



Wind Energy Generation System Reliability & Risk  
Risk Management perspective

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# Risk “Project does not provide the designed results”

Everything is subject to peril and failure

## ▶ Natural Peril

- ▶ Lightning
- ▶ Icing
- ▶ Wild Fire
- ▶ Earthquake - Land slide
- ▶ Storm – Wind & Flood

## ▶ Property Peril

- ▶ Fire
- ▶ Theft
- ▶ Vandalism
- ▶ Terrorist
  - ▶ Political
  - ▶ Environmental
- ▶ 3<sup>rd</sup> party activity

## ▶ Environmental / climate

## ▶ Grid constraint

## ▶ Wildlife mitigation

## Equipment Reliability

### ▶ RNA Component Failure

- ▶ Design defect
- ▶ Human Error
- ▶ Poor (inadequate Maintenance)
- ▶ Control Error
- ▶ Wear and tear
  - ▶ Fatigue Failure
- ▶ Mechanical Defect
- ▶ Electrical insulation breakdown

### ▶ Structure Failure

- ▶ Foundation
- ▶ Tower

### ▶ Project power delivery / substation

- ▶ Transformer

# Wild fire - 20 units damaged



3 Nacelles consumed & more damage on ground level equipment and to towers



## Ice damage on a 3 unit farm



2 units had cracks in the blades one units had total blade failure

## Tornado through 100 unit (150MW) Wind Farm



Tornado destroyed ~ 1 mile of 161 kV transmission line 7% of the length

WTG's all tripped off line with no damage to the units

# Capacitor Bank Fire



## Some thing simple can have an impact on reliability

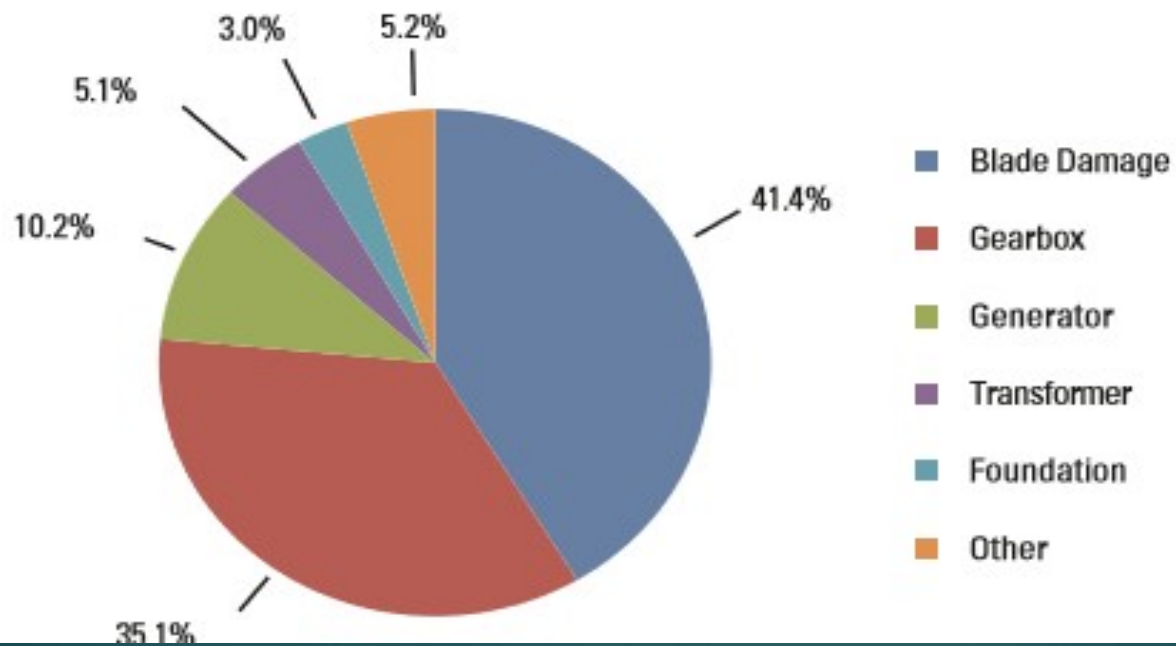


### Oil level sensor

- In cold weather a low level alarm
- Shut down climb the tower
- Check the oil level & it is good
- Disposition,
- Climb down, restart
- After multiple issues upgraded sensor was required

