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# Report for the FRENCH AMERICAN INNOVATION DAY 2019

## FLOATING OFFSHORE WIND ENERGY TECHNOLOGY: INNOVATION TO COMMERCIALIZATION

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2019 | FRENCH AMERICAN INNOVATION DAY BOSTON

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# Floating Offshore Wind Energy Technology

## Innovation to Commercialization

### Engineering, Policy, and Development

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Northeastern University

UNIVERSITÉ DE NANTES

East Village 17th Floor - Northeastern University

**Boston, March 18th-19th 2019**

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Summary report for:

# FRENCH AMERICAN INNOVATION DAY 2019

2019 FRENCH AMERICAN INNOVATION DAY BOSTON

# FLOATING OFFSHORE WIND ENERGY TECHNOLOGY: INNOVATION TO COMMERCIALIZATION

ENGINEERING, POLICY, AND DEVELOPMENT

March 18-19, 2019
Northeastern University, East Village 17th Floor
Boston, Massachusetts, USA

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## EXECUTIVE SUMMARY

A two-day workshop at Northeastern University in Boston on 18-19 March 2019 was designed to share information among practitioners, researchers, and decision-makers from France and the United States on the innovation potential of floating offshore wind energy technology and to discuss and identify the key issues that can lead to lower costs of energy and increased public acceptance. The workshop featured 120 participants from academia, industry and government with expertise in engineering, social science, economics, financing, public policy and regulation. The workshop was organized around four themes: (1) Demonstrations and innovations of floating technology, (2) Risk, regulation, and insurance of floating infrastructure, (3) Structural-geotechnical interaction of moorings of floating systems, and (4) Legal, economic, and technological issues for multi-use offshore development. This report summarizes the content, layout, findings and conclusions of this workshop and is organized as follows. First, an introduction explains the vision for this workshop and provides context for the floating offshore wind energy industry globally and in France and the United States. Next, the narrative layout of the workshop, which consisted of three keynote presentations, five panel discussions, three poster sessions, a working breakout session on three topics, and a reception at the residence of the Consul General of France in Boston, is summarized. This is followed by a summary of the key ideas and findings and then by conclusions and next steps. Finally, several appendices are provided as documentation of relevant materials generated as part of this workshop.


## ACKNOWLEDGEMENTS

The scientific committee and the Embassy of France in the United States gratefully acknowledge the support of our sponsors, including: WEAMEC, the Massachusetts Clean Energy Center, the French consulate in Boston, the Pays de la Loire region, Nantes Metropole, Business France, Polemer Bretagne Atlantique, La French TECH, Make our Planet Great Again, the University of Nantes, and the Department of Civil and Environmental Engineering and the College of Engineering at Northeastern University. This support enabled the workshop to be offered to all participants without fees and was essential to its success.

# 1 INTRODUCTION

Floating offshore wind energy technology has many compelling attributes, including vast harvesting potential in a wide range of water depths, minimal disruption to other offshore activities, and quayside assembly. The commercialization potential of floating technology is enormous, however the technology is still immature worldwide with only a single operating floating offshore wind farm (the 30 MW Hywind farm in Scotland) and only a handful of installed utility-scale demonstrations currently in Europe and in Asia, including the 2 MW FloatGen demonstration in France; careful research, development, and innovation is needed to realize the potential of floating offshore wind technology to be a cost-effective form of renewable energy.

France is a world leader in the development and implementation of floating technology with several utility-scale demonstrations either planned or permitted, one demonstration installed, and several companies developing innovative technology. The United States is a pioneer in offshore technology for the oil and gas industry, and the offshore wind energy industry in the U.S. is showing clear signs of immediate and swift growth. In terms of floating technology in the U.S., the first utility-scale demonstration, the 12 MW Aqua Ventus project, led by the University of Maine, is advancing towards fabrication. Both France and the U.S. have extensive coastlines and rich offshore wind resources, much of which is only accessible with floating technology as the water depths are too great for fixed-bottom technology. In the U.S., the National Renewable Energy Laboratory estimates the net technical offshore wind energy potential in water depths of 0 to 60 m, where both fixed-bottom and floating technology are viable to harvest offshore energy, to be 3.0e6 GWh/year and estimates an additional 3.0e6 GWh/year of potential in water depths between 60 and 700 m, where only floating technology is viable. In France, the European Environment Agency estimates the unrestricted technical offshore energy potential to be 2.0e6 GWh/year. To put these enormous resources in context, the entire U.S. consumed 4.0e6 GWh in 2017 from all energy sources for all sectors of the electric power industry, according to the U.S. Energy Information Administration. These rich resources, combined with the increasing worldwide appetite for energy generated from renewable resources, create a ripe opportunity for France and the U.S. to advance floating wind energy technology from its current state of immaturity.

