Brief by IUML

N°5 | April 2024

Report for the FRENCH AMERICAN INNOVATION DAY 2022

Scientific Committee:
Sanjay Arwade (University of Massachusetts, Amherst), Alison Bates (Colby College), Bruno Cognié (Nantes Université), Justine Dumay (Nantes Université), Ahmed Gueled (Nantes Université), Rodica Loisel (Nantes Université), Pierre-Alexandre Mahieu (Nantes Université), Valentine Rey (Nantes Université), Krish Sharman (University of Massachusetts, Amherst), Franck Schoefs (Nantes Université), Brice Trouillet (Nantes Université)

Introduction

FAID - French American Innovation Day - was born in 2019 in Boston. During this first edition, the established objective **was to set up a series of workshops each year on the subject of offshore wind turbines:** sharing knowledge between the two countries, identifying key points that could help reduce the cost of energy, determining how to change the image of offshore wind turbines in the minds of the public.... A set of issues dedicated to marine renewable energies for a better future.

A second edition to take the subject further

This second edition of FAID, held on the 15th of June 2022, designed to strengthen collaboration between France, and more specifically the Pays de La Loire region, and the East Coast of the United States. The aim was to put the spotlight on the promising technology of offshore wind turbines, with their high energy production capacity (even in deep waters), while ensuring that other marine activities are not disturbed.

It is by bringing together different stakeholders - researchers, companies and investors - that cooperative actions and partnerships can be set up!

Five themes have been identified:

- The perception of floating wind turbines by citizens and sea users
- The socio-economic impact of marine wind turbines
- The environmental impact of marine wind turbines
- Work on the interaction between the environment and biofouling technologies
- Numerical TwinS: How? For what purpose?

Each theme was accompanied by a 15-minute presentation, followed by a 5-minute Q&A session.

PROGRAM

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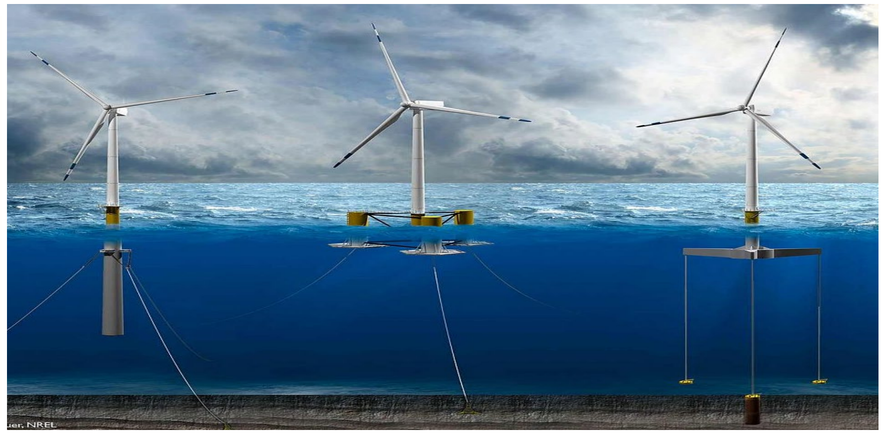


The French-American Innovation Day 2022

The second International Workshop on Floating Offshore Wind Energy Technology:

Innovation to Commercialization

Engineering, Policy, and Development

June 15, 2022

Call for Abstracts – Deadline April 29 2022

Nantes, France

UFR Sciences et Techniques, Nantes Universités ***and on-line***

The increasing worldwide demand for energy generated from renewable resources is an opportunity for France and the U.S. to advance offshore wind energy technology to harvest the rich offshore wind resources from their extensive coastlines. Among existing technologies, innovations in floating wind technology are especially promising because of their high power capacities, extensive harvesting potential in a large range of water depths, and low disruption to other offshore activities.

French-American Innovation Day (FAID) is an annual event organized by the Office for Science and Technology of the Embassy of France in the U.S. The FAID is designed for researchers and companies to exchange views on a specific technological issue, start cooperative activities, and develop partnerships with a transatlantic perspective. The goal of FAID is to facilitate the development of innovations between France and the U.S. by bringing together scientists, practitioners, and other interested stakeholders from both countries and preparing for the next generation of collaborative research projects.

The first French-American Innovation Day (FAID), organized by the Office for Science & Technology of the Embassy of France in the U.S, the Northeastern University and the University of Nantes took place in Boston on march 2019 with the aim to be the first of a series of international workshop on floating offshore wind energy technology (I-FOWT). It was designed to share information on the innovation potential of floating technology and to discuss and identify the key issues that can lead to lower costs of energy and increased public acceptance. A public report of the breakout sessions is available: Report-FAID2019.

This second Workshop is organized with the same philosophy with the objective to reinforce the collaborations between region Pays de la Loire and East Coast of USA. Format will be thematic session comprising of in-person or online presentations (15 min + 5 min Q/A). A public report will be made available after conclusion of the workshop.

This year workshop is organized around five main themes:

- Perception of offshore wind by citizens and other users of the sea
- Socio-economical impact of wind energy: particular/common benefits
- Environmental impact of wind energy: from protocols to assessment
- Modelling interaction between environment and a technological system, with a special attention on biofouling
- Numerical twinS: How? for which goal?

Program (2 pm-6 pm CEST)

2 pm - 2:05 pm – welcome and introduction – F. Schoefs (Nantes Université)

Session 1- **Challenges for accounting for environemental effect on FOWT engineering**

Chair: K. Sharman (University of Massachusetts, Amherst), co-chair: V. Rey (Nantes Université)

- 2:05 - 2:25 Integrated ground modelling for floating wind projects, R. T. Klinkvort et al. (Norwegian Geotechnical Institute)
- 2:25 - 2:45 Multiline anchor force dynamics in floating offshore wind turbines, S. Arwade (University of Massachusetts, Amherst)
- 2:45 - 3:05 Design of innovative mooring systems with the use of FOWT integrated numerical models, V. Arramounet et al. (INNOSEA)
- 3:05 - 3:25 Concept of Qualifying Sea-States for digital twins development, F.Schoefs et al. (Nantes Université).
- 3:25 - 3:45 A Review of Influence of Marine Growth Dynamics on Offshore Structures, M. Maduka et al. (Nantes Université/ University of Massachusetts, Amherst)
- 3:45 - 4:05 Thermal characterization and thermal assessment of biofouling around a dynamic submarine cable of floating offshore wind turbine, Z. Maksassi et al. (Nantes Univ).

Break 10 mn

Session 2- **Challenges for integrating FOWT farms in a socio-economic environment**

Chair: A. Bates (Colby College, USA), co-chair: P.A. Mahieu (Nantes Université)

- 4:15 - 4:35 How stakeholders amplify and attenuate risks and benefits of offshore wind, B. Ram et al. (Ram Power LLC, USA)
- 4:35 - 4:55 Social Acceptance of Offshore Wind Energy: Lessons Learned and Implications for Future Research, A. Bates (Colby College, USA)
- 4:55 - 5:15 Developing large-scale offshore wind power programs: a choice experiment analysis in France, P.A. Mahieu et al. (Nantes Université)
- 5:15 - 5:35 Ocean multi-use in the French and the US offshore wind farms, J. Guyot-Téphany et al. (Nantes Université)
- 5:35 – 5:55 Integration and assessment of artificial reefs in US and France offshore floating wind farms, A. Dubois et al. (Nantes Université)

5.55 pm - 6:25 pm Pannel

Registration

Registration is free but mandatory before June 10 th:

