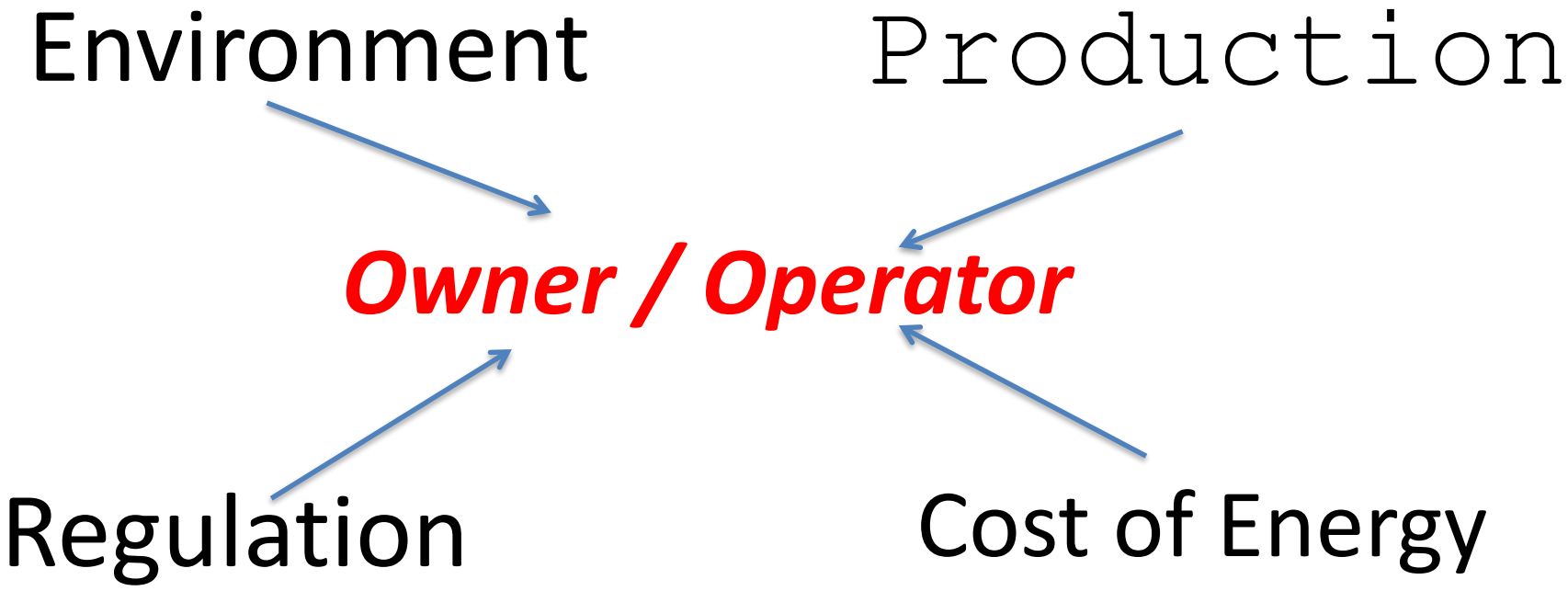
Frontier Wind

Reinventing Wind Power™

StrikeFree™

Situation: The Industry Pain Points

Pressure From All Sides



Environmental issues (birds and bats)

- Key Environmental Pressure on the Industry:
  - Birds (particularly Raptors)
  - Bats (Global issue)
- Bats are environmentally "protected": US
  - One Species (Indiana Bat) ***Endangered***
  - 11 Species "Threatened" (headed to "endangered")
- In the US, nearly one million bats killed each year

Bats: An Operator's Perspective

- Spinning Turbines = Revenue Generation
- "Standing" Turbine = No Revenue
- Bat Migration is ***Regulated—both endangered and threatened***
  - "take permits"
  - Increased scrutiny
  - Exceed the "limit", stop the turbine
  - Research permit
- Permitting is year-round
  - Migration
  - Non-Migration

Existing Solutions

- Complicated algorithms to forecast when and how to **shut down machines**.
- Problem: this is a horrible solution for
  - Production
  - Cost of Energy
  - Future Development
  - Return on existing investments
- Net: The Industry doesn't have a solution ***until today….***

Technical input for StrikeFree™ development

- Every turbine is slightly different
- Every bat species acts slightly differently
- Must address strike and “trauma” kills
- Must resist dirty power in any turbine (*)
- Must have an easy way to “communicate it’s alive”.
- System needs to be species flexible
- System must be capable of addressing multiple species on a given site
- System must deal with the attenuation physics
- Must be retrofittable to impact existing fleets

