



Strategies to improve reliability of offshore wind turbine blades

Megan Rotondo, Principal Wind Turbine Blade Engineer

18 September 2024



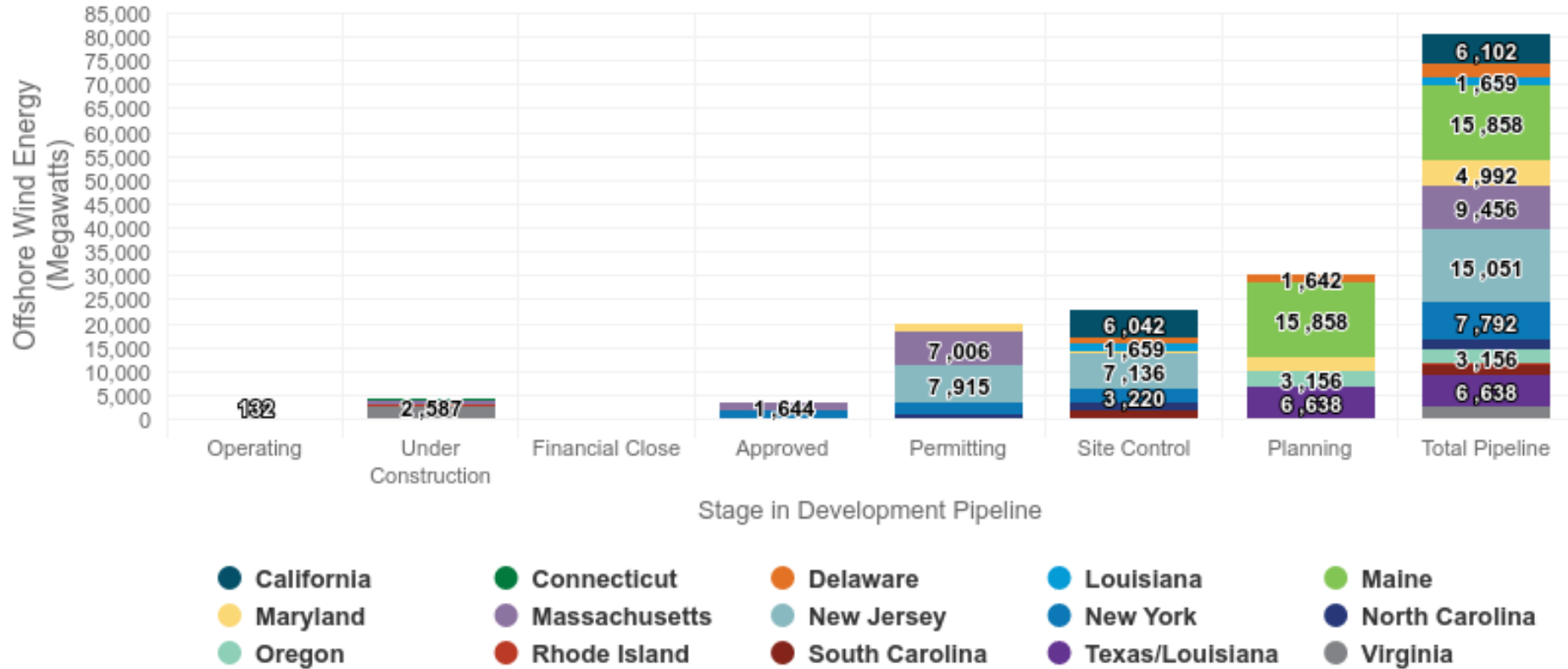
- DNV perceives blade durability as a major challenge the wind industry must address
- White paper issued in May 2023 is intended to advance industry practice towards increased reliability
- Includes inputs from Certification and Advisory, > 200 years of combined blade experience globally
- Examines factors influencing blade durability through the viewpoint of trends across the life cycle of blades

Scan to download report:



U.S. Offshore Wind Energy Pipeline

This map shows offshore wind energy capacity in the United States by state and where in the development pipeline they are as of May 31, 2024, in megawatts.



The location of the project is defined by where the project's power is intended to be sold. If the project does not have an offtake agreement, the location is the project's physical location. This clarification is needed where projects are located in a certain location but sell their power to a neighboring state market.