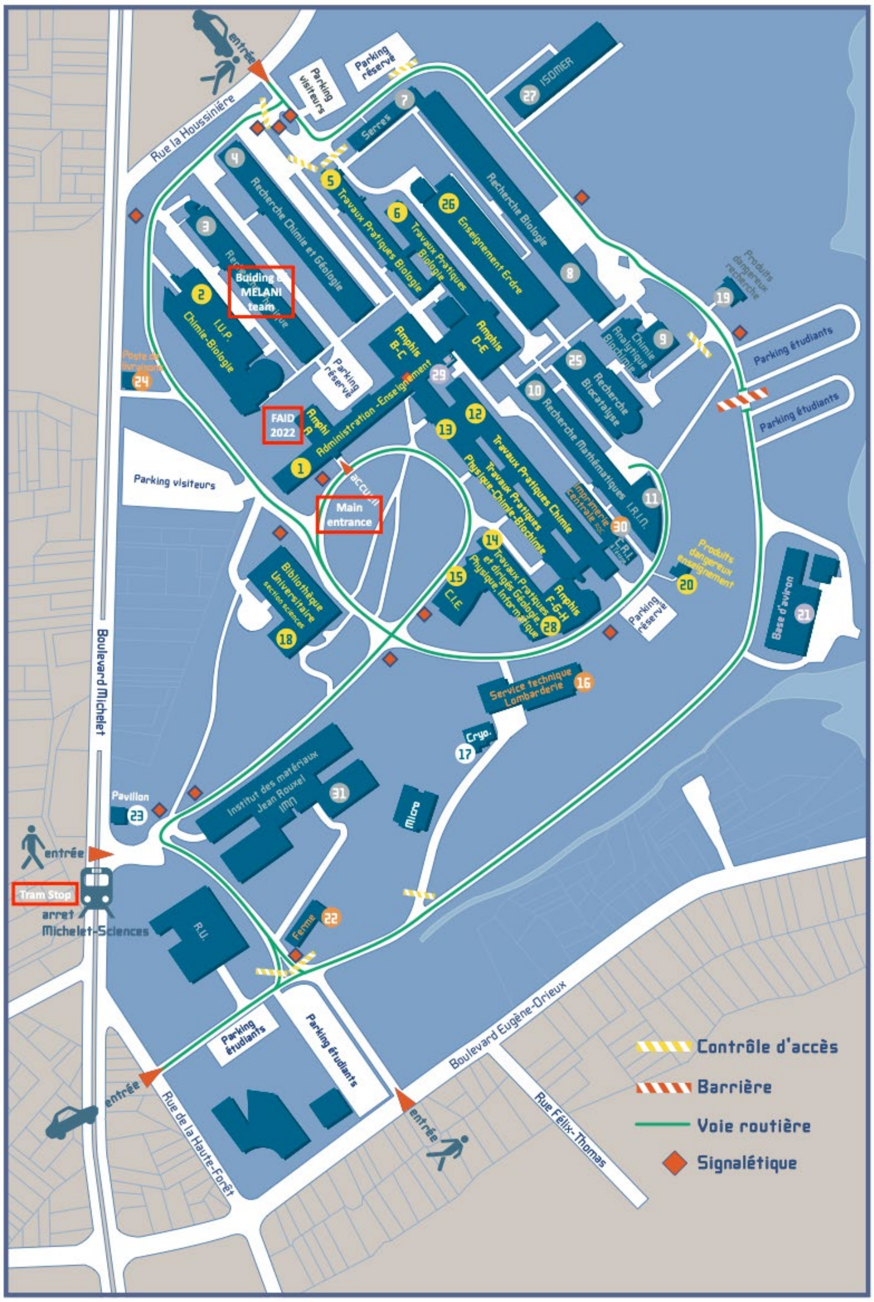
https://questionnaires.univ-nantes.fr/index.php/985826?lang=fr

(please give: Name, First name, Affiliation, e-mail, on-line, in person)

For attendees in the United States, a zoom link will be sent once registered.
Lunch is offered by IUML.

Venue

Nantes Université, Campus “UFR Sciences et Techniques », 2 rue de la Houssinière, 44322 Nantes, Tram Stop « Michelet, fac des sciences », Building A, Amphitheater A (follow the signs):



Scientific Committee

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Organizing Committee

Katherine Coughlan (University of Massachusetts, Antoine Dubois (Nantes Université/ Colby College), Amherts/Nantes Université), Maduka Maduka (Nantes Université/ University of Massachusetts), Josephine Labat (Nantes Université), Ziad Maksassi (Nantes Université), Franck Schoefs (Nantes Université), Boris Teillant (Atlanpole, Pôle Mer Bretagne Atlantique), Florent Vince (WEAMEC)

If you have any questions, please contact dir-iuml@univ-nantes.fr

Abstract: ½ page to be sent to dir-iuml@univ-nantes.fr ; Subject: FAID 2022 by April 29th 2022

Use the template of the workshop

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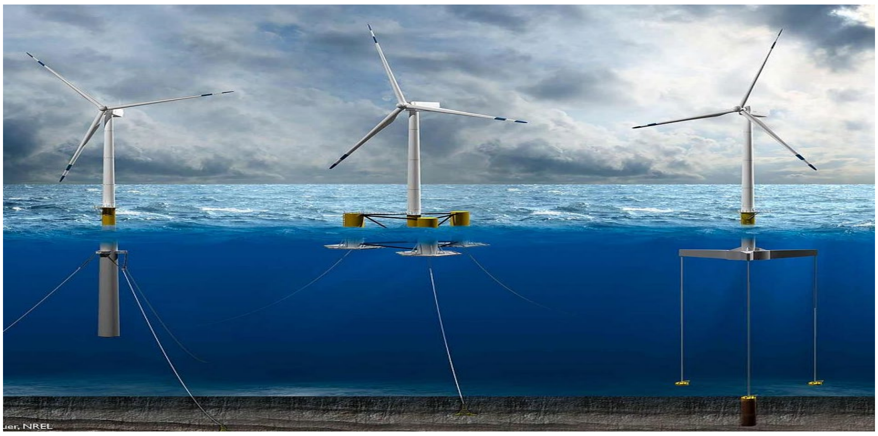

The second International Workshop on

Floating Offshore Wind Energy Technology:

Innovation to Commercialization Engineering, Policy, and Development

June 15, 2022

Integrated ground modelling for floating wind projects

R. T. Klinkvort[1], G. Sauvin[2], M. Vanneste, A. Kort, C. F. Forsberg and M. Vardy

[1]Norwegian Geotechnical Institute, Sandakerveien 140, 0484 Oslo, Norway

[2]SAND Geophysics, Unit 15 The Sidings, Southampton, SO31 5QA, England

Floating wind turbines typically require several anchors per turbine, classically implying the need for more geotechnical soundings compared to traditional bottom fixed solutions. In addition, if anchor layout is updated throughout the project phase, additional investigations may be a necessity.

One efficient way to overcome this problem is by the development of an integrated ground model. The objective of this paper is to show how one can reliably integrate geological, geophysical and geotechnical data into a consistent, quantitative ground model, which can be used for engineering applications. The proposed methodology allows for CPT and soil parameter predictions for non-borehole locations and can therefore be used to optimize the need for geotechnical soundings. The core part of the methodology is a proper integration of knowledge we have from the site. First, seismo-acoustic data are interpreted, resulting in a stratigraphical column, in which the seismic horizons are interpreted – and calibrated – such that they unambiguously match the findings from the geotechnical boreholes. This approach essentially ensures that one obtains a geological sound structural model with distinct definitions of soil units. Laboratory test data can then be calibrated to CPT correlations allowing for site-specific scaling. The result is a 3D CPT model that allows predicting the CPT response and its inherent uncertainty across the entire development area, as illustrated in Figure 1.

We here apply this approach to a publicly available data set from a Dutch wind farm area to demonstrate the methodology and functionality. An important factor of the methodology is that the model does not only predict the best estimate of CPTs / soil parameters, but also predicts the associated uncertainty, which is of critical importance for engineering applications. The model will therefore yield predictions with small uncertainty close to CPT / boreholes, and typically larger uncertainty along the 2D seismic lines and largest uncertainty between data points. We will show how CPT and soil parameter prediction can be accomplished and how the associated uncertainty can be reliably estimated and tuned using cross-validation. The workflow shows that, with a proper integration of geophysical and geotechnical data in a consistent geological framework, one can establish a 3D quantitative integrated ground model. This allows for an anchor design for the area of the site and not only in borehole locations. The integrated ground model can therefore reduce the number of borings needed for floating wind turbine projects.

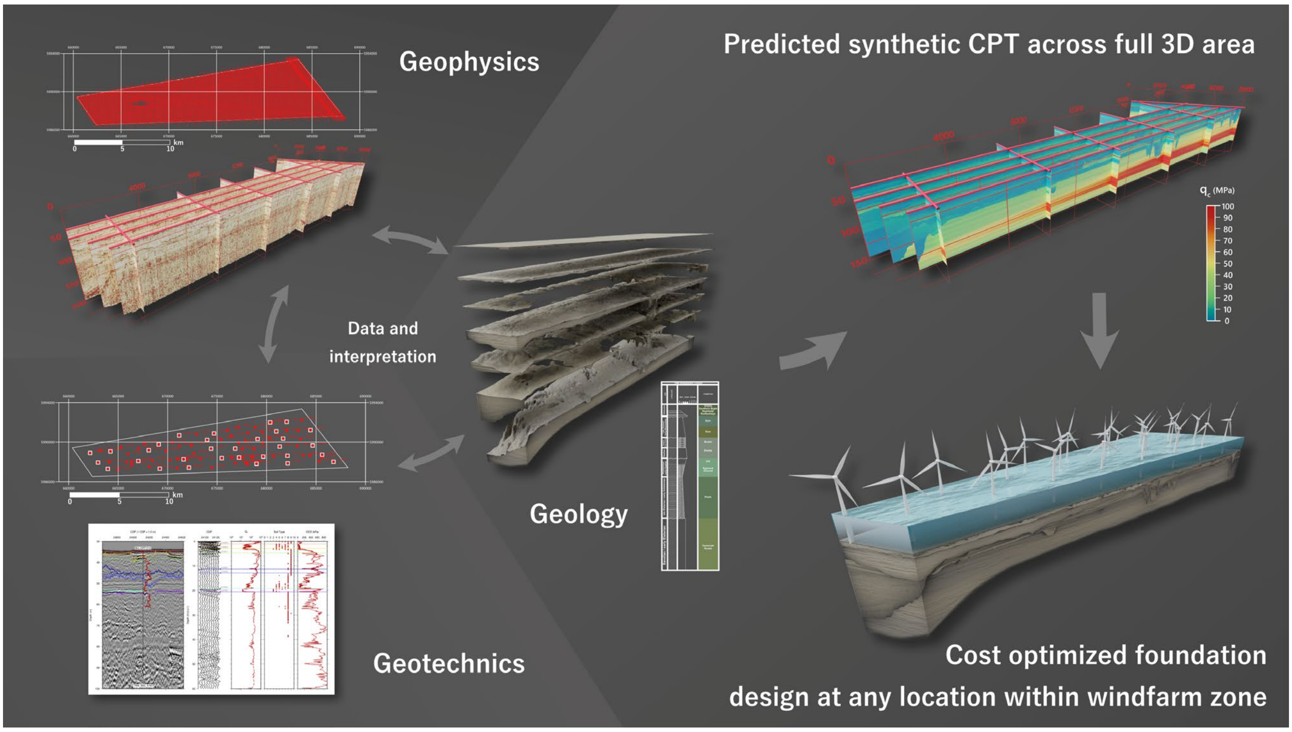

Figure 1 Sketch of the different steps in the development of an integrated quantitative ground model

