Rain erosion environmental load and predicted leading edge blade lifetime based on long-term rain data

Hasager, Charlotte; Tilg, Anna-Maria; Vejen, Flemming

Publication date:
2021

Document Version
Publisher's PDF, also known as Version of record

Rain erosion environmental load and predicted leading edge blade lifetime based on long-term rain data

- *Charlotte Hasager, Anna-Maria Tilg (DTU)*
- *Flemming Vejen (DMI)*

Content

- Research hypothesis
- Wind speed and rain data at 18 locations
- Key questions
- Results
- Conclusions

www.rain-erosion.dk

Research hypothesis

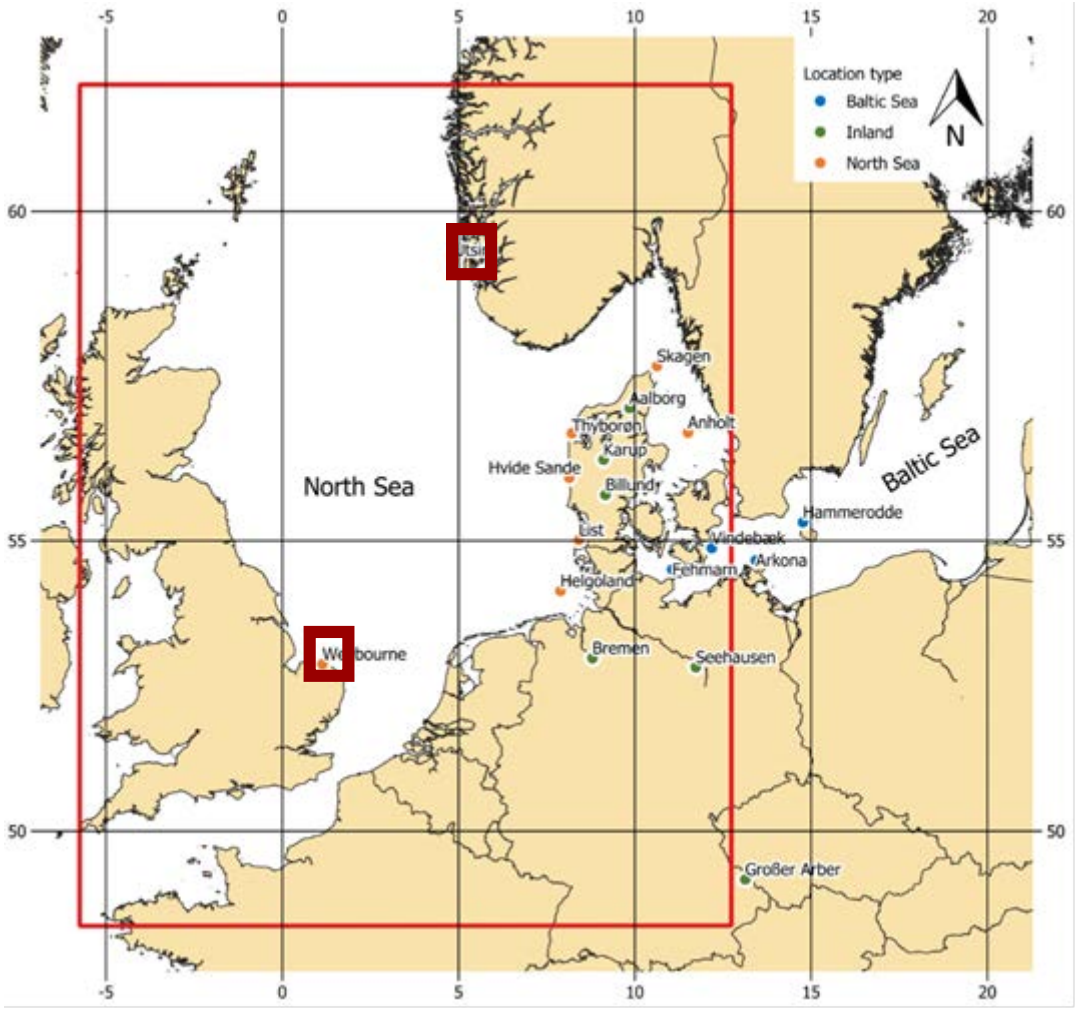
Tilg *et al.*
WESC 2021

Wind and rain data

Location	Number of years
Aalborg	16.9
Anholt	17.9
Arkona	28.2
Billund	16.4
Bremen	28.2
Fehmarn	23.6
Grosser Arber	21.9
Hammerodde	18.3
Helgoland	23.0
Hvide Sande	18.0
Karup	16.9
List	24.1
Seehausen	28.2
Skagen	18.0
Thyborøn	18.0
Utsira	3.3
Vindebæk	13.6
Weybourne	2.6

