



Offshore Wind Energy

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10th Annual Oxford Energy Day: “Energy and Net Zero”
Wednesday 23rd March 2022

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PISA PROJECT



PISA Final Report

October 2016

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Report produced by members of the PISA Academic Work Group (University of Oxford, Imperial College London, University College Dublin) and the PISA representatives of DONG Energy.

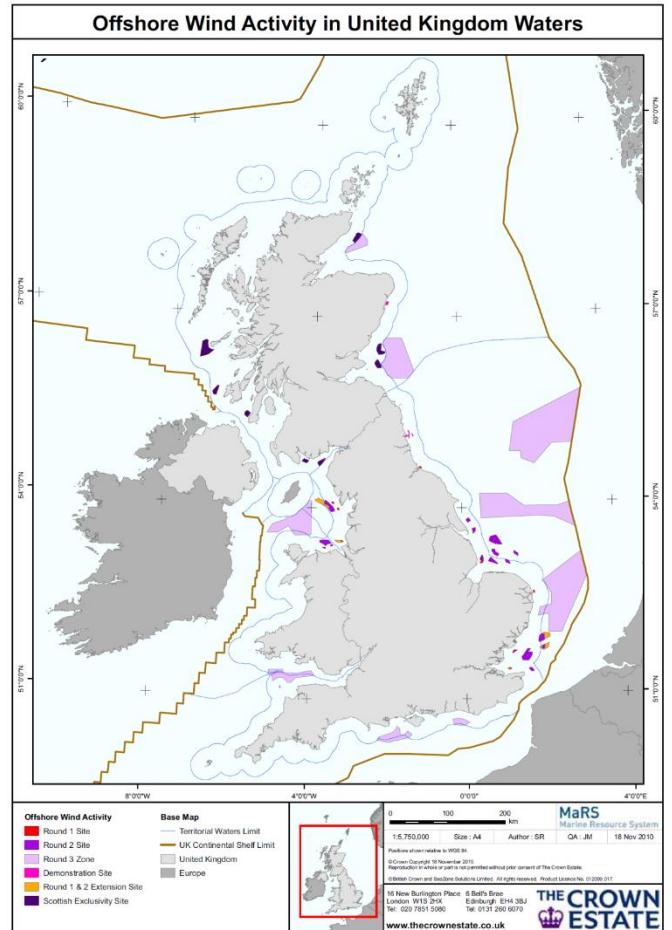
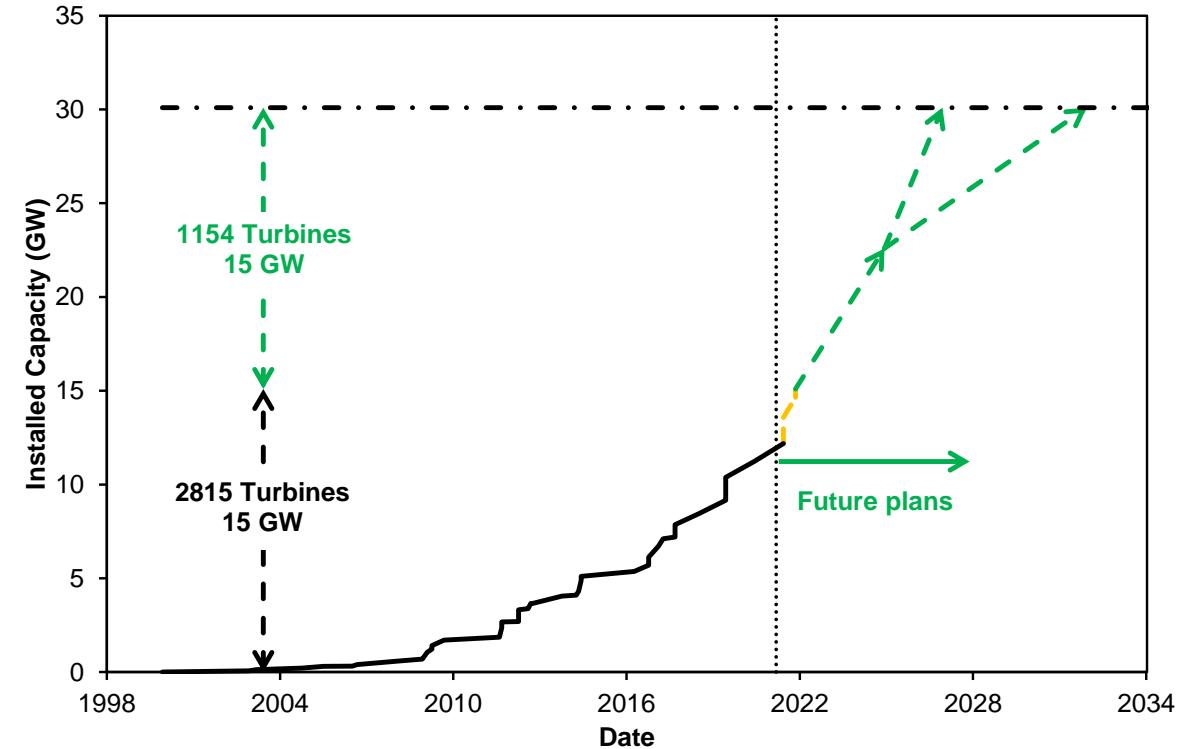
Revision History

