

**GULFWIND**  
TECHNOLOGY

# Challenges for Offshore Blades

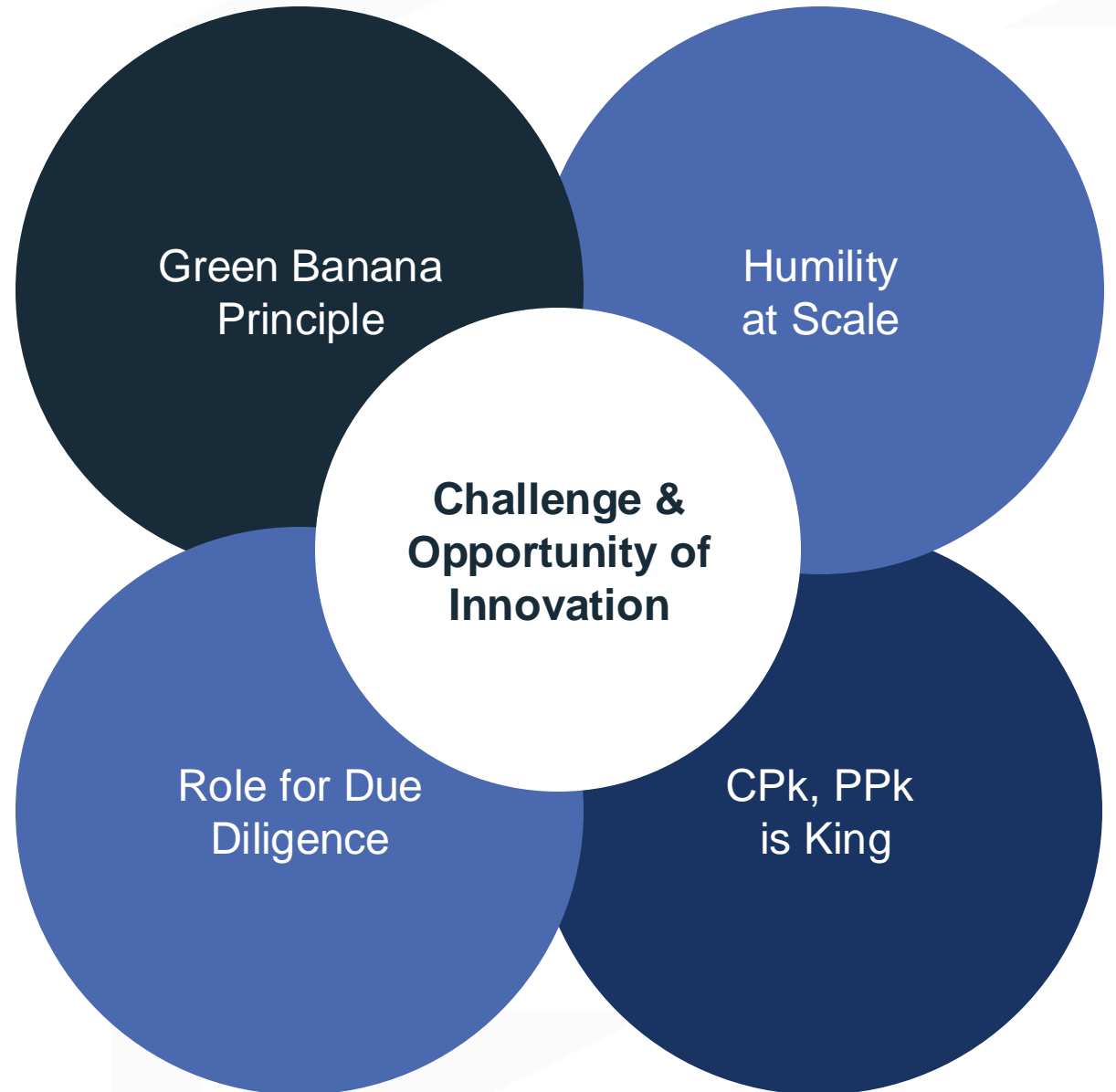
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**AMERICA'S  
INDEPENDENT  
ROTOR  
TECHNOLOGY  
SPECIALISTS**

1. Released for Sandia Labs Blades Workshop September 2024

Released for Sandia Labs Blades Workshop September 2024\_Issued to Wells Fargo

# Challenges for Offshore Blade



# Humility at Scale

Released for Sandia Labs Blades Workshop September 2024

Image Credit: LM Wind Power, Vestas



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## “Green Banana Principle”

- Green Banana Principle isn't cost effective anymore onshore, let alone offshore.
- Systemic blade issues are now unfortunately commonplace.
- Industry calls to standardize & **industrialize** and not continue the rotor growth/MW rating arms race.



# Challenge & Opportunity of Innovation

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**Low Average Wind Speed:**  
Increase Rotor Diameter.