This workshop, which was implemented as part of French-American Innovation Day (FAID), was co-organized with the Consulate of France in Boston, Northeastern University and the University of Nantes and sponsored by many other organizations (see Acknowledgements). It is 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. Northeastern University is committed to use-inspired research that lies at the intersection between academic and industry objectives. FAID is a regular event organized by the Office for Science and Technology of the Embassy of France in the U.S. and is designed for researchers and practitioners to exchange views on a specific technological issue, start cooperative activities, and develop business relationships 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.

## 2 WORKSHOP AGENDA

The workshop was structured with a series of keynote presentations followed by a series of panel discussions. The keynote presentations covered a range of topics, including assessing the markets for floating offshore wind energy in the U.S. and France, summarizing the status of floating demonstration projects in the U.S. and France, and summarizing the status of research and development related to floating technology. The panel discussions highlighted strategies for accelerating innovation, addressing risk, regulation, legal, and policy issues, and discussing key structural and geotechnical issues.

The workshop concluded with three parallel breakout sessions during which the panelists brainstormed on strategies and next steps to progress the floating offshore wind energy industry. The breakout sessions focused on Accelerating the Cycle of Innovation; Structural-Geotechnical Interaction of Moorings of Floating Systems; and Risk, Regulation, Legal, Economic, and Technological Issues for Multi-Use Offshore Development. Each breakout topic had two to three discussion leaders. The participants were divided into three groups, and the groups were rotated between the breakout sessions, enabling all panelists to contribute ideas to each of the breakout topics. These ideas were consolidated and summarized by the breakout group leaders to capture important conclusions from the breakout sessions.

A networking reception was held at the end of the first day at the home of the Consul General, Arnaud Mentré, of the French Consulate in Boston. The reception included Northeastern University President Joseph Aoun and other senior leaders from Northeastern University and from the French Consulate along with the workshop participants.

A summary of highlights from the keynote presentations, panel discussions, and breakout sessions follows in the next section.

## 3 KEY IDEAS AND FINDINGS

The key ideas and findings are summarized individually below for each of the three keynote presentations, five panel discussions, and three breakout sessions. The breakout sessions were organized into three topics and designed for brainstorming on research and development needs to advance the floating offshore wind energy industry, along with mechanisms to support those needs. The intent was that these ideas could serve as a catalyst for identifying areas of collaboration for projects between French and American institutions.

Keynote #1: The Floating Offshore Wind Energy Markets in France and the U.S.

*Abstract:* The global market for offshore wind energy is maturing, while the market for floating wind energy is in its infancy. France and the U.S. have large resources suitable for both markets. This keynote session will discuss the state of the existing markets and their evolution in France and the U.S. for both offshore and floating offshore wind energy. This session was moderated by Franck Schoefs, Professor in the Institute for Civil and Mechanical Engineering Research and CEO of the Sea and Littoral Research Institute (IUML) at the University of Nantes.

Walt Musial, the Principal Engineer and Manager of Offshore Wind at the National Renewable Energy Laboratory (NREL), discussed the expected market opportunity for floating offshore wind in the U.S. and what is currently driving interest in this technology. He provided a breakdown of the floating offshore resource by geographic region and discussed the technology challenges for each. He presented current and projected estimates of the levelized cost of energy for floating wind in targeted regions of the U.S., and a description of the significant steps being taken to address the technology challenges. He concluded by noting that 58% of the offshore wind resource in the U.S. is in water depths > 60 m and that cost models show that floating technology has the potential to have the same price (or lower) than fixed-bottom technology by 2030. He noted the significant economic opportunity to establish national leadership in floating technology.

Matthieu Monnier, the Head of Industry and Offshore wind for the French Wind Energy Association, described the state of the offshore wind energy market in Europe with more than 16 GW (i.e., 4200 wind turbines) in operation in 2018 and with several EU State members (Germany, Netherlands, UK, France, and Belgium) about to extend their offshore wind development programs, He noted how, in 2016, France entered the race of pioneering floating technology by awarding four pilot farm projects; He also noted the recent commissioning of FloatGen, France's first full-scale demonstration. He described the wide benefits of the offshore wind energy industry in revitalizing ports and territories and in accelerating the oil & gas reconversion. He mentioned how the advancement of the floating offshore wind energy industry involves several exciting challenges, including: how to deal with industrialization processes, cost reduction, social acceptability, and technological issues such as dynamic cables, deep-water possibilities, mooring systems, and material alternatives.