10-minute wind speed
10-minute rain rate
Quality control

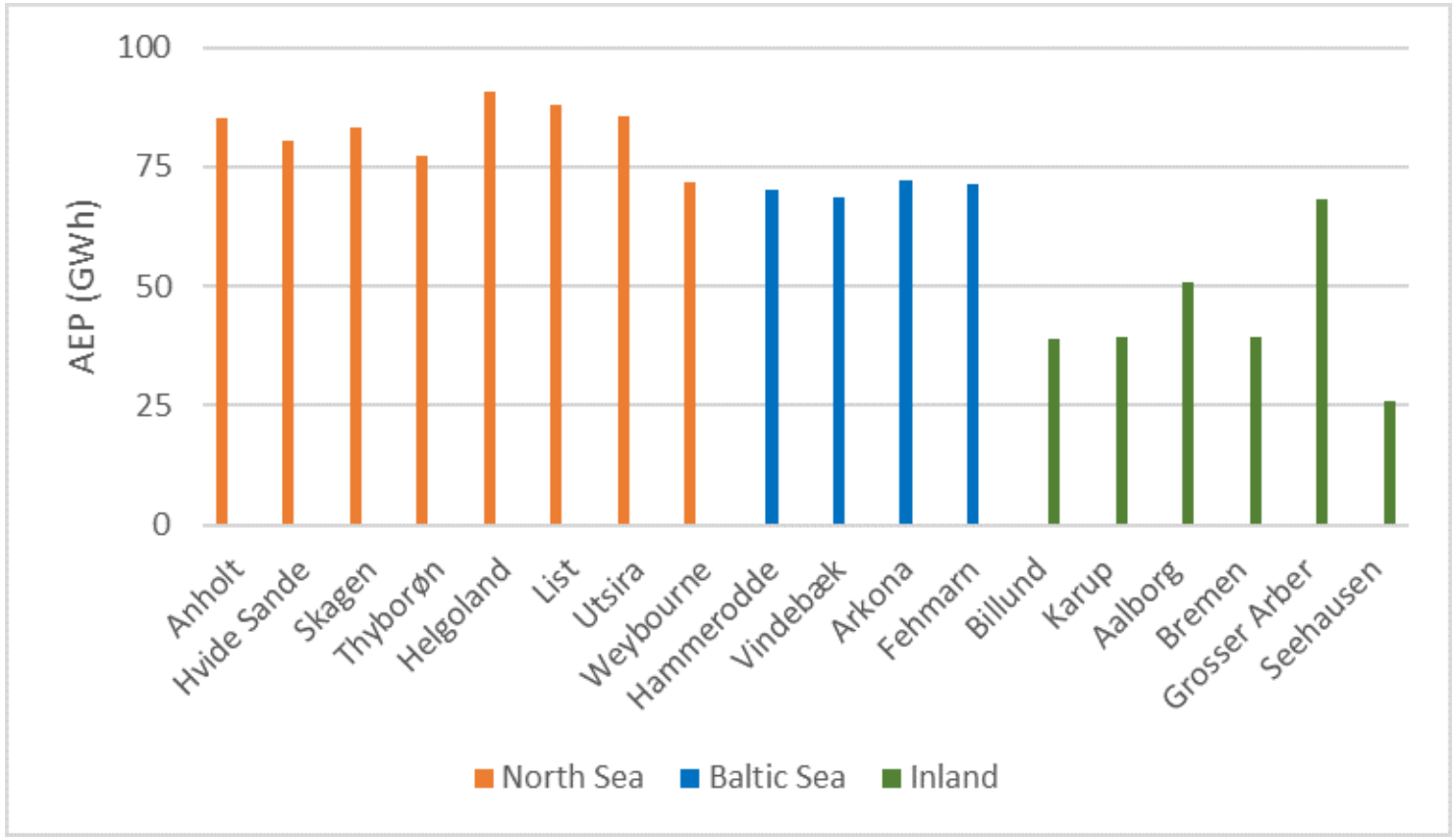
All time series are > 13 years
(except at two stations)



Hasager *et al.* 2021 *Energies*

Annual Energy Production (AEP) for ideal blades

Assume IEA Wind 15 MW turbine is installed at each weather station



Hasager *et al.* 2021 *Energies*

Key questions

Question 1:

What percentage profit would you get if you have ideal blades compared to eroded blades in normal operation?

