



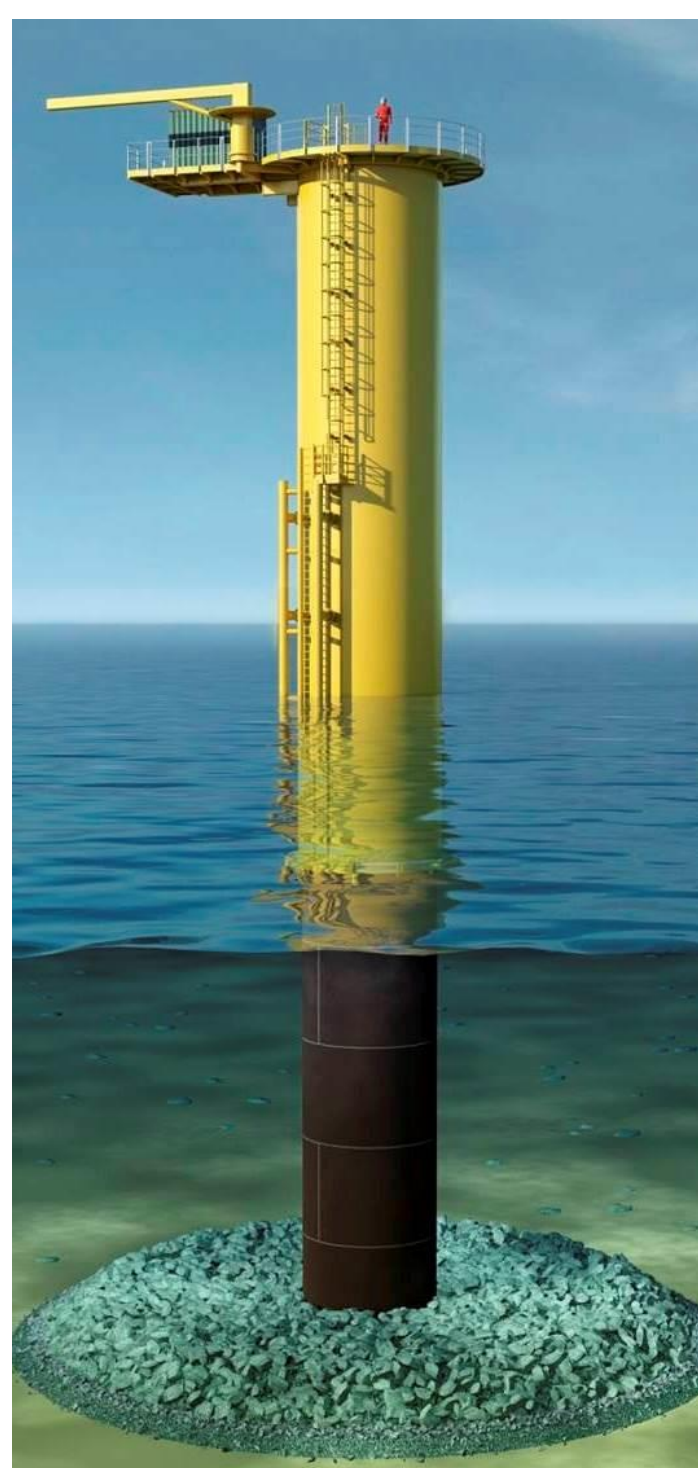
# Strategies for low-cost assessment of lifetime extension of offshore wind monopiles



Lisa Ziegler (lisa.ziegler@ramboll.com)



Ramboll, Germany  
Norwegian University of Science and Technology, Norway  
Cranfield University, UK