Derek Stilwell, the Commercial Leader for North America for General Electric Renewable Energy – Offshore Wind, summarized several global and American trends in the offshore wind energy industry. Globally, he noted the deployment of advanced technology with higher capacity factors, lowering Capex and Opex; He also noted that Europe still leads the global market, with Asian gaining ground. He noted global progress in the development of floating technology. In the U.S., he stated how 15-20 GW of offshore capacity is in development and that this will leverage state-of-the-art European technology resulting in lower than expected bids. He stated that, within the U.S., the Northeast leads the market with the West Coast and Island markets developing and that major global companies are positioning themselves through partnerships, acquisition and bold

investments. For floating specifically in the U.S., he commented how there are large and constrained markets which require floating solutions and how the technology was at a critical development phase. He said the viability of the technology is driven in part by its faster/higher local content and its better fit to current infrastructure. He said that floating technology needs more R&D to solve the substructure lag, close technology gaps in tethering, cables, controls and grids, and establish finance-ability by closing the gap in risk between the substructure and the wind turbine generator.

Keynote #2: Demonstrations of Floating Technology

*Abstract:* Megawatt-scale floating technology currently exists only at the demonstration level. Both France and the U.S. are active in demonstrating innovative floating technology. This keynote session will provide updates on the Aqua Ventus project in the Gulf of Maine of the U.S. and explain how the French projects of Groix Belle-Ile on the Atlantic coast and others on the Mediterranean coast contribute to the development of the floating wind industry. Industrial contractors will also share their experiences on preparing utility-scale commercialization. This session was moderated by Fara Courtney, an Independent Consultant focusing on policy innovation and collaboration to advance the low carbon economy and the Strategic Advisor for the Partnership for Offshore Wind Energy Research (POWER-US).

Emmanuel Brochard, the Vice President of Business Development of Naval Energies, provided commentary on why floating wind technology is a game changer, what the key success factors are for floating wind, and how Naval Energies is positioned prepared to bid on commercial tenders. He also provides an updated on the French Groix Bell-Ile floating wind pilot project from EOLFI. This project consists of four 6 MW floating turbines with turbines and generators supplied by General Electric and the semi-submersible hull designed by Naval Energies. The project is expected to be commissioned in 2021.

Habib Dagher, the founding Executive Director of the Advanced Structures and Composites Center at the University of Maine, described the capabilities of Alfond W2 (Wind-Wave) Ocean Engineering Laboratory for testing of floating technology and presented a history on the University of Maine's laboratory-scale and 1:8 scale demonstrations of floating technology. He then presented an update on the developments of the New England Aqua Ventus I Advanced Technology Demonstration project, which will deploy two 6 MW commercial-scale floating wind turbines 24 km off the Maine Coast using a semisubmersible floating concrete hull called VolturnUS. He said they expect the project to be grid-connected by 2022.

Dominique Roddier, the Chief Technology Officer at Principle Power, Inc. and co-inventor of WindFloat, described the history and commercialization plans of the WindFloat technology, a semi-submersible concept that includes an active ballast hull trim system, heave plates for dynamic stability, and water ballast to achieve operational draft. He described the successful demonstration and recommissioning of this concept at prototype scale supporting a 2 MW wind turbine. He then described the current pre-commercial phase of this technology, which is designed to support 6 to 10 MW turbines, and the planned commercial (2020) and industrialized phases (> 2025). He described Principle Power's role in the Les Eoliennes Flotantes du Golfe du Lion project, one of the four French pilot projects. He concluded that Principle Power's current efforts are to develop partnership and supply chains to deliver a globally competitive project.

Thomas Choisnet, the Chief Technology Officer at IDEOL and inventor of the damping pool, describe the technical and "soft matter" motivations for demonstrating floating wind technology to make the technology bankable. He described the 3 MW demonstration of their technology in

Japan and the 2 MW demonstration in France (i.e., the FloatGen project). He described IDEOL's next steps to achieve serial production at 12 MW scale, including their R&D priorities of simplifying and industrializing hull construction, developing the "last bricks" missing before commercial farms, making design methods more efficient, and assessing the environment.

