University of Strathclyde

A Surrogate Model Framework for Structural Lifetime Extension Assessment of Monopile Wind Turbines
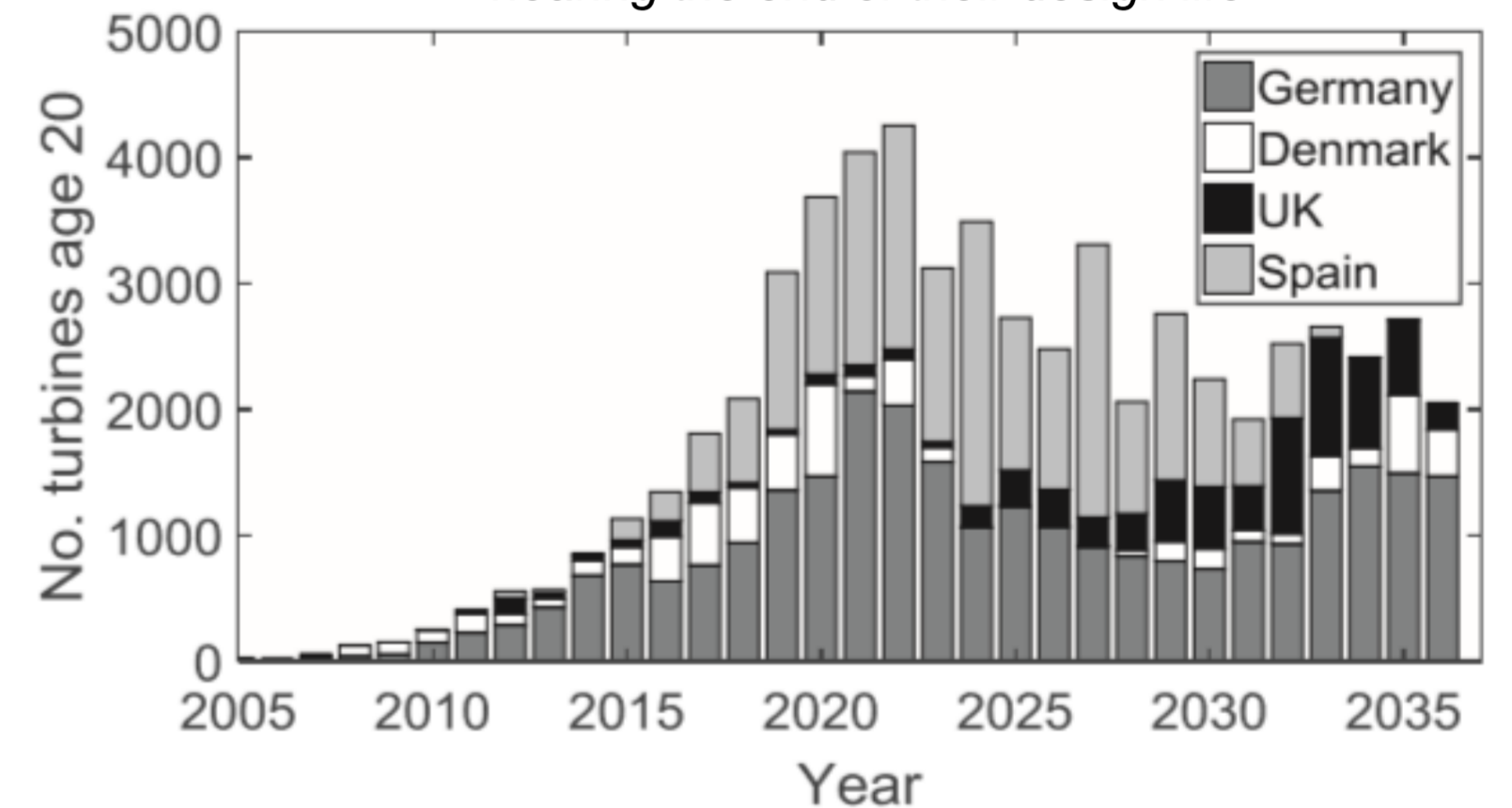
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Introduction

The industry needs a plan for turbines approaching end of design life. Currently, there are three options: decommissioning, lifetime extension or repowering. A combination of technical, economic and legal forces has created an appetite for lifetime extension option: using targeted remedial/maintenance work to allow the wind turbine to operate for longer than originally designed.

IEC Wind Classes

	I (High Wind)	II (Medium Wind)	III (Low Wind)	IV (Very Low Wind)
Reference Wind Speed	50 m/s	42.5 m/s	37.5 m/s	30 m/s
Annual Average Wind Speed (Max)	10 m/s	8.5 m/s	7.5 m/s	6 m/s
50-year Return Gust	70 m/s	59.5 m/s	52.5 m/s	42 m/s
1-year Return Gust	52.5 m/s	44.6 m/s	39.4 m/s	31.5 m/s

Source: *www.lmwindpower.com*

Source: *www.bbc.co.uk*

How do you re-assess a wind farm to find suitable turbines without wasting time and money

Significant number of currently installed wind turbines are nearing the end of their design life

Source: Ziegler et al (2018) *Lifetime extension of onshore wind turbines: A review covering Germany, Spain, Denmark, and the UK*

Key Points:

1. Fatigue damage is the main determinant of structural design life
2. Fatigue design is usually based on conservative assumptions (e.g. wind classes) due to uncertainties in design parameters.

Observation:

The reassessment of a wind turbine using site specific conditions and as-built information may show that the structure possesses structural reserves (Remaining Useful Life) beyond the original design predictions.

Research Aim: *Produce a screening tool for accurate, practical and quick assessment of a wind turbine's potential for structural life extension*

Research Objectives

1. Develop a parametric approximation model
2. Train the model using deterministic simulations covering expected variations of structure and loads.
3. Use the trained surrogate model to predict the structural response of any wind turbine ➔ no need for expensive and lengthy simulations

Future Work