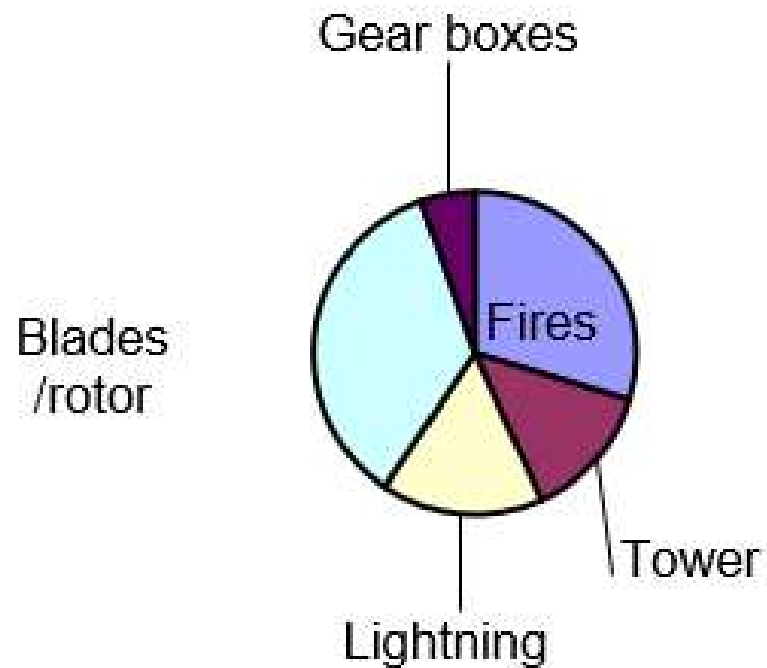
# Component Failures

Most Frequently Reported Component Damage\*



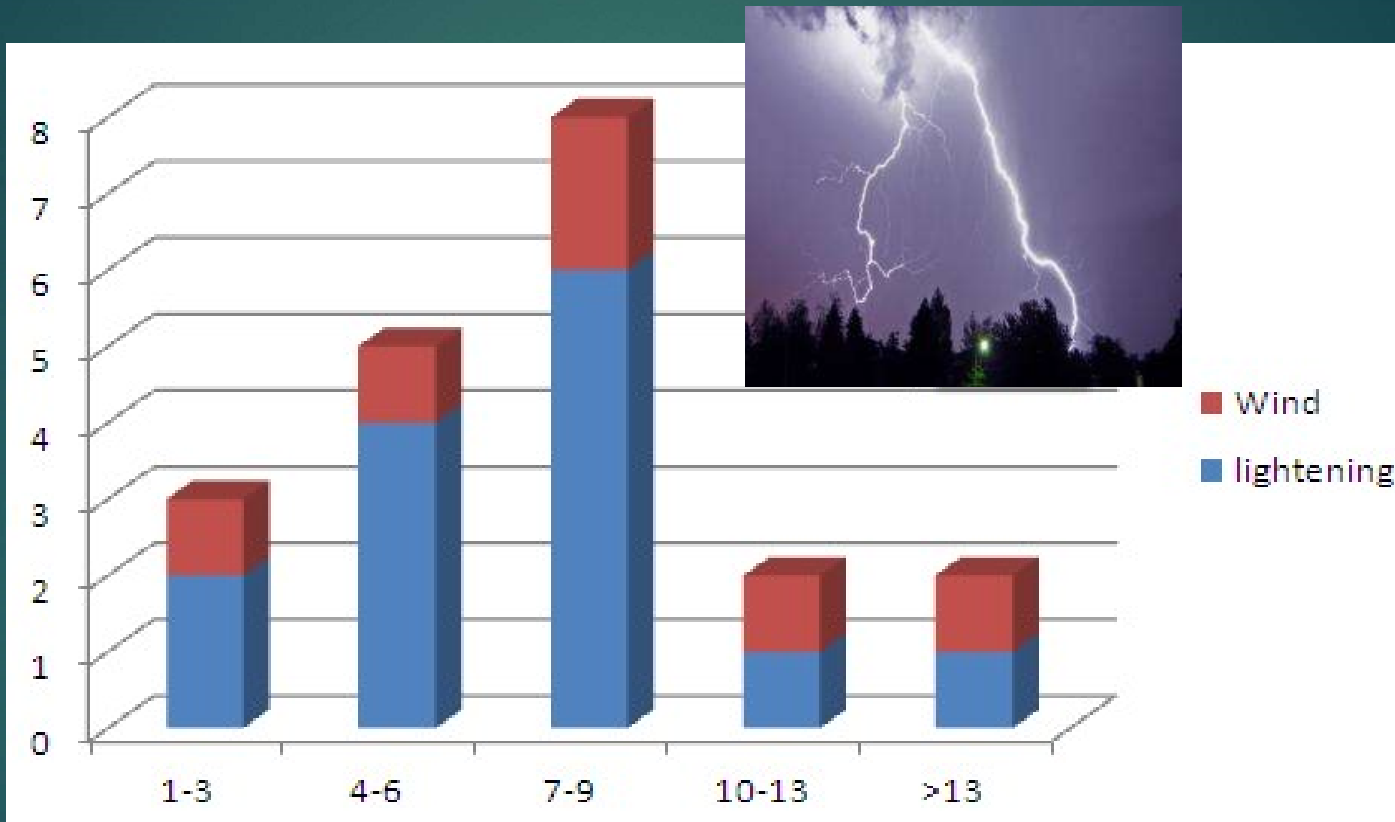


## WIND TURBINE LOSS TYPE > \$1 MUSD



# Loss experience by age of wind farm

- Natural Peril



# Mitigated risk through a pooled risk program only partially protects the owner

- ▶ Monetize risk (Not completely covered) (insured / self insured)
  - ▶ Property coverage Deductible from \$10,000 to \$500,000
  - ▶ Warranty & Machinery Breakdown coverage from \$10,000 to \$500,000
  - ▶ Business Impact coverage Time Element 14 days to 60 days (not always purchased)
  - ▶ Wind availability - First 5% to 15%
  - ▶ Policy limits & Exclusions
- ▶ Programmatically mitigate the risk – to be effective you need data
  - ▶ Critical spares
  - ▶ Maintenance
  - ▶ Inspection
  - ▶ Test
  - ▶ Monitoring

## Your plan to mitigate the risk will depend on basic information

- ▶ How long was it out of service?
- ▶ Why did the equipment not function / operate?
- ▶ What caused the equipment to not operate?
- ▶ How often does the equipment not operate?
- ▶ What are the consequences if the equipment to not operate?
- ▶ How much did cost in lost revenue?
- ▶ Can you prevent / mitigate to avoid or minimize equipment not operating?