Rev No	Date	Rev No	Date	Doc No	Description
0	13/05/2016	24/01/2016	24/01/2016	240100	Final report first revision
0	20/05/2016	24/01/2016	24/01/2016	240100	Final report second revision. Header plus an acknowledgement of the funding provided by the Cadent Trust on Page 4.
0	14/10/2016	24/01/2016	25/10/2016	250100	Final report third revision. Header plus an acknowledgement of the funding provided by the Cadent Trust on Page 4. Includes updated figures and addition of analysis of wave loadings for one

The sole responsibility for the content of this report lies with the PISA Project Academic Work Group. This comprises of Byron Byrne, Oxford University, as the Principal Investigator and then in no particular order (a) Christopher Lethbridge, University of Oxford, Guy Phipps, University of Manchester, (b) Dr. Tomasz Zdziarski, David Talbert, David Pitts, Richard Jardine, (c) University College Dublin; Ken Gavin, David Morris.

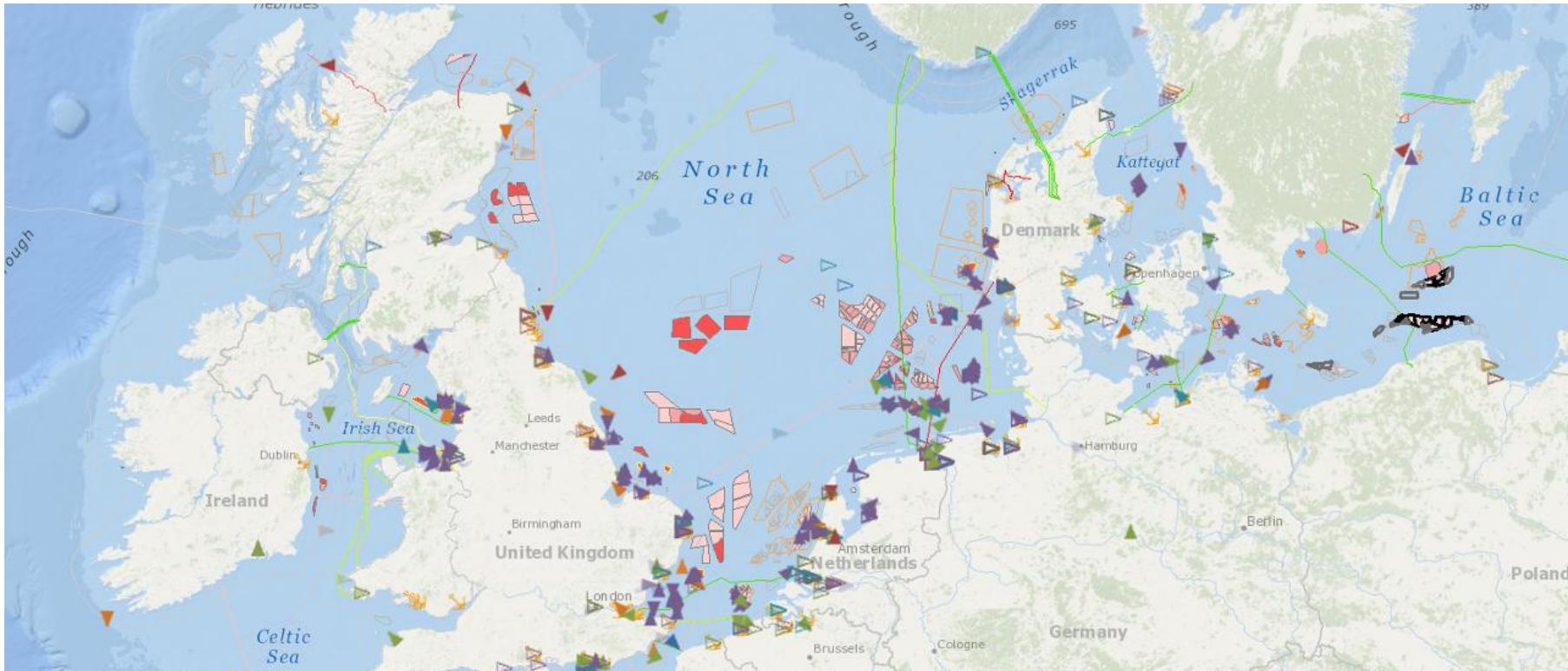
Other energy research interests:
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UK Ambition