Question 2:

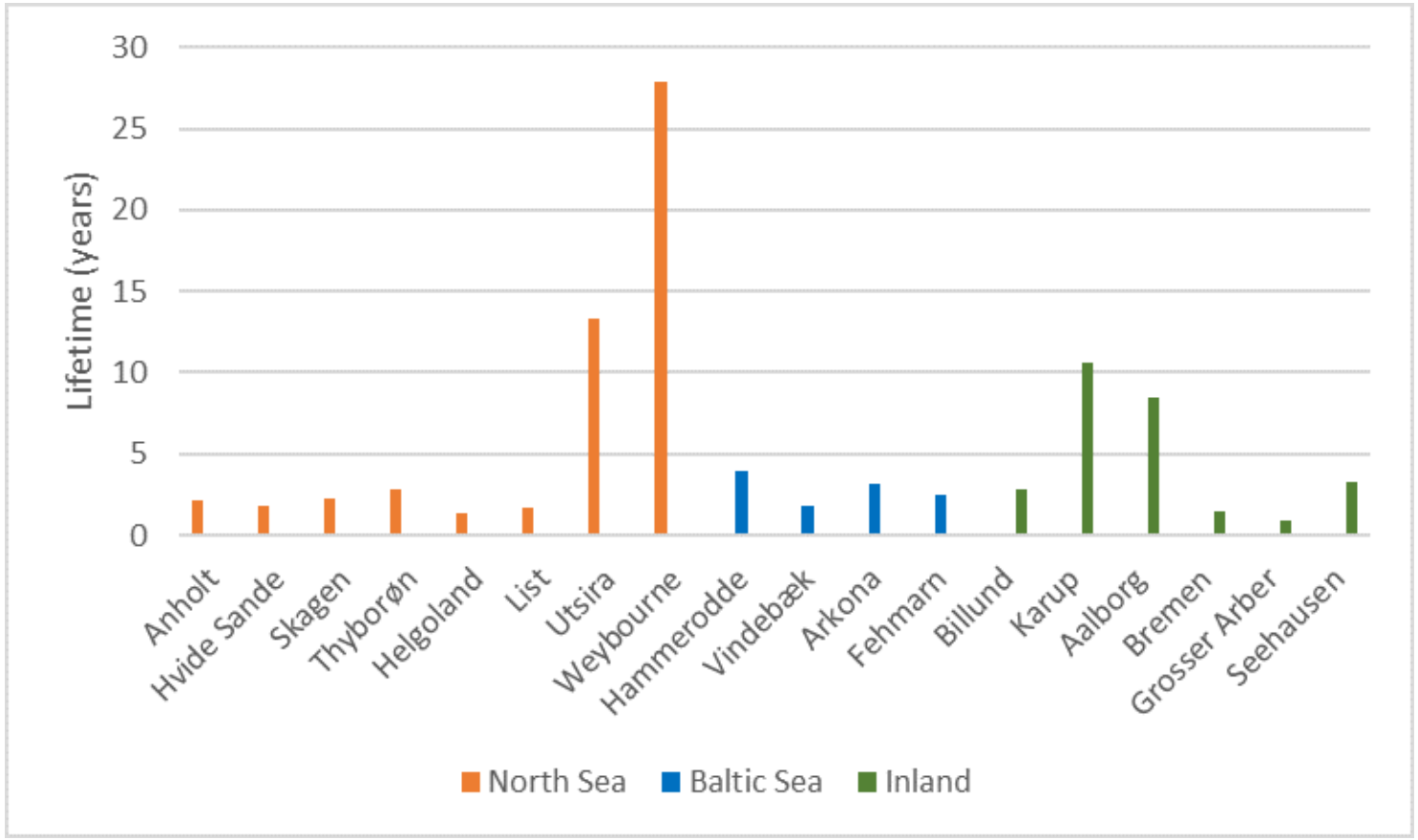
What percentage profit would you get if you use erosion-safe mode compared to eroded blades in normal operation?