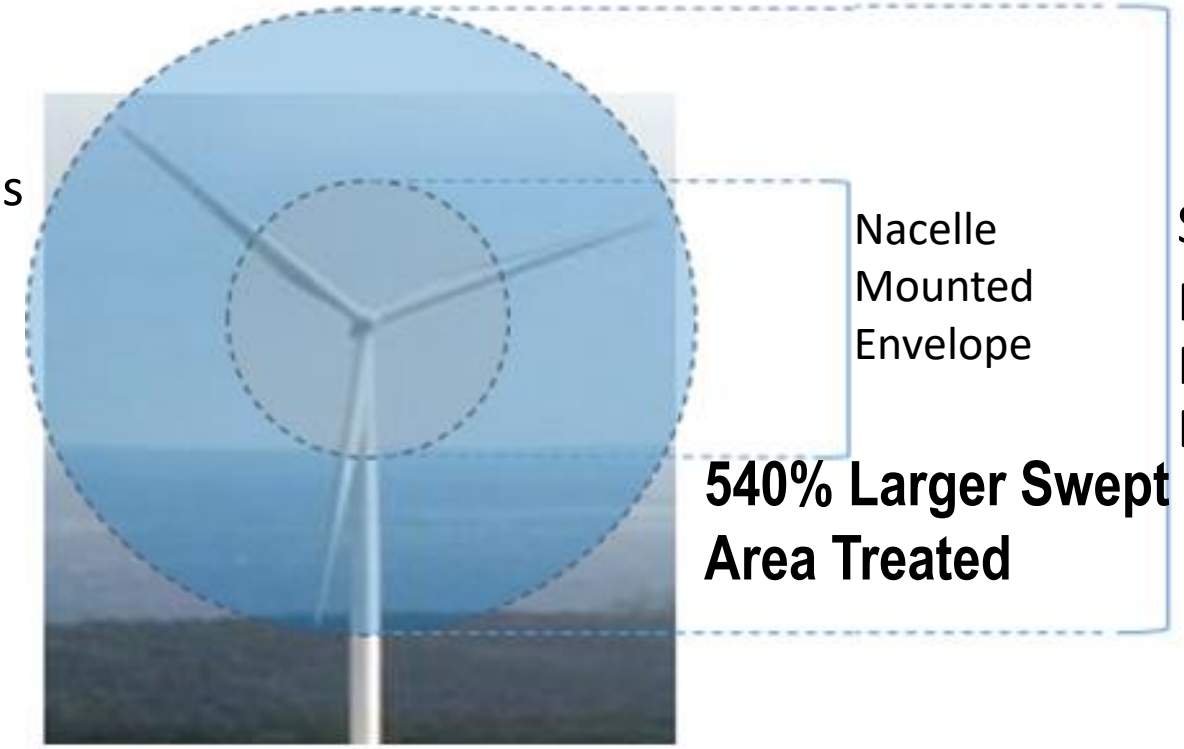
StrikeFree™

- StrikeFree™
  - The world's only blade mounted deterrent system

Technical Approach

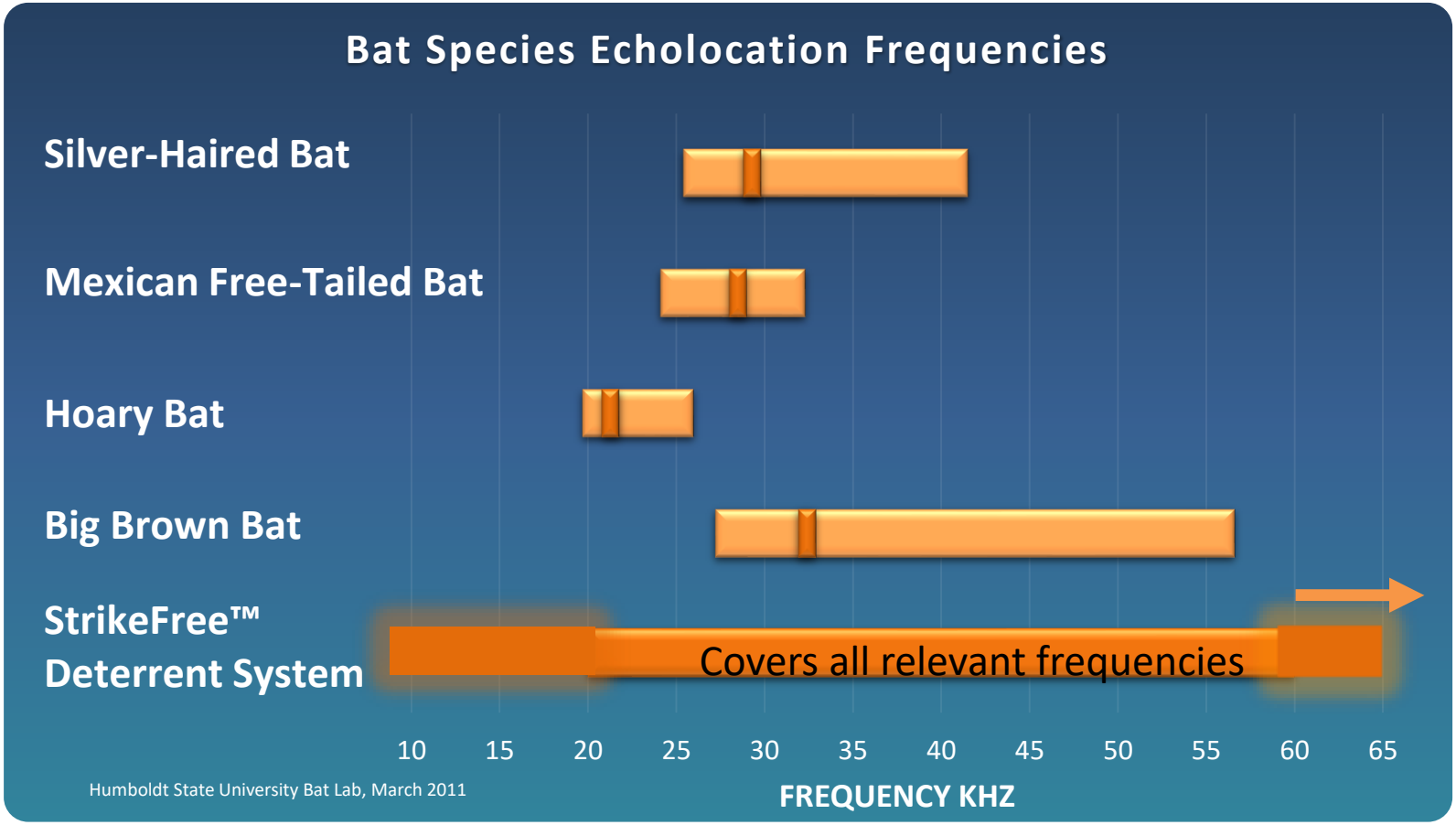
- Invent, design, and fabricate an ultrasonic bat deterrent that acoustically treats the ***entire*** wind turbine rotor

This unique approach ensonifies the ***entire wind turbine rotor area (and beyond)*** with ultrasonic noise versus treating the nacelle alone.



✓ System provides ***cost effective*** site / turbine make-model and bat species ***flexibility***

Target Specific Bat Species Echolocation Frequencies

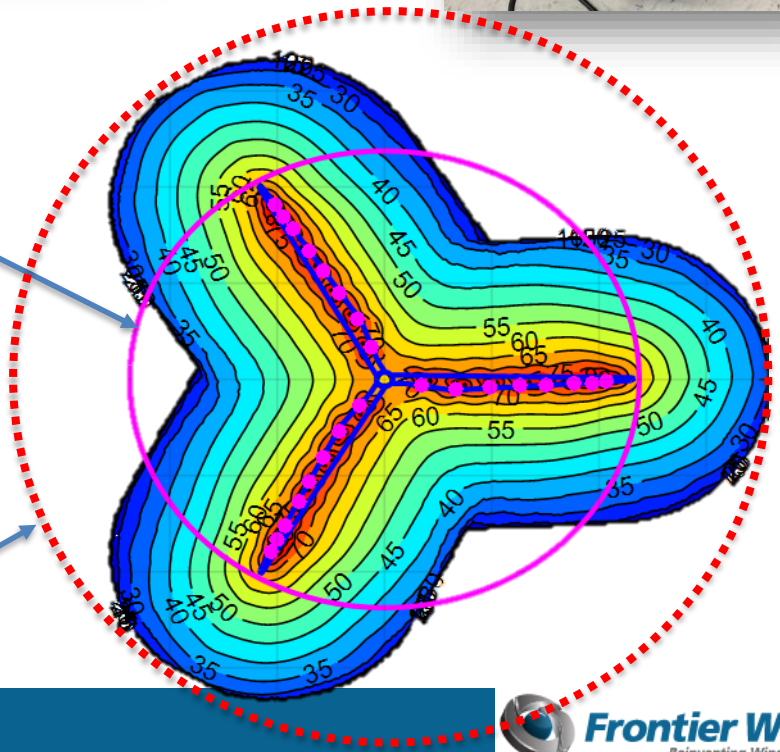


Develop Proprietary Approaches

- Transmitter designs
- Utilize operations experience
- Build on Blade knowledge
- Special Ultrasonic modeling
- IP protection in key areas:
  - Transmitter location
  - Frequency Management

Aero-transparent Transmitters

"Mount Friendly" Control Box



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Issues in the field

- Power supply failed due to dirty power in the turbine
- Checking if the system works was a lengthy and expensive exercise
- Version 2 of the power supply was developed
- Iteration no 2 is successfully running in the field

Power supply – gen2

Power supply - gen1

Remote check power supply “alive”

02/15/2018

5 months

QA