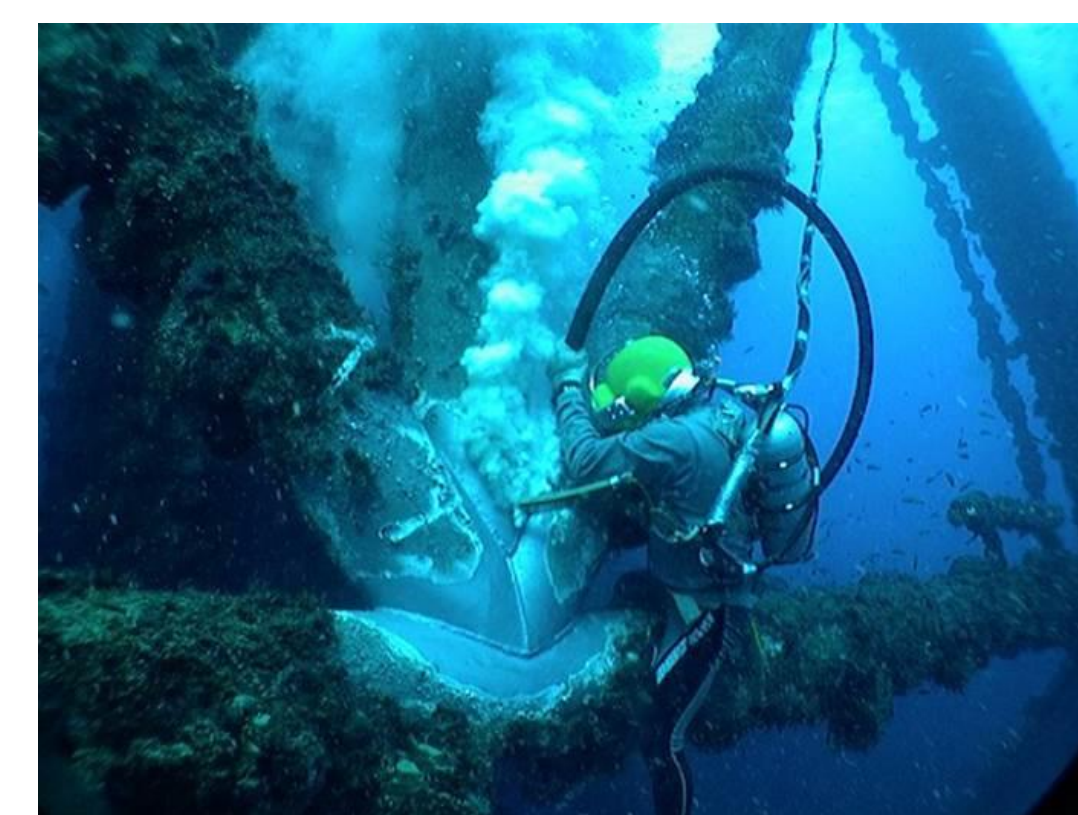
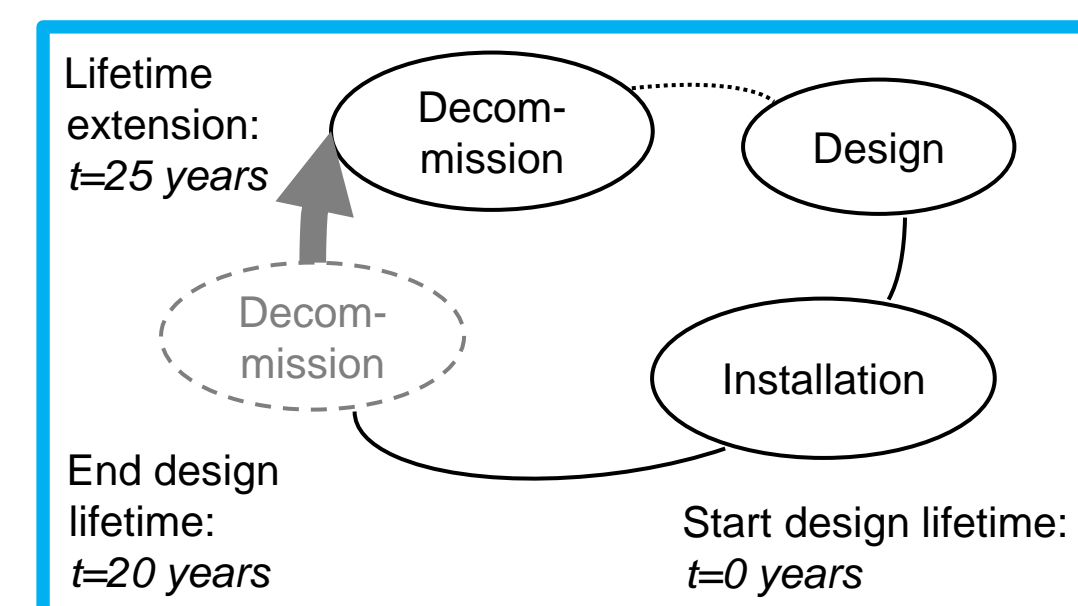
## Lifetime extension is a today's problem!

### Trends in the offshore wind industry:

1. Aging wind farms
2. O&M costs increase
3. Low-cost monitoring solutions available



- Decision on lifetime extension soon necessary
- No experience yet
- When and what should be monitored?