Damage model

We assume Bech *et al.* 2018 kinetic-energy model

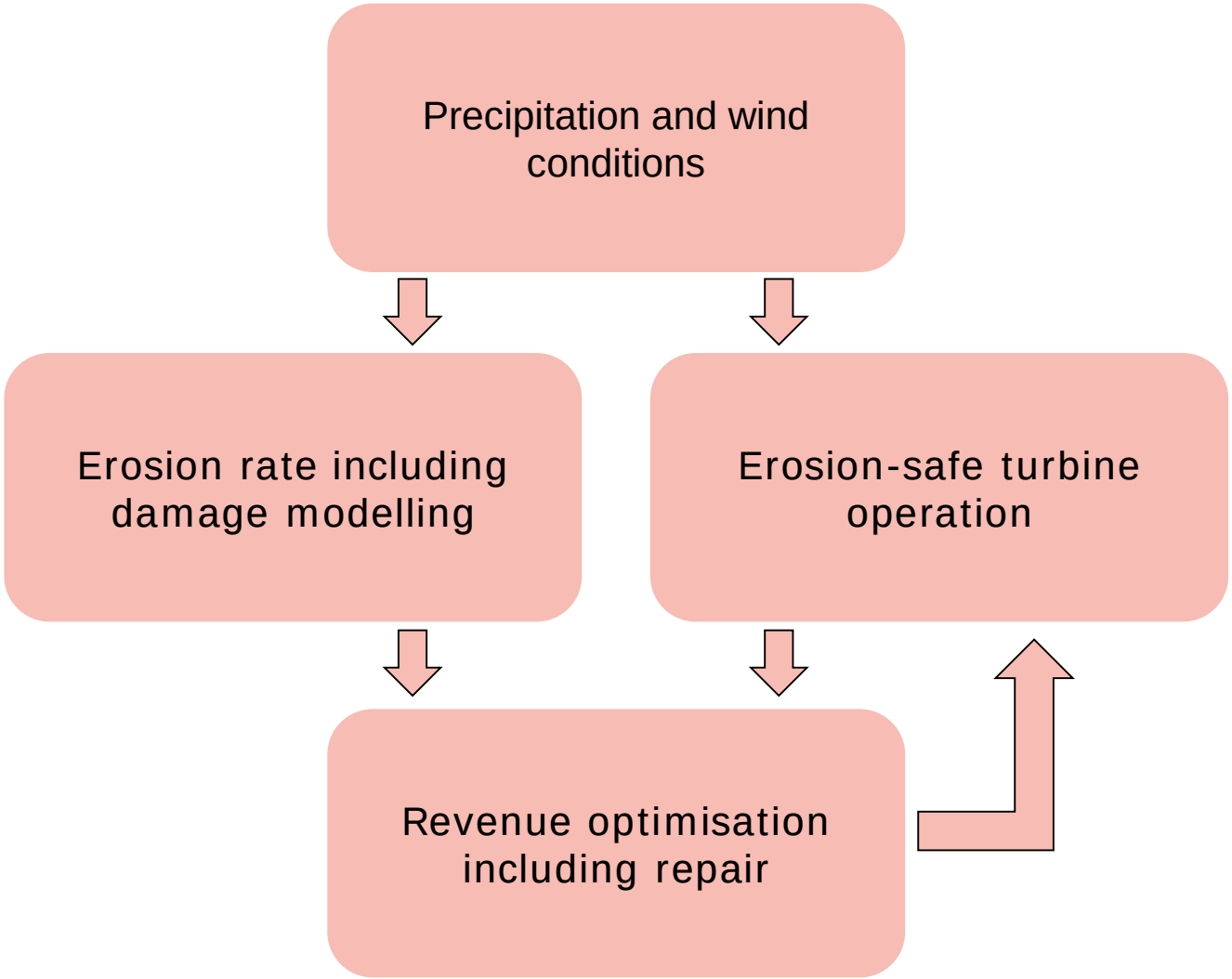
Damage will occur as a function of rain and wind speed events during the years in normal operation