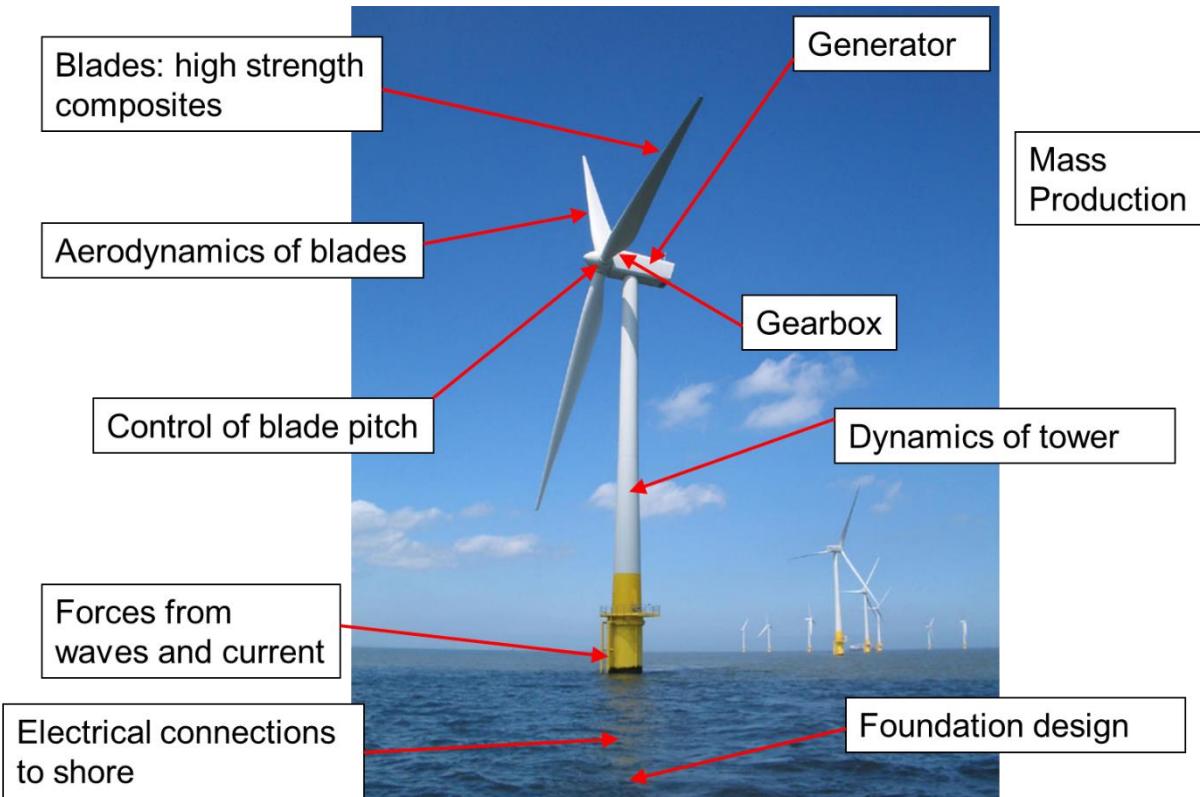


Source: The Crown Estate

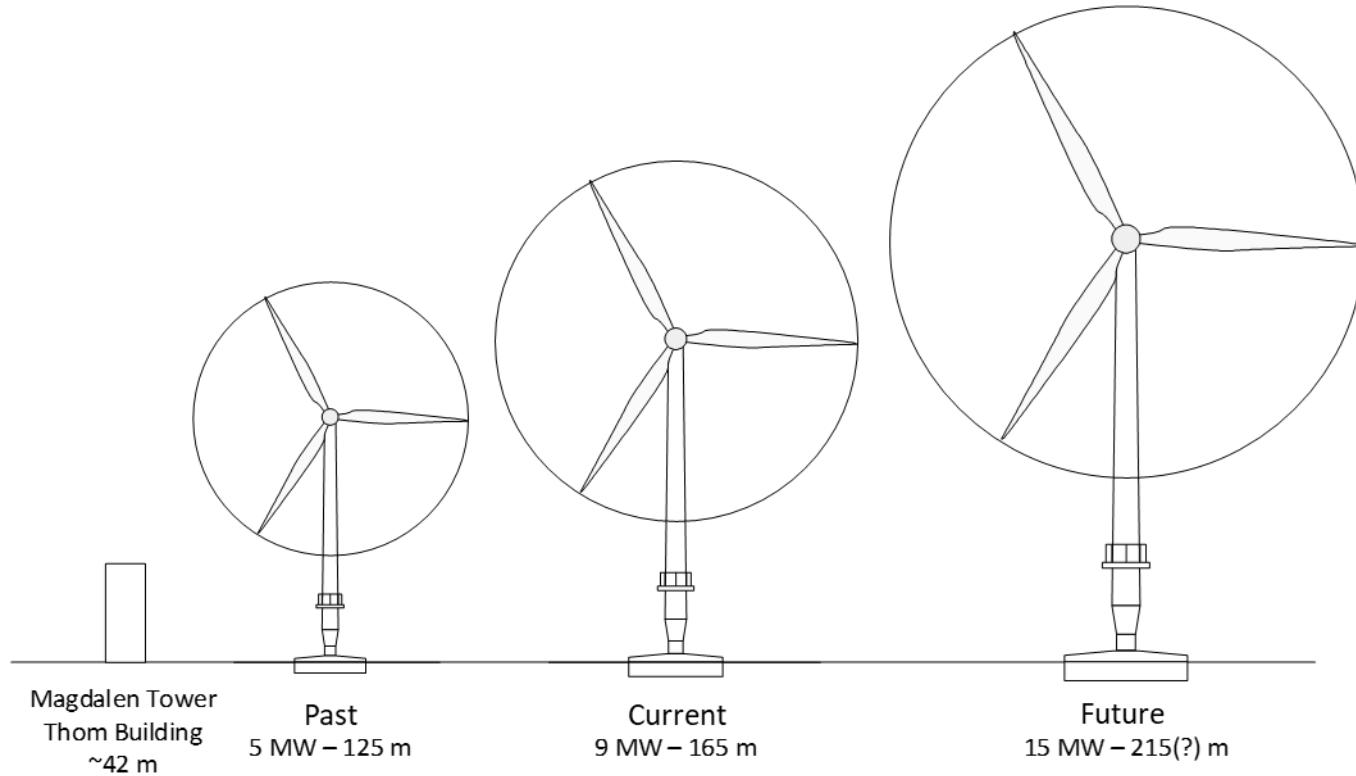
Offshore Wind Map – 4COffshore



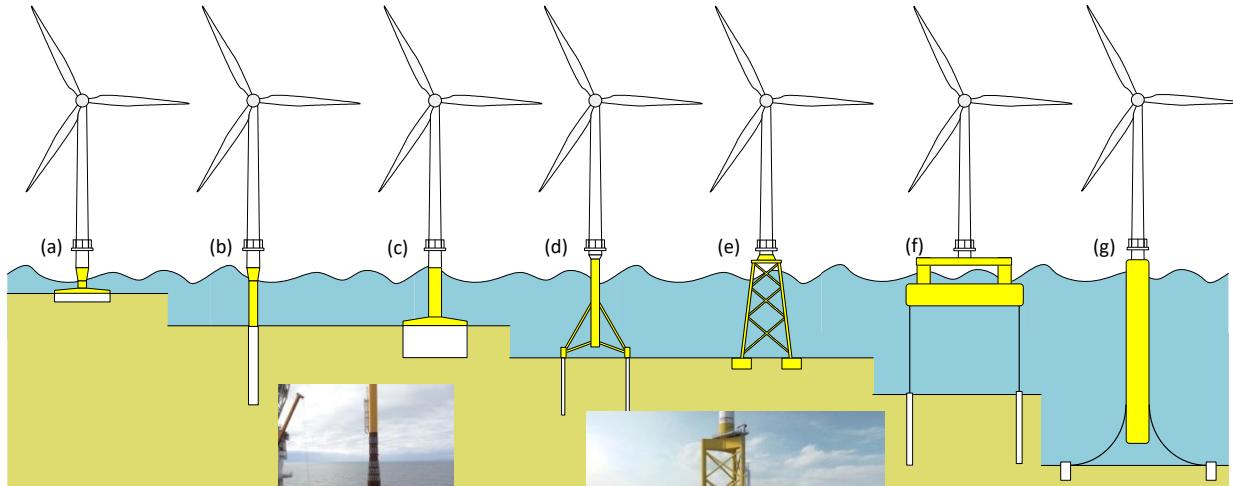