Need a means to quantify the answers to these questions in a consistent fashion

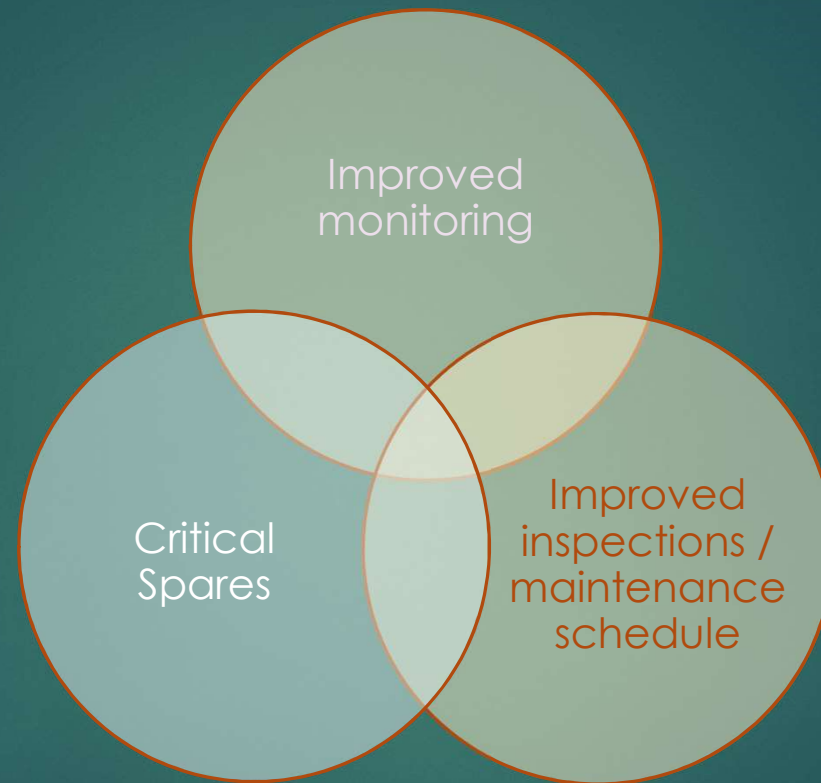
## Risk evaluation in a continuing process

- ▶ To understand the cost of risk measuring and reporting on reliability is crucial
- ▶ Data from wind farms needs improvement, and may be limited by OEM. More complex than thermal plants,
- ▶ Transparency, comparability and consistency in terms is essential (but not fully developed at this time)
- ▶ Reliability should be measured at the wind turbine and Wind generating plant level.
- ▶ Identify and focus on critical systems/components ones that impacts projects success the most: Equipment cost, frequency of failure, impact when failed, time to return to service,

## GOALS OF THE RISK EVALUATION:

- ✓ Identifying the Right Equipment to Apply Resources
- ✓ When and where to apply monitoring
- ✓ What inspection and testing can be done
- ✓ Perform the Right Maintenance
- ✓ Perform the Right Maintenance at the Right Interval
- ✓ Making the Right Plant Improvements or Upgrades
- ✓ Buying the Right Spares
- ✓ Replace the Right Assets

# Risk Mitigation Plan



LEARN FROM OTHERS THROUGH USER'S GROUP / INDUSTRY ORGANIZATIONS

Thank you