Lifetime in normal operation



Hasager *et al.* 2021 *Energies*

Erosion-safe mode



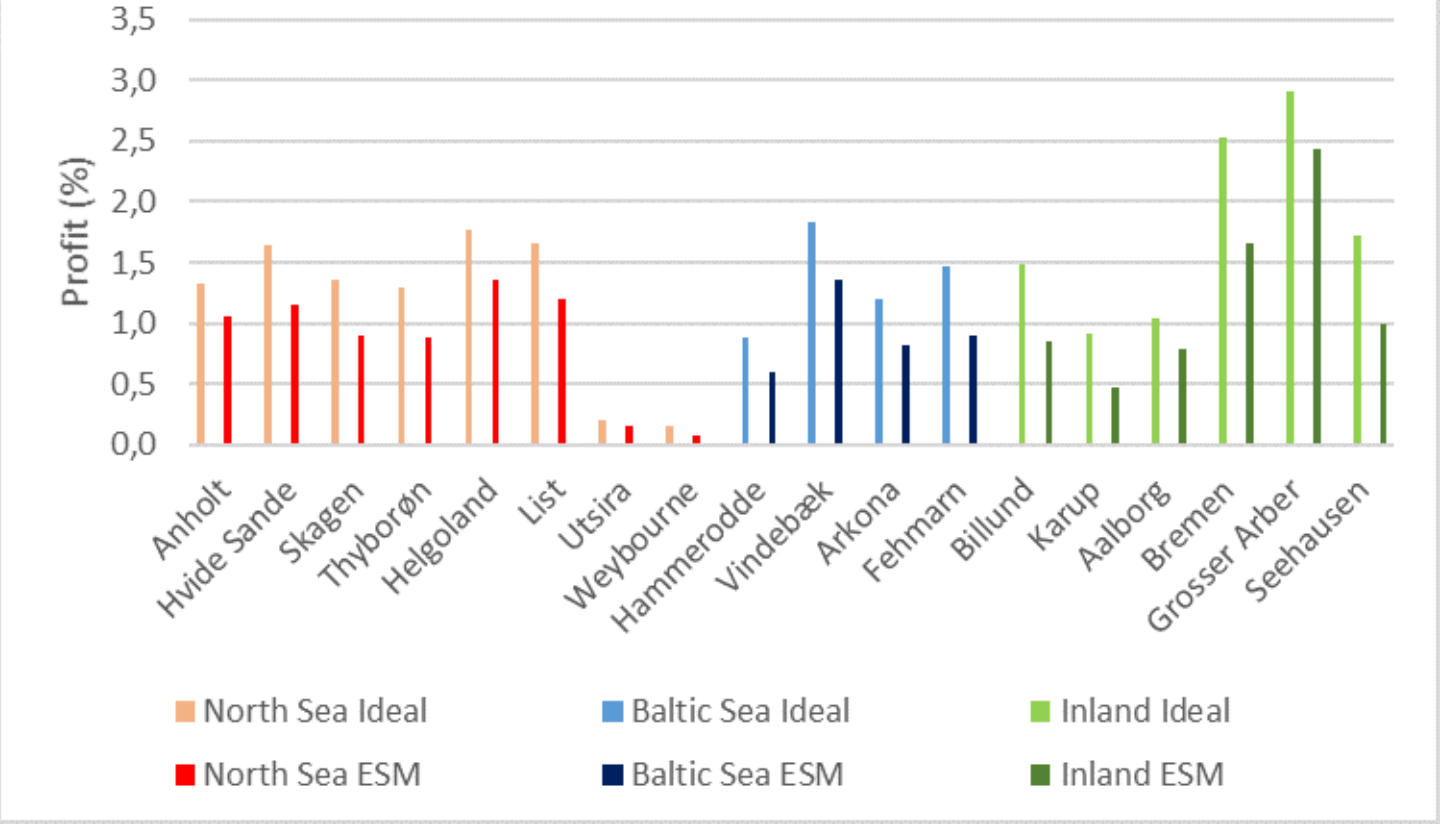
Hasager *et al.* 2020 *Renewable Energy*

Profit for ideal blades and for erosion-safe mode

Assume cost of electricity at Euro 0.05 per kWh, 20k Euro each repair and six days downtime for repair

