in Region II

Gen. 3 New Blade Design
- Lower weight blade design using plasma actuators as a ‘virtual trailing edge’
Beyond Utility Scale Wind Turbines

- Small Wind
- Rotary Wing Aircraft
- Fixed-wing Aircraft
- Automotive
- Munitions & UAV's
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