Source: *Offshore Wind Market Report: 2024 Edition*, U.S. Department of Energy Wind Energy Technologies Office
U.S. Department of Energy

Offshore challenges

One of the top O&M challenges for developing offshore wind energy in the US identified in the “An Operation and Maintenance Roadmap for US Offshore Wind”*

“Unplanned maintenance: Unplanned maintenance can lead to costs that are often not accounted for during the development stage of a wind energy project, and can also lead to expensive repairs. As a result, there is a need to **reduce the frequency of major component overhauls or replacements throughout a wind turbine’s design life**, and to consider maintainability as a metric during the turbine design or project development stage”

*Paquette, Josh, et al. (2024) An Operations and Maintenance Roadmap for U.S. Offshore Wind. Available at: https://www.energy.gov/sites/default/files/2024-05/operations-maintenance-roadmap-us-offshore-wind.pdf?utm_medium=email&utm_source=govdelivery (Accessed: 6 September 2024)

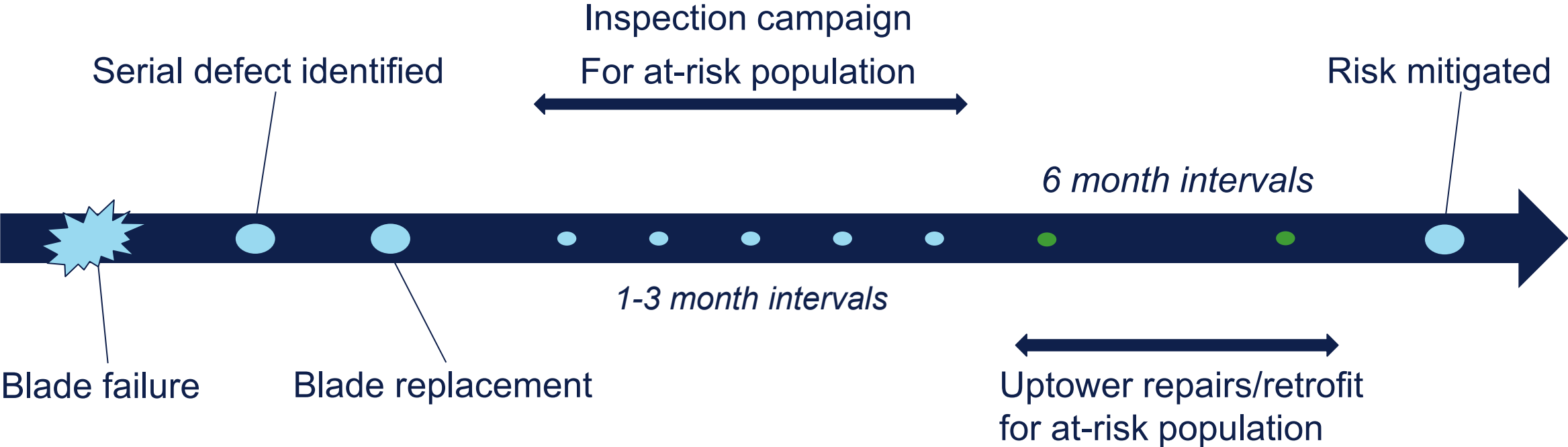
Offshore challenges

- Access
 - Mobilization & availability of vessels
 - Jack-up vessel – blade replacements
 - Service Operation Vessel – long repair campaigns
 - Crew Transfer Vessel – smaller, closer to shore projects
 - US specific – Jones Act
- Environmental conditions
 - Sea condition
 - Wind speeds
 - Lightning
 - Erosion
- Production loss
 - Larger turbine capacity = higher cost of downtime



Source : US Department of Energy. [./www.energy.gov/eere/wind/articles/top-10-things-you-didnt-know-about-offshore-wind-energy](https://www.energy.gov/eere/wind/articles/top-10-things-you-didnt-know-about-offshore-wind-energy)

What happens if you have a blade issue **onshore**?



Improving reliability

Design

- Structural margins
- Robustness /redundancy
- Testing
- Design for manufacturing
- Tolerances

Manufacturing

- Process capability
- Automation
- Training
- Quality controls
- Repairs

Operation

- Inspections
- Monitoring
- Repairs

How to Mitigate Risk?