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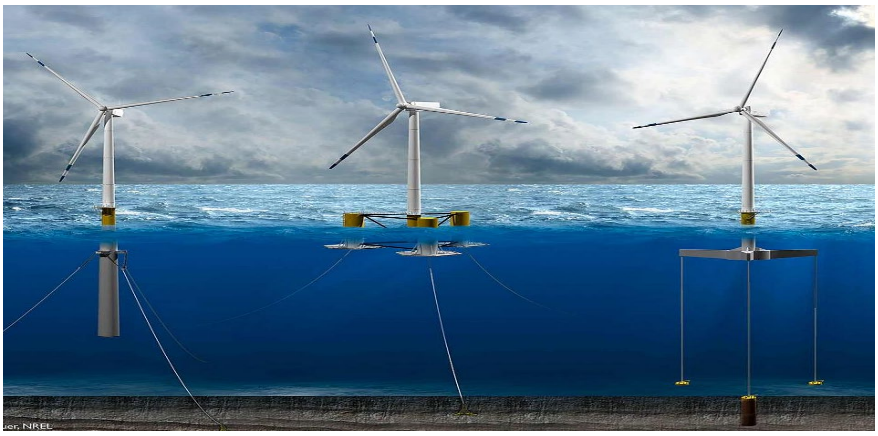

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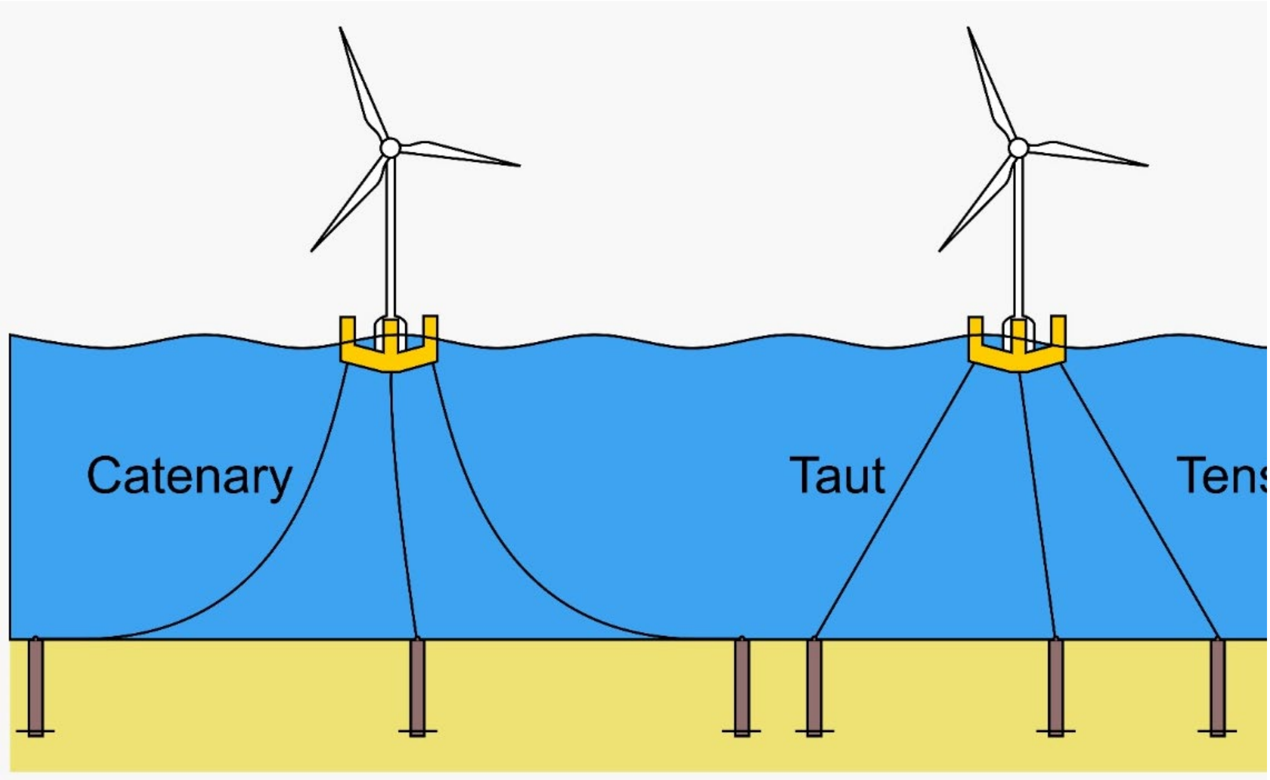
June 15, 2022

Multiline anchor systems for floating offshore wind

S. Arwade[1]

[1] Wind Energy Center, University of Massachusetts Amherst

This research assesses the reliability of floating offshore windfarms utilizing two different anchor configurations: a conventional single-line system in which each anchor is loaded by a single mooring line and a multiline system in which each anchor is loaded by three mooring lines. While there are advantages to adopting a multiline system for floating offshore wind farms, the interconnectedness of this concept introduces disadvantages, such as reduction of system reliability and the potential for cascading failures among multiple structures. The reduction in system reliability is investigated here by running Monte-Carlo simulations in which mooring line and anchor demands and capacities are sampled from probability distributions. Demand distributions are generated through dynamic simulations with environmental conditions corresponding to the 500-year storm. Failure of mooring lines or anchors are initiated when their capacity is exceeded by their demand. The results of this research show that the reliability of the multiline system degrades significantly when progressive failures are taken into consideration. This research also shows that design considerations, such as the sizing of mooring lines and anchors and designing for single-line or multiline loads, significantly influence the system reliability of a floating offshore wind farm. An application to Hywind farm in Scotalnd is suggested.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June 15, 2022

Design of innovative mooring systems with the use of FOWT integrated numerical models.

V. Arramounet[2], J. Serret[1], F. Castillo[2], M. Chemineau[2], B. Kahn[2]

[1]INNOSEA LTD, Murchison House, 10 Max Born Crescent, Edinburgh, EH9 3BF, UK

[2]INNOSEA SAS, 1 rue de la Noe, 44321, Nantes, FRANCE

INNOSEA is currently involved in two European projects which deal with the design of innovative mooring systems dedicated floating wind turbines concepts. These two projects exemplify how integrated numerical models are crucial for the design of innovative mooring systems.

FLOTANT project [1] aims to provide technological innovations for floating wind turbines to decrease the cost of the technology and increase its performance. The primary objective of FLOTANT project is to develop an innovative and integrated Floating Offshore Wind solution, optimized for deep waters to sustain a 12MW wind turbine generator. The FLOTANT technology aims to achieve an overall 60% reduction in CAPEX and 55% in OPEX allowing a competitive LCoE in the range of 85-95 €/MWh by 2030.

The main innovations proposed by the FLOTANT concept are a mooring system using high-performance polymers to reduce both weight and peak loads, a hybrid concrete-plastic floater with the singularity of getting floatability by using blocks of extruded polystyrene foam material (XPS) filling the void spaces within the floater substructure, and a power export system with long self-life and low-weight dynamic cables. The project includes enhanced O&M strategies, sensoring, monitoring and the evaluation of the techno-economic, environmental, social, and socio-economic impacts of the floating development.

The new proposed floating system was tested by means of fully coupled hydro-servo-aero-elastic simulations performed using both an open-source certified aeroelastic code (NREL-FAST) and the industry-leading hydrodynamic analysis software OrcaFlex.
To ensure the desired behaviour of the floating system, a relevant subset of design load cases (DLCs) covering the global performance of floater and moorings and based on the requirements stated in the International Electrotechnical Commission (ICE) standards has been simulated.
The floating system has been developed to fulfil the requirements of two different locations: Gran Canarias (GC) and West of Barra (WoB) sites. Barge-type floating offshore substructures have the

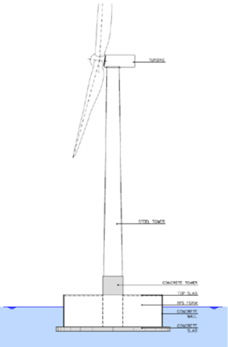
potential to be built at very low costs if the right technology and planning is implemented. However, they are used to be considered not suitable for rough environmental conditions. Even though the technology is best suited for calm environmental conditions as demonstrated for the GC site, it is still valid for more demanding environments as illustrated for the WoB site.