## What is the best strategy to determine the remaining useful fatigue life (RUL)?

### Practical assessment

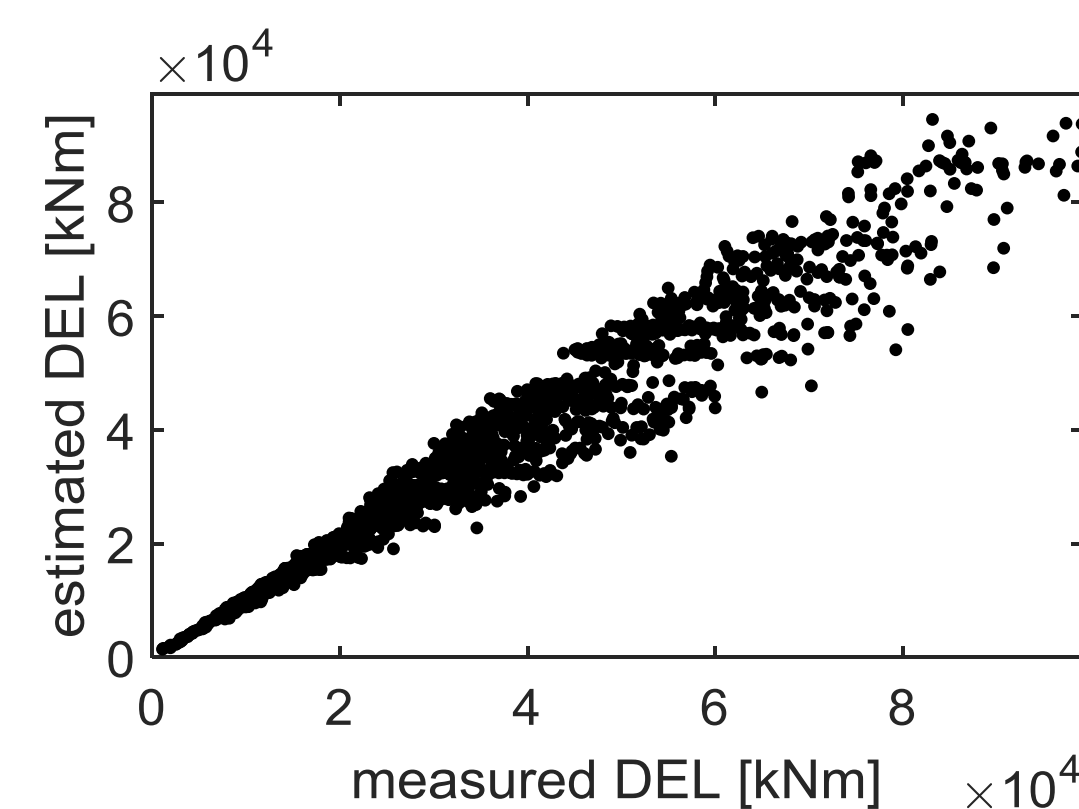
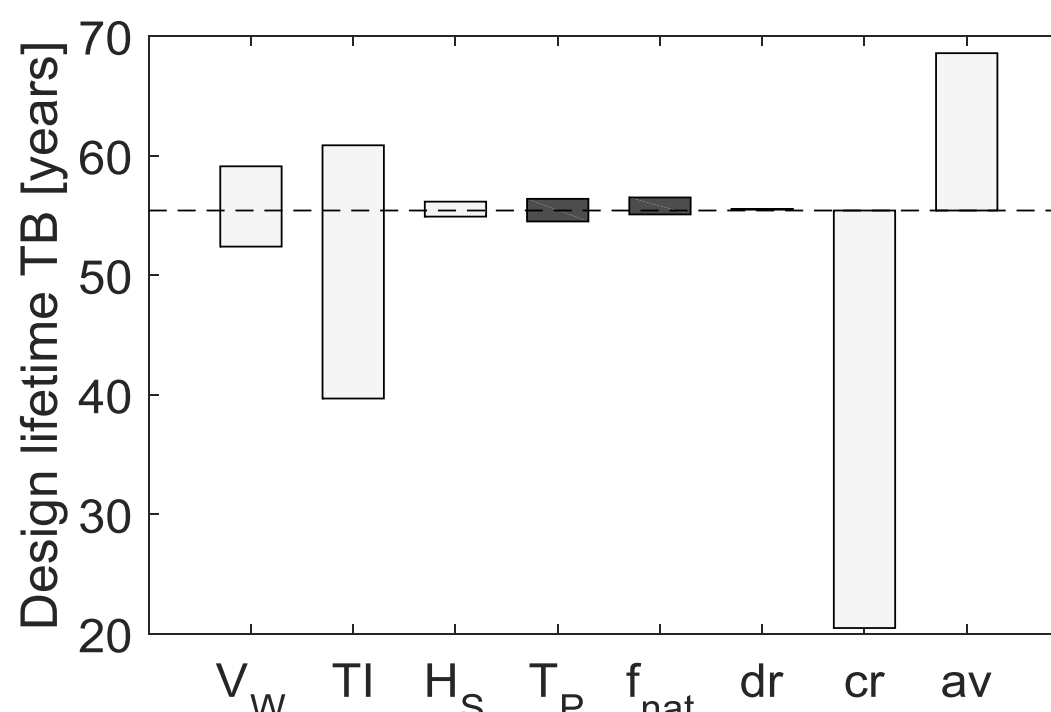
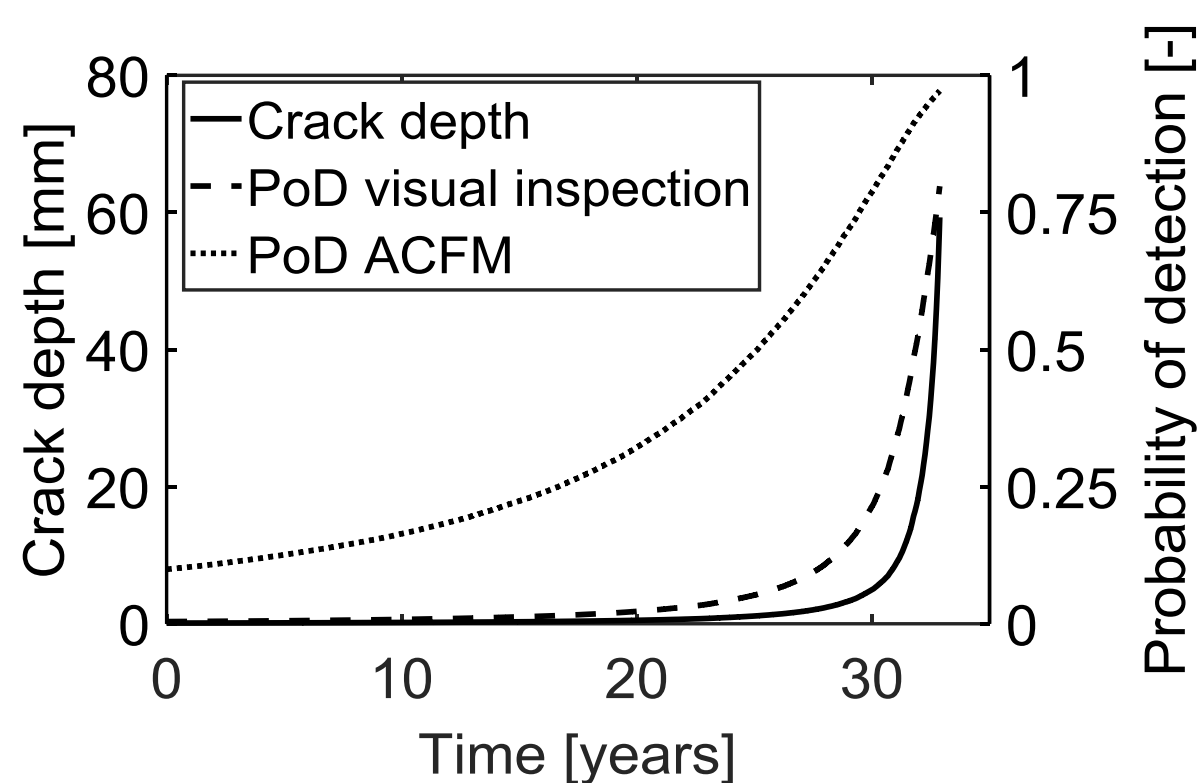
- Reduction of uncertainty [1] **+**
- Low probability of detection of decisive fatigue cracks [2] **-**
- High costs due to offshore risks **-**
- Cannot predict RUL directly **-**