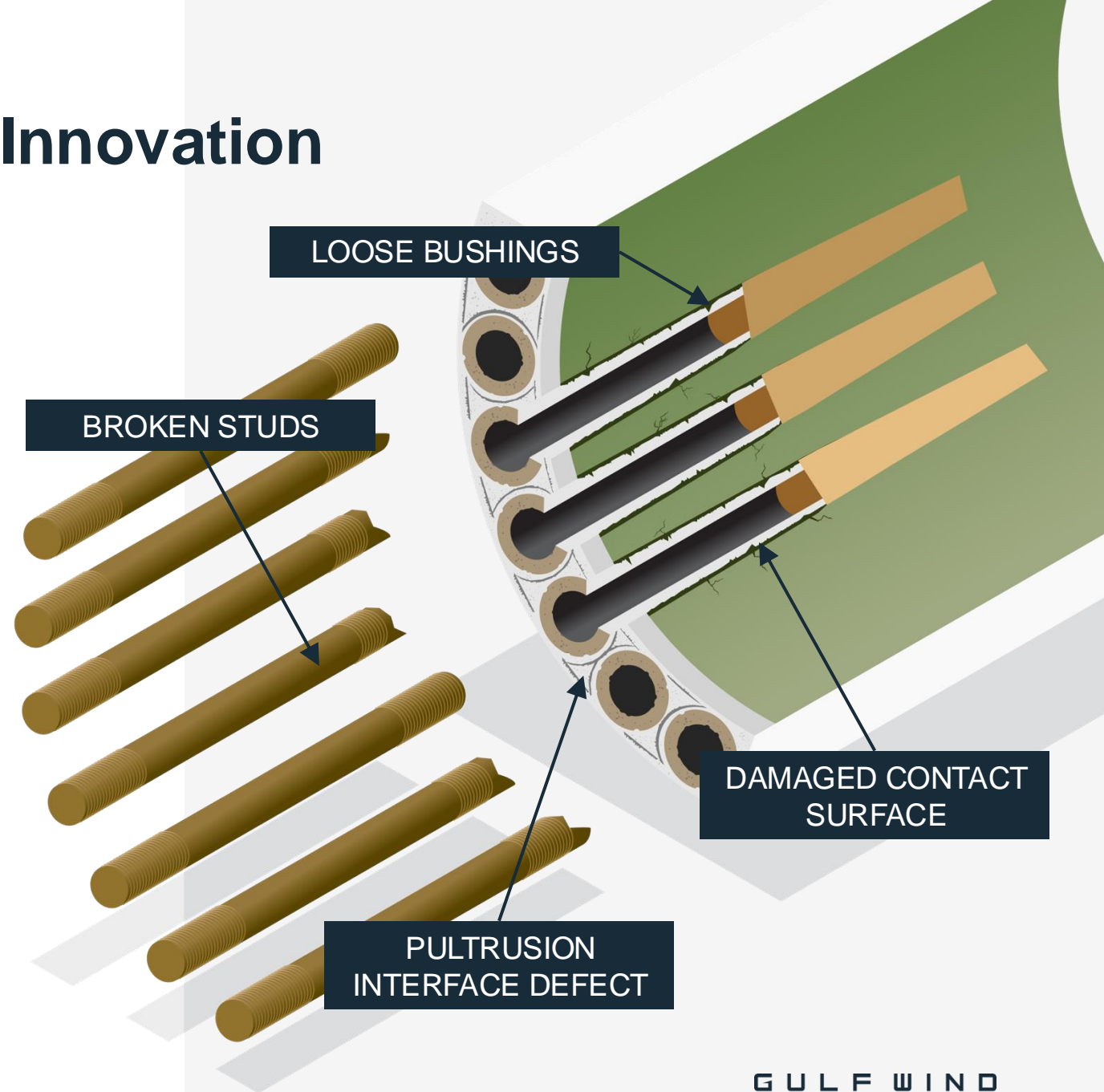
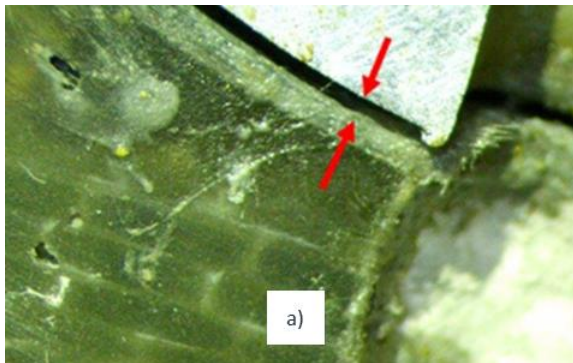
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**Elevated Extreme Wind Speed:**  
Smaller, Reinforced Rotor.