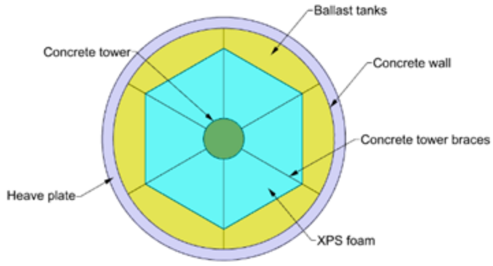
COREWIND project [2] main objective is to achieve significant cost reductions and enhance performance of floating wind technology by concentrating the research and optimization efforts on two essential components, the mooring and anchoring systems and power dynamic cables. The development of key cost-effective and reliable innovative solutions has been applied to two different concrete-based floating substructures designs (semi-submersible and spar) supporting large wind turbines (15 MW), installed at water depths greater than 40m for semi-submersible and above 90m for spar concept. Special focus is given to develop and validate integrated solutions that significantly improve installation techniques and operation and maintenance (O&M) activities. Such innovations aim to not only reduce costs from new concepts but also through technology standardization and market uptake (i.e. the same components may be used under different floater concepts) and digitalization for both better design process and enhanced operation and maintenance. These will prove the benefits of concrete structures to substantially reduce the levelized cost of energy (LCOE) by more than 15% compared to the current Bottom-Fixed Offshore Wind state of the art, both in terms of capital expenditures (CAPEX) and operational expenditures (OPEX), respectively.

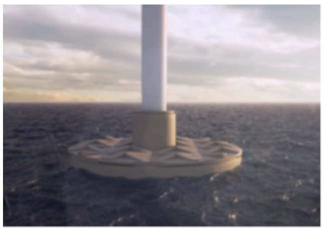
Within this project, Innosea oversees the mooring design optimisation work package. The main innovations proposed by this work package are:

- Optimisation of mooring system design (number of lines, materials, layout, fairlead systems, auxiliary components, delta-line arrangement, etc.) and anchor types depending on water depth, seabed morphology and structure dynamics, using multidisciplinary optimization approaches including the wind turbine dynamics impact over the life cycle of other FOWT components.
- Development of advanced coupled numerical methods for fatigue, extreme loads, non-linear and second-order wave and current forces, to quantify reliably the design loads and provides an accurate instrument for design optimization.
- Definition and analysis the technical feasibility, potential cost reductions and lower footprint brought by novel solutions (shared mooring, and anchors, mooring design requirements versus power dynamic cables restrictions, etc.) at wind farm level.
- Reduction of peak loads and fatigue to mitigate mooring failures and thus extending lifetime and lowering station keeping system cost.
- Identification of mooring and anchoring standardized solutions which could be used interchangeably under the two different floater concepts investigated (semi-submersible and spar-buoy) to unlock economies of scale

The presentation will show the main results of the two projects as well as the numerical modelling methodology used in each case. They will emphasize the need for integrated numerical models for the design of innovative mooring systems.







References

[1] https://flotantproject.eu/

[2] http://corewind.eu/

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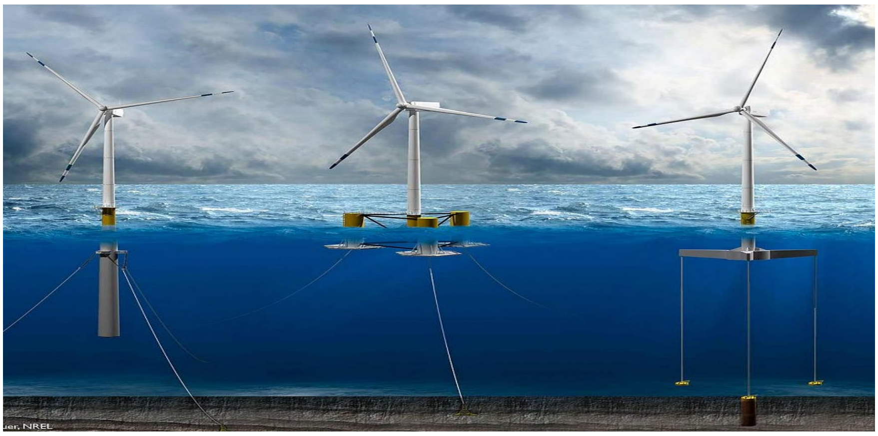

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Floating Offshore Wind Energy Technology:

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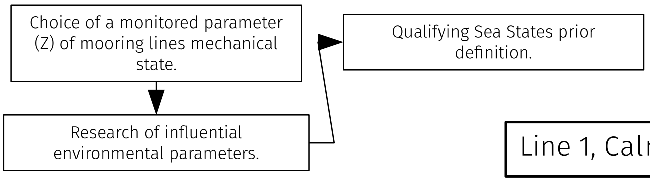
June 15, 2022

Concept of Qualifying Sea-States for digital twins development

F. Schoefs[1]

[1]Sea and Littoral Research Institute (IUML)-FR CNRS / GeM UMR CNRS, Nantes Université

For floating wind turbines, the target annual probability of failure for the mooring system without redundancy is equal to 10-5. However, the reality is relatively different, with an annual probability of failure around 3.10-3. The nascent floating offshore wind industry then faces a challenge: reducing mooring system CAPEX without increasing the risk of high consequences in case of failure. This presentation comes within the scope of Structural Health Monitoring (SHM) to mitigate mooring lines fatigue failure risk. The use of a Digital Twin (DT) in SHM is a common and justified practice. However, one main difficulty is to update the DT such that it can accurately mimic the real structure dynamics. The mooring system of the DT has variable errors, which are due to temporal change of intrinsic parameters of the model. It is then necessary to update them periodically. The main objective of this presentation is to present a calibration methodology of intrinsic parameters that relies on the definition of environmental contexts (called Qualifying Sea States) that enables their calibration by measuring mooring lines mechanical responses. This methodology is successfully applied to bio-colonisation mass calibration of a dedicated case.



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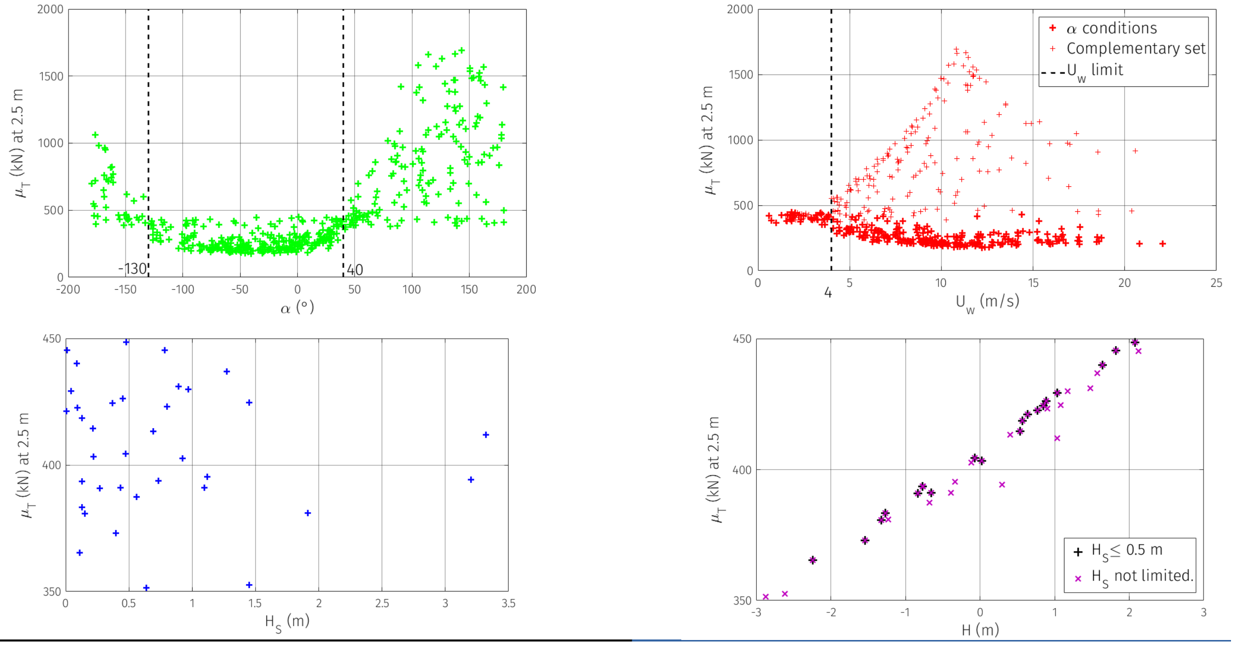