Engineering for Offshore Wind Turbines



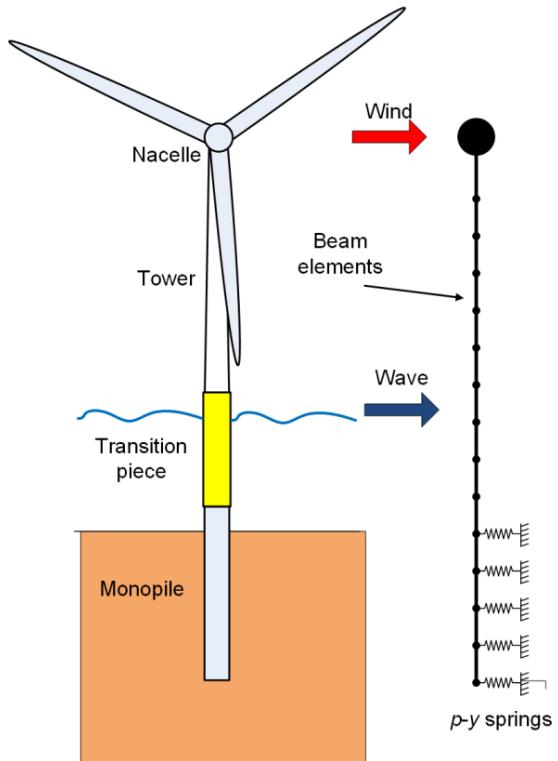
Scale of Engineering Design



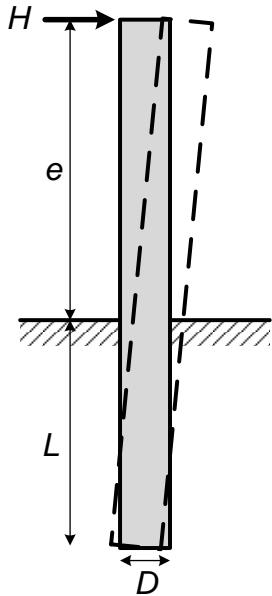
Offshore Wind Structures



Oxford Focus on Monopiles

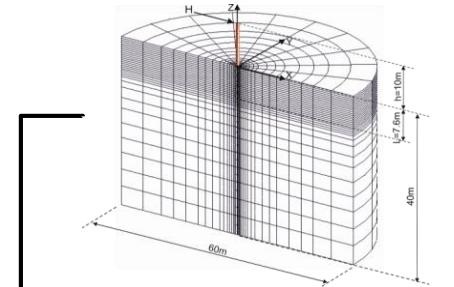


$$\begin{aligned}L/D &= 2 \text{ to } 6 \\e/D &= 5 \text{ to } 15 \\D &> 10 \text{ m}\end{aligned}$$