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# Challenge & Opportunity of Innovation

- **Common Early Tell-Tale Signs:**
  - Breaking of studs can often be an indicator.
  - Composite dust in and around roots.
  - In-ability to tighten blade studs.
- **Progressive Damage Mode:**
  - As one bushing fails, load is shed to adjacent bushings.
  - Worst case scenario – blade composites on the ground, with studs and bushings still attached to the tower.





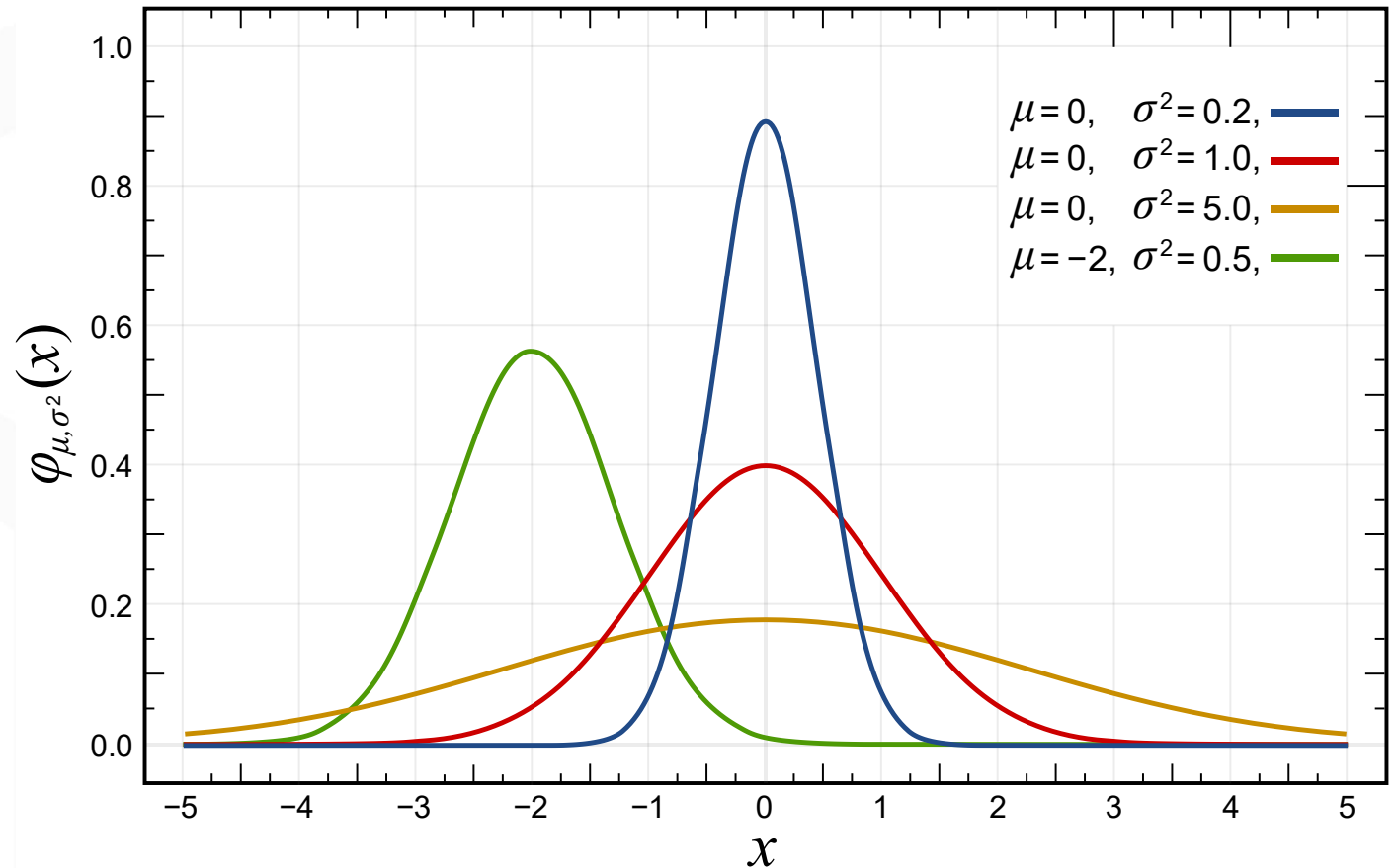
# Role of Due Diligence

- N = 1 sample size for certification tests and prototype turbines.
- Factory audits that happen one day out of 365.
- Receiving inspection versus quality control inspection.

# CPk, PPK is King

$$Cpk = \min\left(\frac{USL - \mu}{3\sigma}, \frac{\mu - LSL}{3\sigma}\right)$$

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## Murray's “Rules” at Gulf Wind Technology

1. “In God we trust, all others bring data.”
2. Clearly defined assumptions – even for our “pet tool” – with clear DFMEAs and PFMEAs that actually capture the factors that matter.
3. No pass without test data from a measurement system with a valid MSA & GRR.
4. Process capability data is a must – not just a mean and standard deviation – from a sample size  $N > 30$ .



Thank you

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