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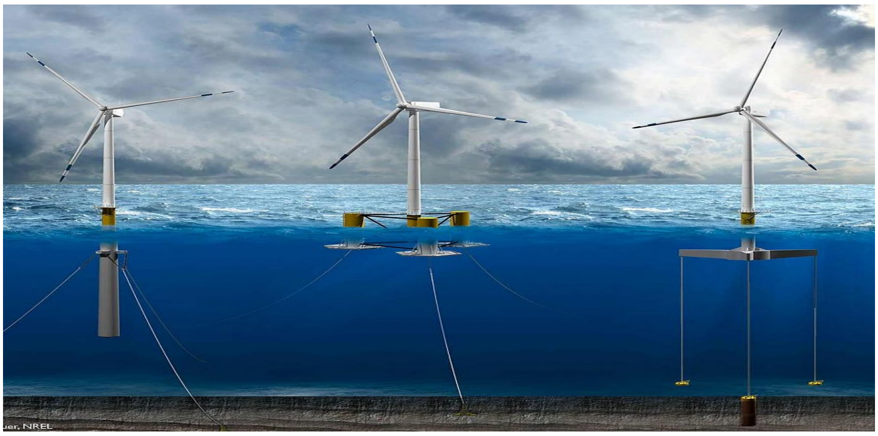

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June 15, 2022

A Review of Influence of Marine Growth Dynamics on Offshore Structures

Maduka Maduka[1,2], Franck Schoefs[1], Krish Thiagarajan Sharman[2]

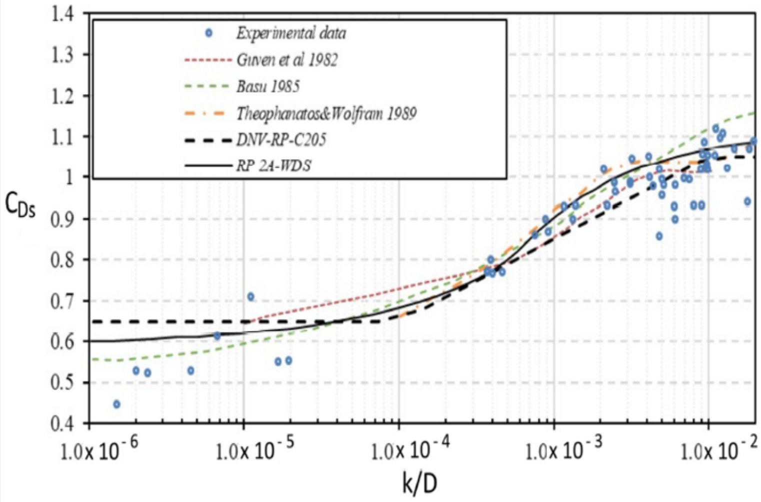
[1]Institut de Recherche en Génie Civil et Mécanique (GeM)-UMR CNRS 6183, Institut Universitaire Mer et Littoral (IUML)-FR CNRS 3473, Nantes Université, 44035 Nantes, France.

[2]Ocean Resources and Renewable Energy (ORRE) Unit, Department of Mechanical and Industrial Engineering, University of Massachusetts, Amherst, MA 01003, USA.

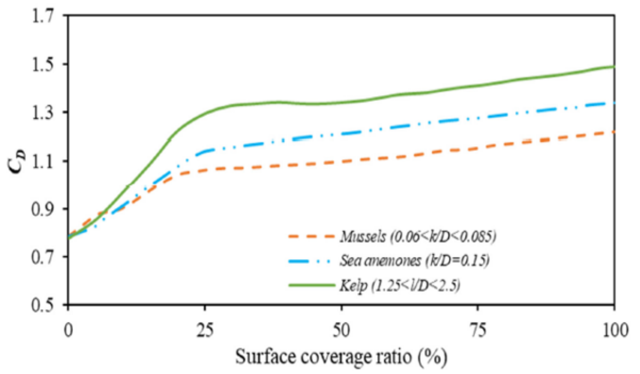
Offshore structures, which are installed in the open ocean, have been found to solve the spatial difficulty of scaling up the deployment of renewable energy farms. However, bio-colonization of underwater components of offshore structures by marine species is a major issue. The rapid proliferation of marine species has been shown to have major negative effects on offshore structures and is still a design and maintenance challenge for engineers. A detailed survey of the literature on biofouling in offshore/marine structures is first presented. Most previous experimental research assumed that biofouling effects are a function of surface roughness that is either uniform or nearly uniform and that the stationary roughened cylinder is fully covered. Some other studies, however, have proven that the surface roughness alone cannot precisely characterize marine growth; other marine fouling parameters such as roughness geometry, surface coverage ratio, facility testing set-up, biofouling species, and colonization pattern can all have a significant impact on the hydrodynamic force coefficients. The 3D vortex instability affecting these coefficients could explain the differences in experiment-to-experiment variations in hydrodynamic coefficients. There have been also far fewer experimental tests on non-stationary roughened cylinders, the porosity of multi-layers of marine growth on cylinders, lack of information on the areal density of peaks, and experimental data for cylinders with relative roughness less than 2.10^{-3}, according to the reviewed studies. In an attempt to highlight knowledge gaps on collective influential aspects of biofouling to date, suggestions for several lacking investigations on marine fouling are then discussed.

Keywords: offshore structures; marine species; biofouling; surface roughness; hydrodynamic coefficients

Effect on C_d



Variation of the mean drag coefficient with relative roughness



Drag coefficient (C_d) vs biofouling coverage ratio (Adapted from Zeinoddini et al. 2017)

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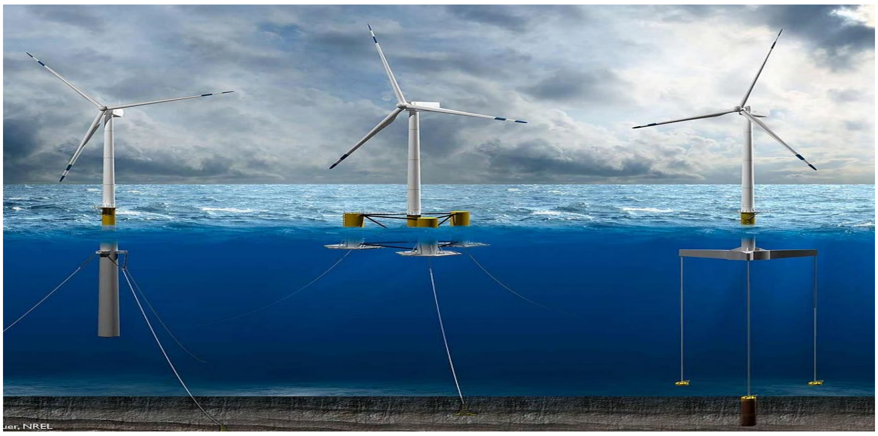

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June 15, 2022

Thermal characterization and thermal assessment of biofouling around a dynamic submarine cable of floating offshore wind turbine

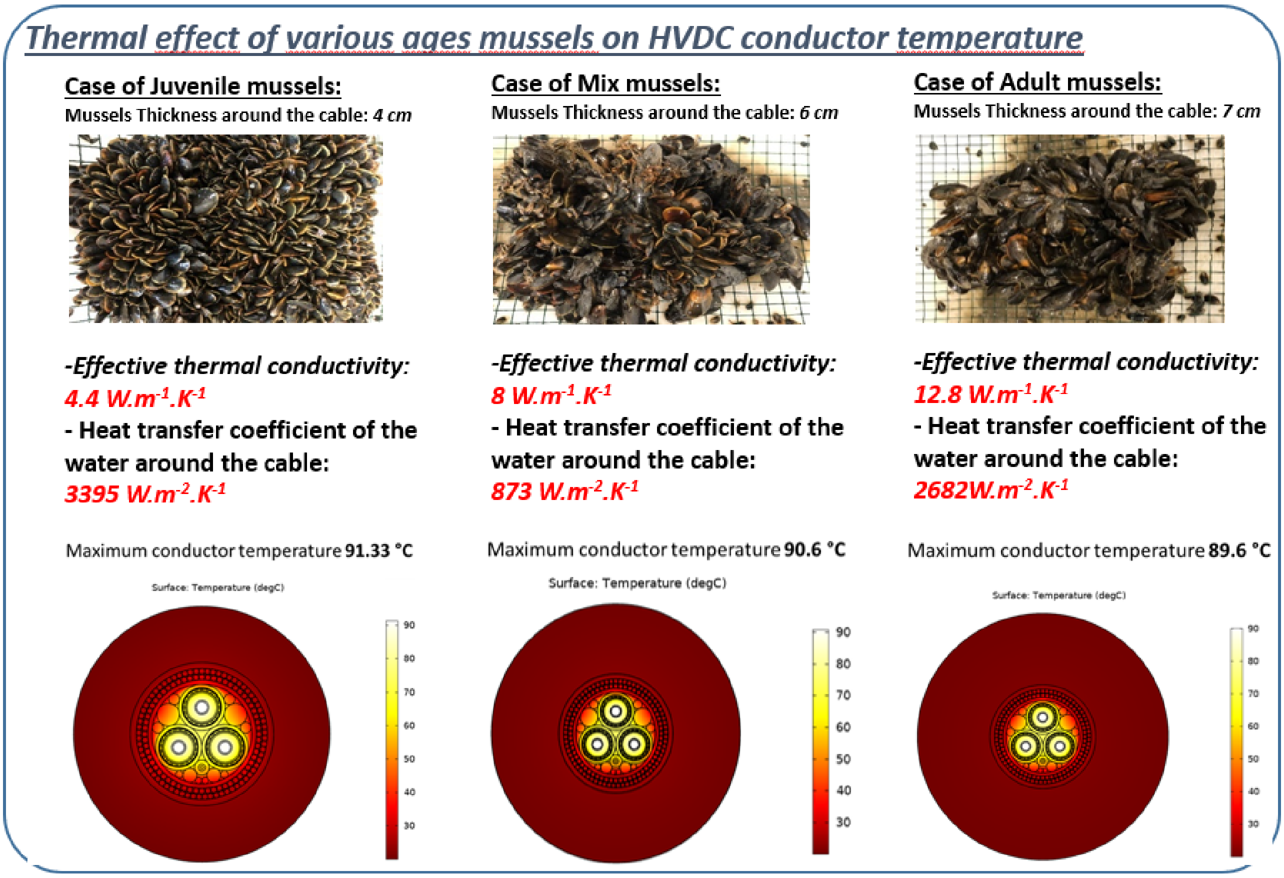
Ziad Maksassi [1,2], Bertrand Garnier [1], Ahmed Ould El Moctar [1] and Franck Schoefs