Average potential profit using erosion-safe mode is 70 %

The last 30 % can only be obtained with ideal blades



Hasager *et al.* 2021 *Energies*

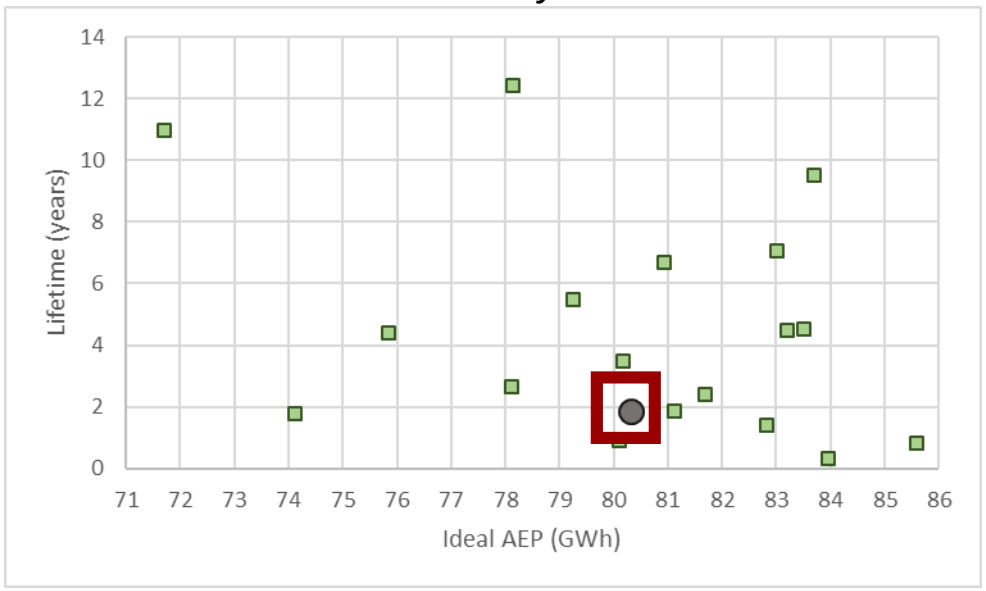
AEP loss in percentage

Average AEP loss is 0.46 % from the 18 stations and it vary little from site to site

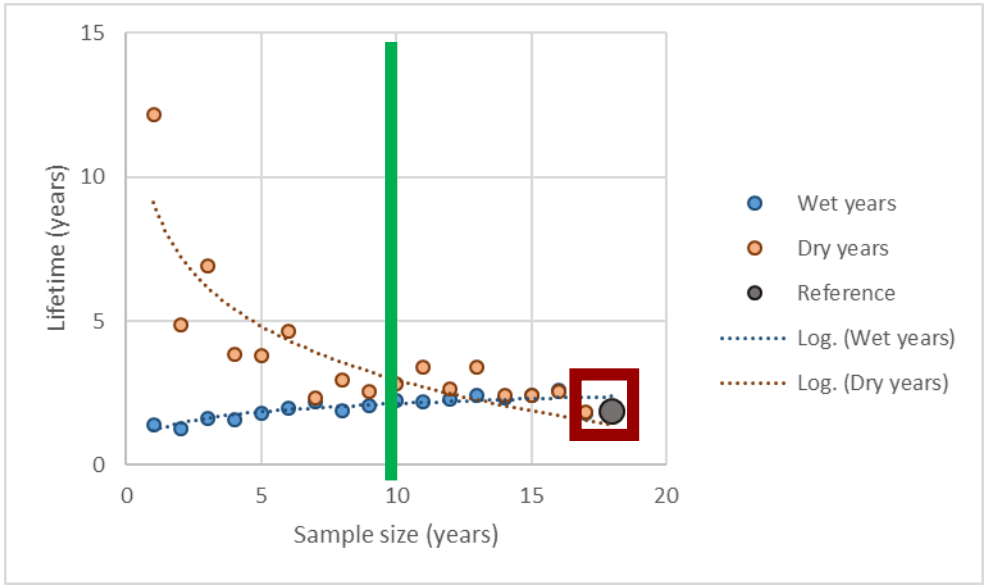
Hasager *et al.* 2021 *Energies*

Calculation of blade lifetime and its sensitivity to length of time series

Individual years



Year samples from 1 to 17 years dry and wet



References is 18 year's data at Hvide Sande from 2002 to 2019

Hasager *et al.* 2021 *Energies*

Conclusions

On potential profit

- Average potential profit using erosion-safe mode 70%
- The last 30 % can only be obtained with ideal blades

On meteorological data

- Ten years or more of wind speed and rain data are needed to produce robust results

Hasager *et al.* 2021 *Energies*

Acknowledgements

- We acknowledge the funding support by the Innovation Fund Denmark
- grant 6154-00018B for the project EROSION.

www.rain-erosion.dk

Innovation Fund Denmark