Blade Due Diligence

Design-for-manufacture review



Manufacturing evaluation



Production monitoring



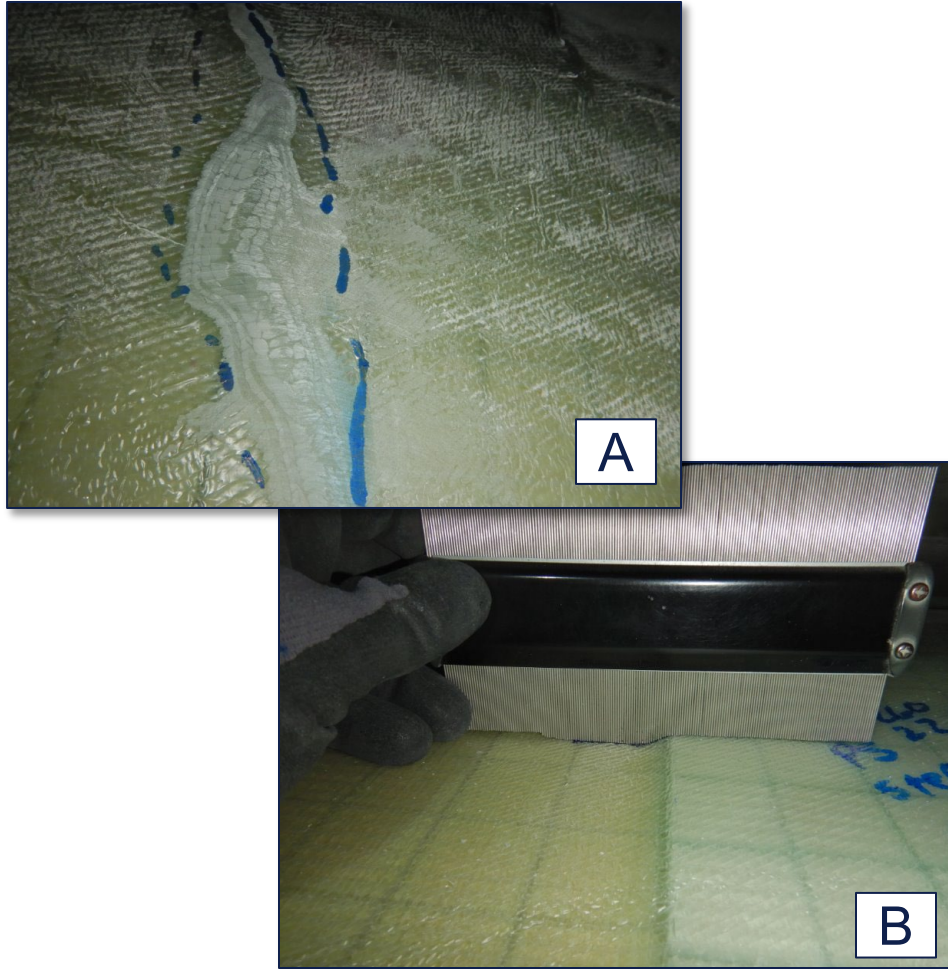
Finished blade inspections



Outcomes

- **Blade remediation prior to operations**
- More informed commercial risk mitigations
- More informed blade management program (risk-based inspections)
- When blade quality is observed to **meet or exceed industry expectations**, provides confidence and trust that risks are acceptable

Examples – quality escapes



- Factory:
 - Chemical contamination on bondlines
 - Insufficient surface preparation for bonding of Trailing Edge
 - Ply placement gaps: plies designed to overlap were found to have a gap between them
 - Incorrect material storage and labelling
 - Out of tolerance defects left in blade without repair
 - Lack of environmental controls in factory during production
- Blade Inspection
 - Wrinkles [A]
 - Core steps [B]
 - Grinder damage [A]
 - Foreign Objects
 - Delaminations

Moving the industry forward

- Offshore wind industry cannot accept the current blade quality seen in North American onshore market
- Recent failures have hurt public perception, the blade industry needs to show the public that wind turbine blades are reliable
- Prevent quality issues before they happen
 - Move to proactive from reactive
 - Collaborative effort