[1] Nantes Université, Centre National de la Recherche Scientifique (CNRS), Laboratoire de thermique et énergie de Nantes (LTeN), Unité Mixte de Recherche (UMR) 6607, F-44000 Nantes, France;

[2]Nantes Université, École Centrale Nantes, CNRS, Institut de Recherche en Génie Civil et Mécanique (GeM), UMR 618, Institut Universitaire Mer et Littoral (IUML) FR 3473, F-44000 Nantes, France

Wind energy is expected to play a big role on the next 20 years to fulfil the emission requirements. Due to the quality of resource, to the environmental and to activity constraints, offshore wind turbine in deep water (>150m) has to be developed. Floating wind will be the best technology for reaching these targets. The high voltage dynamic cable (HVDC) is a key component of the floating offshore wind turbine. Its electric insulation system is designed to support a maximum conductor temperature of 90ºC. However, the growth of biofouling, particularly mussels, can modify the heat transfer around the cable and thus its maximum temperature and moreover the fluctuation of temperature that will affect the fatigue lifetime. In our work we estimate the effective thermal conductivity of mussels of various ages, as well as the heat transfer coefficient of the water around the mussels. The effective thermal conductivity of the mussels is calculated using a 1D analytical stationary model (Fourier's law) that assumes the mussels are colonized uniformly around the tube. Furthermore, in case of non-uniform conolization of mussels around the tube, the effective thermal conductivity of mussels of different ages and the heat transfer coefficient of the water around the mussels are estimated using a numerical method (finite elements via COMSOL) to solve the 2D heat transfer equation and a parameter estimation technique (the simplex method) for inverse analysis. The results revealed that the effective thermal conductivity of juvenile mussels is lower than that of mix (both juvenile and adult) and only adult mussels. This variation in effective thermal conductivity with mussel's age is

related to the water porosity of the mussel's layer. Then, the thermal effect of the resulting global thermal resistance can lead the HVDC conductor wire to either overheat (in the case of juvenile and mixed mussels colonization) or cool down (in the case of adult mussels colonization). This effect is quantified through numerical simulations. As a result, thermal characterization of mussels is an important factor in HVDC monitoring in order to avoid failure.



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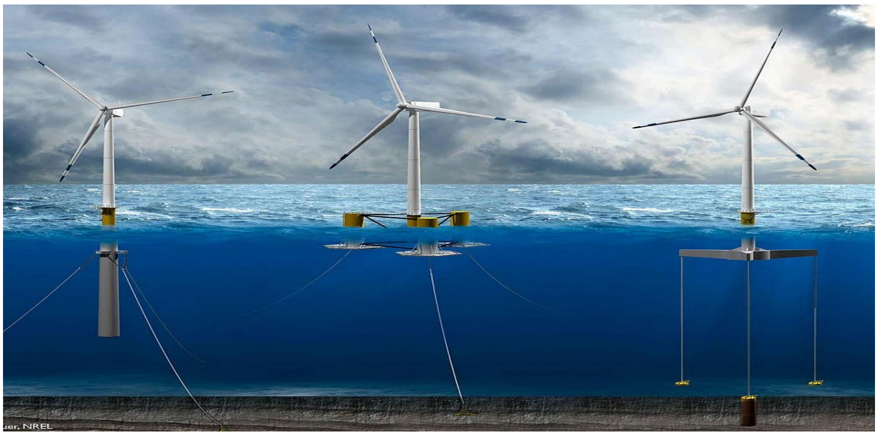

The second International Workshop on

Floating Offshore Wind Energy Technology:

Innovation to Commercialization Engineering, Policy, and Development

June 15, 2022

How stakeholders amplify and attenuate risks and benefits of offshore wind

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Objectives and Relevance

The social amplification of risk framework proposed that risks are amplified or attenuated by interested parties employing different rhetorical strategies to give information about risk a certain "spin." The original literature explained that this happens through the use of "informational mechanisms." Despite decades of attention to social amplification, these mechanisms have never been explicated in detail. Here we flesh out the meanings of these four informational mechanisms by examining and documenting how they are used in discussions as well as disputes about building offshore wind projects off the Mid-Atlantic coast of the United States.

Methods

This work is the result of investigations into policies, regulatory developments, and community views on wind energy projects and was conducted in two phases. The first phase focused on defining the expert knowledge base and perceived risks around offshore wind projects along the Atlantic Coast. The second phase took a deeper dive into the specific projects in the Mid-Atlantic region off the coasts of Delaware and Maryland and reached into the coastal communities to understand their views.

Results

Proponents and opponents of offshore wind energy installations invoked the four informational mechanisms to amplify and attenuate both risks and benefits. We describe how this manifested in five impact areas: climate and public health, visibility, jobs, economic development and tourism, property values, and ecology. We interpret how the policy process used to site and approve installations shaped the risk dialog. We found that proponents of the wind installations sought to attenuate risks to visibility and tourism and to amplify climate benefits beyond what might be technically justifiable. Meanwhile, opponents focused mainly on visual impacts and impacts to tourism and property values.

We also found that uncertainty and ambiguity about risks and benefits created openings for parties to invoke informational mechanisms.

Conclusions and Implications for Practice

This paper focused on the challenges with realizing one critical component of the clean energy revolution — offshore wind energy developments. The social amplification of risk framework was used to comprehend how the siting of offshore wind turbines fares in the public policy arena and local communities and to inform how industry, government, and organizations can better understand and responsibly manage the risks, benefits, and uncertainties associated with offshore wind. We recommend that more effective national and state legislation with appropriate resources that would require regular communication between all parties over the course of the long planning process would help reduce uncertainties and ambiguities about the project design and the concomitant risks and benefits.

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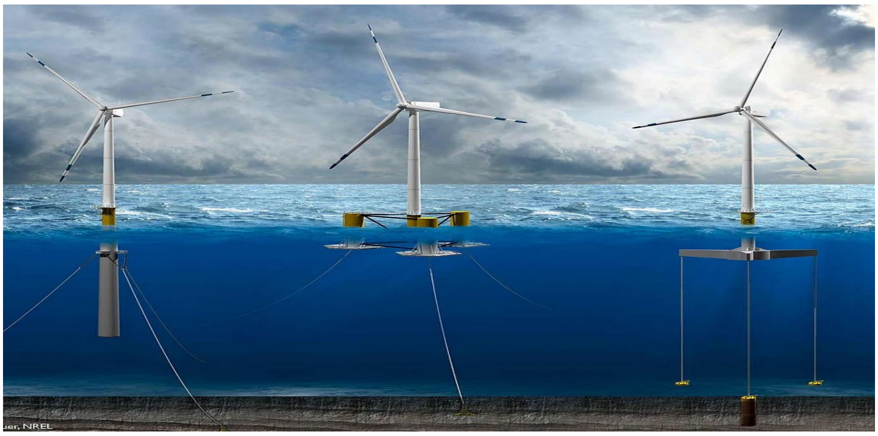

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Social Acceptance of Offshore Wind Energy: Lessons Learned and Implications for Future Research

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Offshore wind energy development in the United States is rapidly nearing reality. Considerable research has examined how the general public, communities, ocean users, or specific stakeholders perceive U.S. offshore wind energy. Simultaneously, a growing number of offshore wind projects have been proposed which are sited within or proximate to federally-recognized tribal territory, near working waterfronts, and rural coastal communities. Social science research around offshore wind has generated a number of key findings that are helping to shar the research agenda of Government, Industry, and Academic researchers. In this presentation, four major research findings will be presented from the author's work: 1) Social acceptance studies reveal the unique and nuanced aspects of communities; 2) A range of quantitative tools are available to evaluate tradeoffs with marine communities; 3) U.S. consultation processes for offshore wind can de-legitimize stakeholders and perpetuate colonial power structures where marginalized voices are co-opted for personal gain; and 4) Defining equity in the "just" energy transition. The research will summarize both quantitative and qualitative scholarship and further offer some major findings such as: Social acceptance work highlights the need for place-based research; offshore wind fits into a larger framework of the energy transition; technology-centric focus perpetuates inequities through continued marginalization; and the "energy transition" is not a "just transition" without intentionality. This work will provide a basis for discussion and generation of a research agenda for social scientists working on ocean-based energy problems.