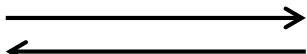


PISA Project Overview – 2014-2018

Advanced Numerical Modelling



Design



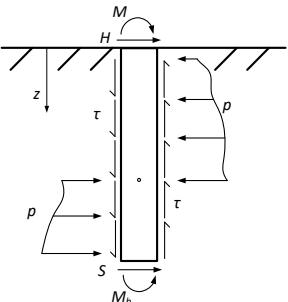
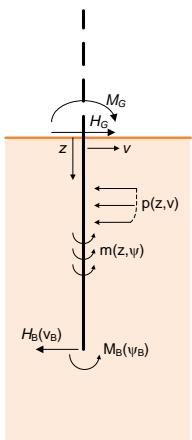
Validate



Field Tests

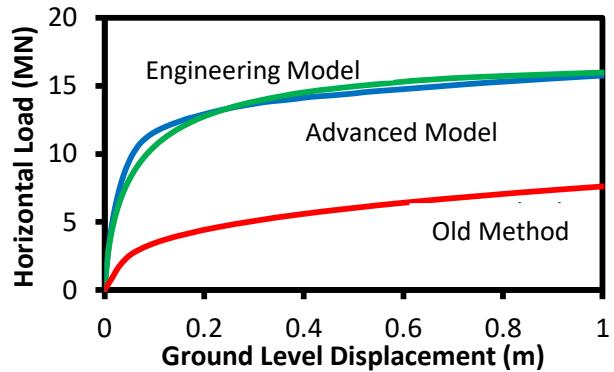


Simplified Engineering Models



Apply to Design

Accurate Response Prediction



Géotechnique

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Ahead of Print

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PISA design model for monopiles for offshore wind turbines: application to a stiff glacial clay till

Authors: Byron W. Byrne* Guy T. Headley* Harvey J. Bund* Kenneth G. Gavin† David J. P... Show All

[https://doi.org/10.1608/0518-P205](#)

Published Online: December 06, 2019

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Keywords: design limit state design analysis numerical modeling offshore

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Abstract

Offshore wind turbines in shallow coastal waters are typically supported on monopile foundations. Although three-dimensional (3D) finite-element methods are available for the design of monopiles in contexts, much of the routine design work is currently conducted using simplified one-dimensional (1D) methods based on the $p-y$ method. The $p-y$ method was originally developed for the relatively low values of the pile-to-soil interaction length (L/D) associated with deep foundations in soil. It is well known, however, that this analysis approach may not be appropriate for monopiles with the relatively low values of L/D that are typically adopted for offshore wind turbines. This paper describes a new design approach for such monopiles, which is specifically formulated for offshore wind turbines, although the general approach could be adopted for other applications. The model draws on the conventional $p-y$ approach, but it extends it to include additional components of soil reaction that act on the pile. The new approach is demonstrated to provide significant improvements in the design of monopiles. The new design approach is also shown to reduce conditions that span a preferred design space. The calibrated 1D model provides results that match those obtained from the 3D finite-element simulation, but at a fraction of the computational cost. Moreover, within the calibration space, the 1D model provides a more robust solution than the 3D finite-element simulation. The new design approach is also shown to be effective in modeling the response of monopiles installed in a stiff, overconsolidated glacial clay till with a typical North Sea strength and stiffness profile. Although the current form of the model has been developed for homogeneous soil and monotonic loading, it forms the basis from which further work for soil layering and cyclic loading can be developed. The new design approach can be applied for other foundation and soil-structure interaction problems, in which bespoke calibration of a simplified model can lead to more efficient designs.

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Trust publishes PISA treasure trove

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Carbon Trust seeks massive wave analysis

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Research papers from the Carbon Trust's £1m-plus joint industry Pile Soil Analysis (PISA) project have been made available for free online.

Academic articles written during the project, which aimed at reducing the cost of monopile foundations, have been published open-access in the journal *Géotechnique*.

"The release of the PISA papers by Géotechnique, one of the most prestigious geotechnical journals, is another important milestone for the successful joint industry project," PISA technical manager Miguel Pacheco said.

"The use of the PISA methodology represents a major paradigm shift in

searenergy



WIND

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Monopiles' steel cost could be slashed 'by 30%' after design debunk

New research from Ørsted-led project points to cheaper, re-engineered concepts informed by more accurate estimate of interplay between foundation and seabed soil

21 February 2020 13:38 GMT | UPDATED 22 February 2020 08:07 GMT By Dennis Finsen

Monopiles – the offshore wind industry's go-to foundation concept for the vast majority of its projects to date – might be manufactured and installed much more cheaply than in the past, according to convention-questioning research published by UK government industry body the Carbon Trust.