### Analytical assessment

- Estimation of RUL **+**
- Identifies important parameter to monitor [3] **+**
- Environmental conditions required **-**
- Design model required **-**

### Structural monitoring

- Tracks load history **+**
- Compare to design for RUL **+**
- Needs extrapolation from limited number of sensors **-**
- Restricted to selected turbines [4] **-**



### References

[1] Stutzmann J, Ziegler L, & Muskulus M. To appear. Fatigue crack detection for lifetime extension of monopile-based offshore wind turbines. *Energy Procedia*.  
 [2] Ziegler L, & Muskulus M. Lifetime extension of offshore wind monopiles: Assessment process and relevance of fatigue crack inspection. *12th EAWC PhD Seminar*, DTU Lyngby, Denmark; 2016.  
 [3] Ziegler L, & Muskulus M. 2016. Fatigue reassessment for lifetime extension of offshore wind monopile substructures. *Journal of Physics: Conference Series (Vol. 753, No. 9)*. IOP Publishing.  
 [4] Weijtens W, Noppe N, Verbelen T, Iliopoulos A, & Devriendt C. 2016. Offshore wind turbine foundation monitoring, extrapolating fatigue measurements from fleet leaders to the entire wind farm. *Journal of Physics: Conference Series (Vol. 753, No. 9)*. IOP Publishing.