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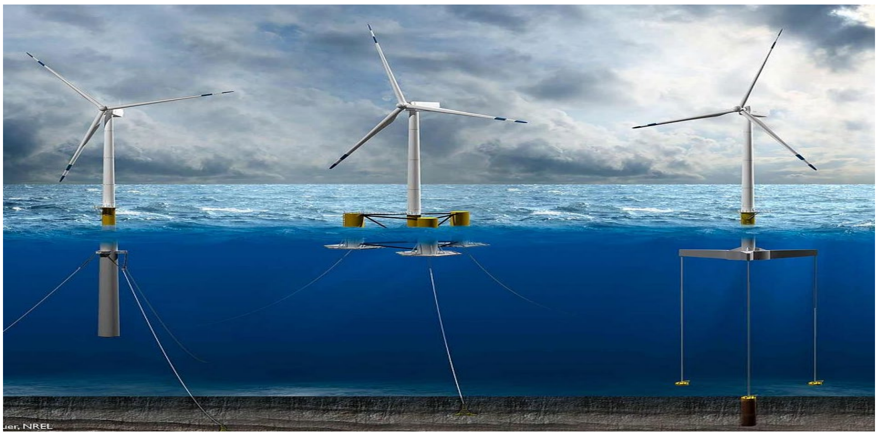

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Developing large-scale offshore wind power programs: a choice experiment analysis in France

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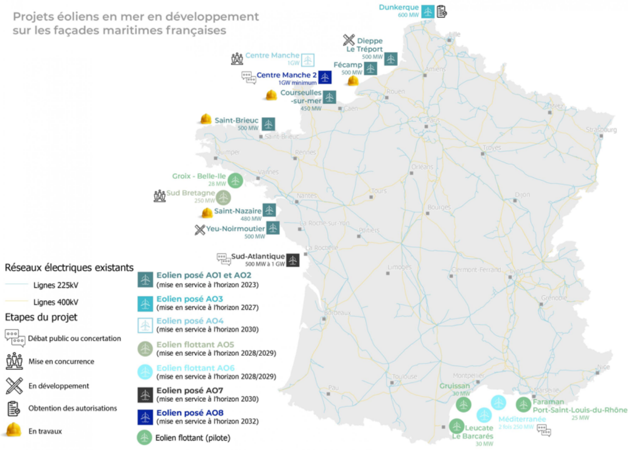
Many offshore wind farms are expected to be installed along the European coasts in the next few years. However, developing offshore wind power may affect other maritime activities already established in the sea space (e.g. commercial fishing). We conducted a discrete choice experiment in France on a national sample, where a wide range of the effects that large-scale offshore wind power programs can have on maritime activities were considered. So far, the valuation of preferences for offshore wind power has mainly focused on the visibility of the wind farms and on their impacts on marine biodiversity. In addition to these impacts, our results show that other types of consequences matter to the public. Employment in the maritime economy, the effect on fresh seafood offer, and conditions for the practice of recreational activities are also found to be significant. Our study also highlights that social acceptance of offshore wind power varies depending on the information given to the public about other sources of electricity generation that could be prioritised. Policy implications of our results are discussed.



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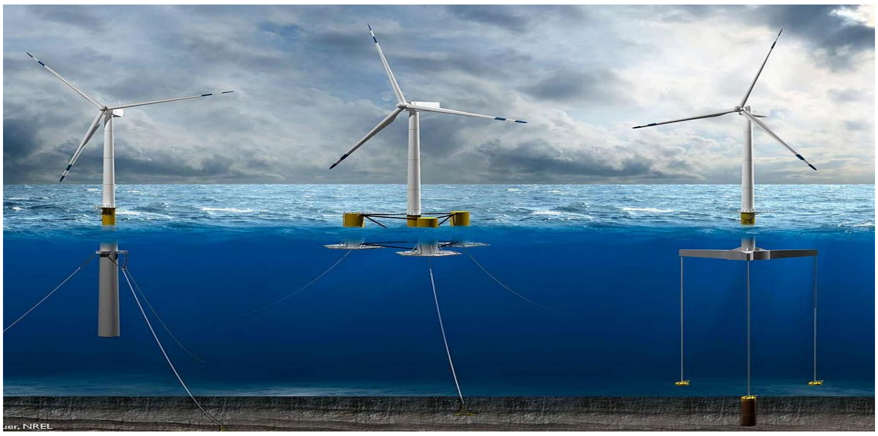

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Ocean multi-use in the French and the US offshore wind farms

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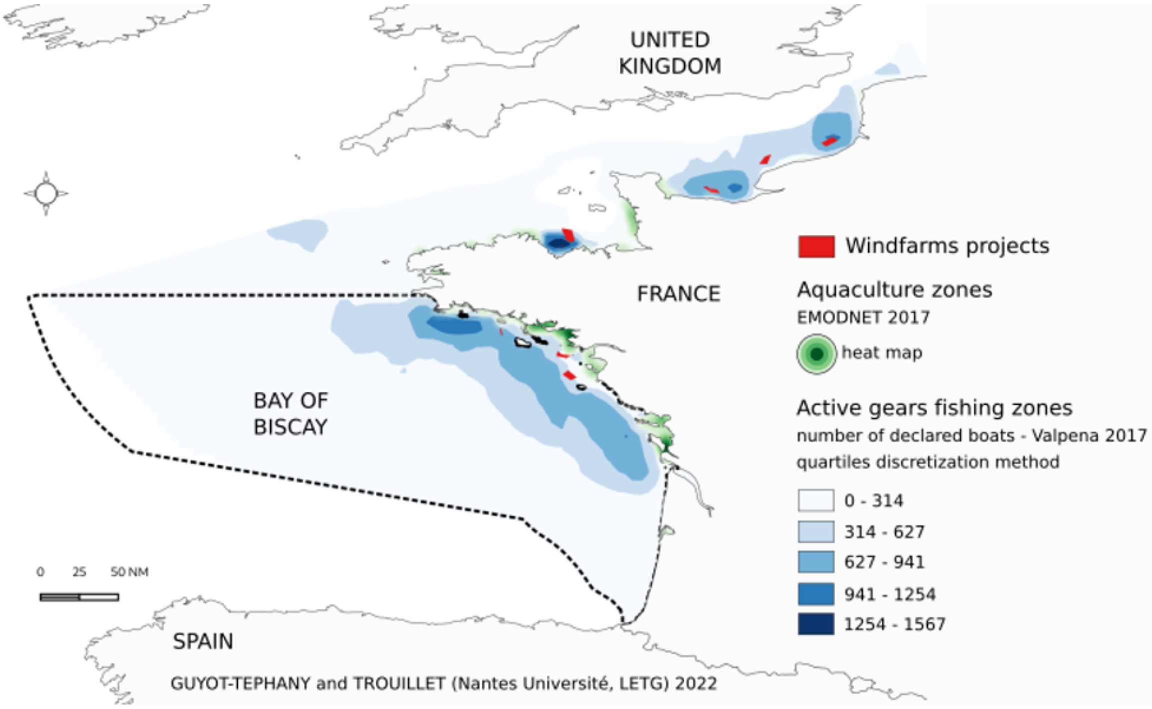
Ocean multi-use is a novel concept addressing challenges resulting from the intensification and diversification of human activities at sea. It is defined as the intentional joint use of space and resources in close geographic proximity. It was introduced in the early 2000's by German researchers investigating the potential of integrating aquaculture into offshore wind farms. During the next decade, the European Union promoted multi-use within the Blue Growth Strategy and funded large-scale applied research programs aiming at identifying and assessing promising marine uses combinations. Multi-use is conceived as a more rationale and integrated approach to maritime spaces management maximizing economic benefits while reducing conflicts between users and freeing up space from human pressures. Although operational remain very are still rare, this concept starts disseminating outside Europe along with the deployment offshore wind farms. This emerging industry both generates tensions with traditional activities, such as fishing, and represents an opportunity to foster synergies and new forms of collaborations between marine users.

This paper aims at reflecting on multi-use potential and limits in fostering offshore wind farms' social acceptance and territorial integration. It elaborates on preliminary results of the Mutli-Frame project (2020 -2023). The purpose of this international research program is to develop, test and optimize a generic assessment framework to evaluate multi-use interest, potential and challenges at a global scale. We will first present the assessment framework, as well as the French and the US case studies aiming at assessing scenarios combining offshore wind with commercial fishing, aquaculture or tourism. We will then discuss results gained from a self assessment of these scenarios and semi-structure interviews conducted with marine users and planners.