Studies looking at the interactions between the cylindrical steel design and clay and sand sea-bottoms commonly found at many offshore wind farm sites, point to engineers having "underestimated the support that the seabed soil provides, resulting in over-conservative design calculations."

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New design methods for offshore wind monopiles to create cost savings for industry

21 February 2020 PRESS RELEASE

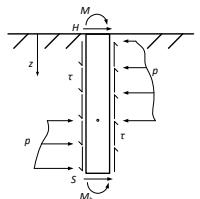
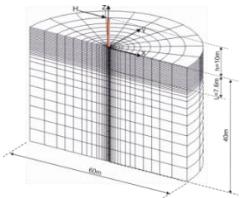
21 February 2020 LONDON: Research papers on design methods for offshore wind power monopile foundations in clay and sand seabed conditions, now available Open Access from the *Géotechnique* journal, detail new industry-specific guidance to model the interactions between monopiles and the soil.

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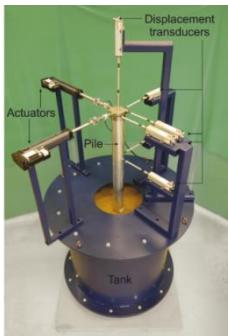


PICASO: Oxford – Ørsted Collaboration 2018-2023

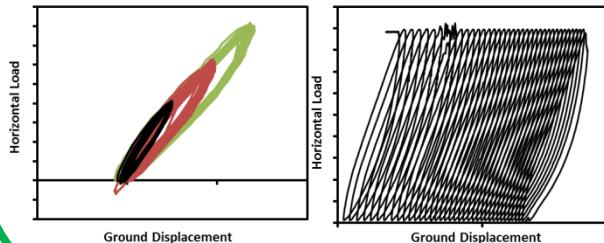
WP1: Modelling



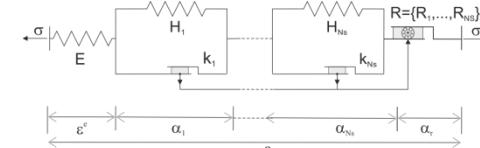
WP2: Calibration Methods



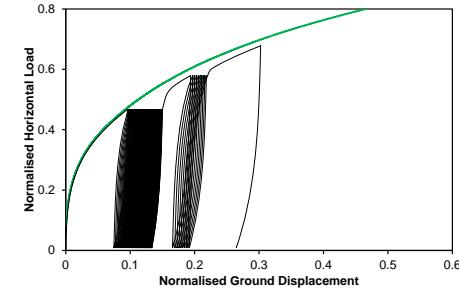
WP4: Field Testing



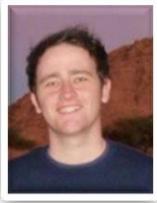
WP3: Theoretical Methods



WP5: Application to Design



Oxford Centres for Doctoral Training



- EPSRC funded - creating future technical specialists for the sector
- REMS: Renewable Energy Marine Structures (2014 to 2022)
 - Collaboration with Cranfield and Strathclyde Universities
 - Focus on geotechnical and structural engineering
 - 7 Oxford graduated students working in the industry, 6 Oxford students on-course
- WAMESS: Wind and Marine Energy Systems and Structures (2019 – 2027)
 - Collaboration with Strathclyde and Edinburgh Universities
 - Focus on disciplines across the range – electrical, mechanical, structural, geotechnical, fluids
 - 11 Oxford students on-course across three cohorts
- Taught program combined with doctoral research activities
- Significant industry engagement including through a DEng program
 - Ørsted, E.ON / RWE, Fugro, Atkins, HR Wallingford, Siemens

Concluding Remarks

- Offshore wind energy is a major part of the UK and World Energy mix and will be for the foreseeable future
- New approaches have been developed to more accurately design wind turbine foundations to allow site-wide optimisation
- Cyclic loading from the environment is the most significant challenge to address and is the focus of current efforts across the industry
- Oxford is leading the training of the next generation of technical specialists for the offshore wind and renewable energy sector