II. THE BAY OF BISCAY (FRANCE)



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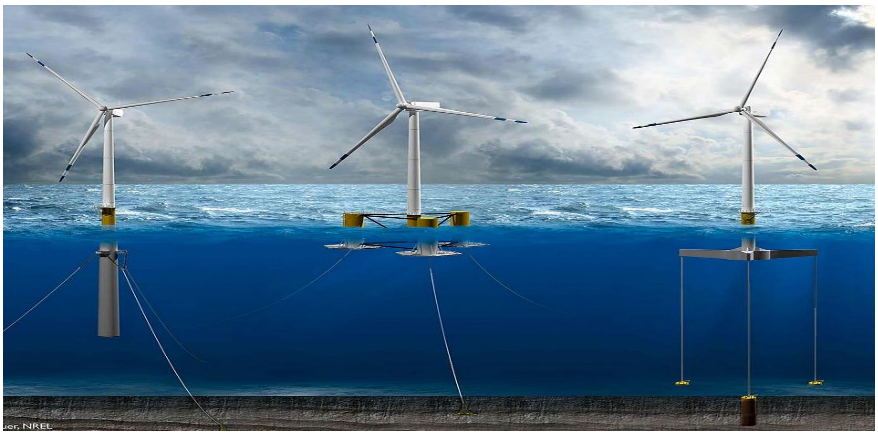

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Integration and Assessment of artificial reefs for Floating Offshore Wind Farms: a review

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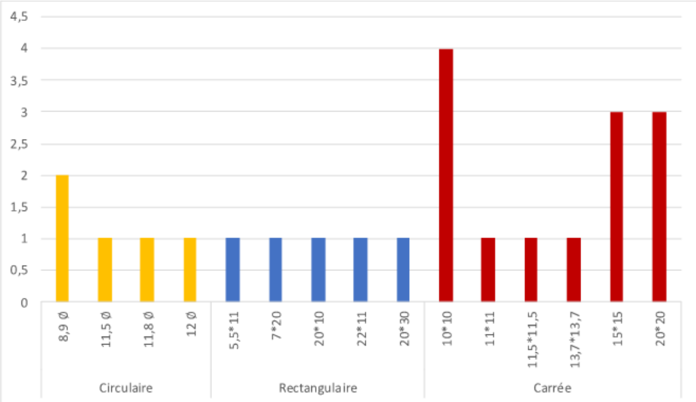
Implementation of structures in open sea have several impacts and effects on ecosystem. But the opposite impact is also true. Indeed, any submerged structure is bound to be colonized over time by marine organisms, or the so-called biofouling. This have a significative impact on Marine Renewable Energy components as for examples mooring lines. This colonization This biological colonization of man-made structures makes these components more exposed to hydrodynamics constraints but also to corrosion and mechanical degradation (Schoefs & Ameryoun, 2013, Spraul et al., 2017; Wolfram & Feld, 1995; Picken, 1985). This biocolonization by marine organisms will attract other species as for example their predator, and will create a reef effect (Langhamer et al., 2009).
This reef effect is identified in Offshore Wind Farms (OWF) because in some parks where authors revealed increase of fish abundances. However, this effect is not clear, depending on methods used to analyze these communities (ichthyofauna). In some case, authors have found increased abundance for several species (*e.g.* Andersson & Öhman, 2010; Reubens et al., 2011, 2013) but in some other case authors found either no increased abundances (De Backer & Hostens, 2019) either abundances increased for one species (*e.g.* Lindeboom et al., 2011, van Hal et al., 2017).
In the marine ecological domain, this colonization by the biofouling and by mobile species have interested scientists, and more generally humans (*e.g.* Polovina, 1991). This interest led to the development of artificial reefs, submerged structures developed in order to modify the characteristics of the environment related to marine resources (Guillén et al., 1994, Walles et al., 2016). Several

designs, materials and even methods of monitoring these Artificial Reefs (ARs) exist and no consensus has been reached to standardize the use of ARs. Reef designs and materials, as the monitoring methods, are objective and author dependent as the Reef Balls®, a patented AR, that is immersed to support coral communities most of the times (*e.g.* Bachtiar & Prayogo, 2010).
Recently, an author (Glarou et al., 2020) emitted the hypothesis to combine both subject: Offshore Wind Farms and Artificial Reefs. Indeed, increase the scour protection of monopile wind turbines could be efficient to support and to increase abundances of biodiversity, and could possibly have an impact on social acceptance of these wind farms. It is the purpose of the MOORREEF project which is being developed to immerse ARs in an OWF for the first time.

References:
Andersson, M. H., & Öhman, M. C. (2010). Fish and sessile assemblages associated with wind-turbine constructions in the Baltic Sea. Marine and Freshwater Research, 61(6), 642. https://doi.org/10.1071/MF09117
Bachtiar, I. & Prayogo, W. (2010) Coral recruitment on Reef Ball™ modules at the Benete Bay, Sumbawa Island, Indonesia. Journal of Coastal Development, 13(2), 119-125.
De Backer, A., & Hostens, K. (2019). Effects of Belgian Offshore Windfarms on soft sediment epibenthos and fish: An updated time series (p. 13).
Guillén, J.E., Ramos, A.A., Matinez, L. & Sanchez Lizaso J.L. (1994) Antitrawling reefs and the protection of Posidonia oceanica (L.) delile meadows in the Western Mediterranean Sea: demand and aims. Bulletin of Marine Science, 55(2-3), 645-650.
Glarou, M., Zrust, M., & Svendsen, J. C. (2020). Using Artificial-Reef Knowledge to Enhance the Ecological Function of Offshore Wind Turbine Foundations: Implications for Fish Abundance and Diversity. Journal of Marine Science and Engineering, 8(5), 332. https://doi.org/10.3390/jmse8050332
Langhamer, O., Wilhelmsson, D. & Engström, J. (2009) Artificial reef effect and fouling impacts on offshore wave power foundations and buoys – a pilot study. Estuarine, Coastal and Shelf Science, 82, 426-432.
Lindeboom, H. J., Kouwenhoven, H. J., Bergman, M. J. N., Bouma, S., Brasseur, S., Daan, R., Fijn, R. C., de Haan, D., Dirksen, S., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld, K. L., Leopold, M., & Scheidat, M. (2011). Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environmental Research Letters, 6(3), 035101. https://doi.org/10.1088/1748-9326/6/3/035101
Picken, G. B. (1985). Review of Marine Fouling organisms in the North Sea on offshore structures. *Discussion Forum and Exhibition on Offshore Engineering with Elastomers, Plastics and Rubber Inst., 5.*
Polovina, J.J. (1991). Fisheries Applications and Biological Impacts of Artificial Habitats. In Artificial Habitats for Marine and Freshwater Fisheries (p. 153-176). Elsevier. https://doi.org/10.1016/B978-0-08-057117-1.50011-1
Reubens, J. T., Degraer, S., & Vincx, M. (2011). Aggregation and feeding behaviour of pouting (Trisopterus luscus) at wind turbines in the Belgian part of the North Sea. Fisheries Research, 108(1), 223-227. https://doi.org/10.1016/j.fishres.2010.11.025
Reubens, J. T., Pasotti, F., Degraer, S., & Vincx, M. (2013). Residency, site fidelity and habitat use of Atlantic cod (Gadus morhua) at an offshore wind farm using acoustic telemetry. Marine Environmental Research, 90, 128-135. https://doi.org/10.1016/j.marenvres.2013.07.001
Schoefs, F., & Ameryoun, H. (2013). Probabilistic Modeling of the Bio-Colonization Effects on Hydrodynamic Forces with Several Combinations of Sea-State Condition: A Study on Jacket-Platforms in the Gulf of Guinea. *Volume 1: Offshore Technology*, V001T01A056. https://doi.org/10.1115/OMAE2013-11100
Spraul, C., Pham, H.-D., Arnal, V., & Reynaud, M. (2017). *Effect of Marine Growth on Floating Wind Turbines Mooring Lines Responses*. 17.
van Hal, R., Griffioen, A. B., & van Keeken, O. A. (2017). Changes in fish communities on a small spatial scale, an effect of increased habitat complexity by an offshore wind farm. Marine Environmental Research, 126, 26-36. https://doi.org/10.1016/j.marenvres.2017.01.009
Walles, B., Troost, K., van den Ende, D., Nieuwhof, S., Smaal, A.C. & Ysebaert, T. (2016) From artificial structures to sel-sustaining oyster reefs. Journal of Sea Research 108, 1-9.
Wolfram, J., & Feld, G. (1995). Bias in the estimation of wave-induced fatigue damage of offshore structures. *Applied Ocean Research*, *17*, 363-378.

Settlement Plates monitoring methods:

- As fo Artificial Reef: no standardized monitoring method but…
- Bibliography research highlights trends: plate/coupon dimensions
- Modest size plate (avoid overloading unnecessarily), and Fixation methods proposal (Field et al., 2007)
- Goal and Author dependent



Distribution of Settlement Plates size used to measure biofouling (n = 33)

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