Keynote #3: Research Initiatives and Testing Infrastructure

*Abstract:* Floating wind concepts are evolving quickly and research initiatives and physical testing at multiple scales are essential to this process. Both France and the U.S. have significant capabilities in physical testing and active research networks. This keynote session will include updates on the research consortia led by NYSERDA in the U.S. and WEAMEC in France and a summary of relevant large-scale testing infrastructure in the U.S. This session was moderated by Sandrine Aubrun, Professor at the Ecole Centrale of Nantes in the Laboratory of Research on Hydrodynamics, Energetics and Atmospheric Environment (LHEEA).

Richard Bourgeois, Senior Project Manager at the New York State Energy Research and Development Authority (NYSERDA) with a portfolio in renewable energy and energy storage and the Principal Investigator for NYSERDA's project with the U.S. Department of Energy to establish the National Offshore Wind Research and Development Consortium, presented an update on the status of the research consortium, including its research roadmap and expected solicitations. He noted that the consortium is dedicated to managing industry-focused research and development of offshore wind to maximize economic benefits for the U.S.

Philippe Baclet is the Director of WEAMEC, an organization that oversees the Marine Renewable Energy ecosystem in terms of research, innovation and education within the Pays de la Loire Region in France. He noted that WEAMEC brings together around thirty institutions and research laboratories, around sixty companies at the regional level, and more than sixty companies at the national and international levels to foster collaboration among academic and industrial stakeholders. WEAMEC research projects are supported by 19 research units within the Sea and Littoral Research Institute (IUML), along with 3 principal partners for research and innovation in Marine Renewable Energy: Ecole Centrale de Nantres, University of Nantes and Ifremer. WEAMEC incorporates capabilities from thirty experimental facilities that contribute to Marine Renewable Energy studies. Philippe concluded by noting that one of WEAMEC's research programs provides financial support for international collaborations involving a laboratory in the Pays de la Loire Region and an international laboratory.

Eric Hines, a Professor of the Practice for the Department of Civil and Environmental Engineering at Tufts University, discussed how the U.S. has substantial research assets in wind energy, ocean and atmospheric science, electric grid integration, and infrastructure development. These assets are held by a variety of federal agencies including the Department of Energy, the National Science Foundation and the National Oceanic and Atmospheric Administration. He introduced these assets in the context of a potential network that could build on more than two decades of U.S. experience with national initiatives in Earthquake Engineering, Ocean Science, and Composites Manufacturing. He described five strategic research themes to advance the industry in the U.S. including (1) advancing near-term deployment and investing in long-term innovation, (2) moving state-of-the-art to state-of-the-practice for resource characterization, (3) planning long-term for ports, supply chain and transmission, (4) establishing a data-driven engineering paradigm for resilient infrastructure, and (5) pursuing the public interest and adapting to U.S. conditions.

Panel #1: Accelerating the Cycle of Innovation

*Abstract:* The cycle of innovation, from laboratory to demonstrations and commercialization, can be accelerated through physical testing that is tightly linked to numerical simulations. This requires both complex and large facilities that can represent physical conditions realistically and numerical models that represent behavior accurately. This panel will include examples of the cycle of innovation of floating technology in France and the U.S. and a discussion on ideas for accelerating this process. This session was moderated by Matthew Lackner, Associate Professor of Mechanical and Industrial Engineering at the University of Massachusetts Amherst.

James Manwell, Professor of Mechanical and Industrial Engineering at the University of Massachusetts Amherst, highlighted some of the key contributions that the academic community has made to the emergence of wind energy as an important source of electricity, including contributions to better understanding of the wind itself and the turbine's response to it, rational design standards, detailed aerodynamic and structural dynamic design codes, application of information technology, and modern control, power electronics, better materials and understanding of those materials. He discussed the role for the academic community in supporting continued evolution of wind energy science and technology to the point where it could supply a significantly larger fraction of world's energy supply. He also discussed the role of academic organizations such as the European Academy of Wind Energy and the North American Wind Energy Academy.

Jean-Christophe Gilloteaux, a Researcher in the Marine and Ocean Energy team at the Research Laboratory in Hydrodynamics, Energetics and Atmospheric Environment (LHEEA) at the Ecole Centrale of Nantes, highlighted current research projects at the LHEEA Lab that aim at improving and facilitating the design of floating wind turbines. These research activities were presented in terms of (1) facilitating the maturation of floating technology, (2) performance improvement, and (3) exploration of novel concepts, including hybrid platforms, floating vertical axis wind turbines, maintenance operations, and mobile far offshore wind energy conversion systems (e.g., sailing wind turbines, energy ships).

Anthony Viselli is the Manager of offshore model testing and structural design at the Advanced Structures and Composites Center at the University of Maine. He described the capabilities of the Alfond W2 Wind-Wave Ocean Engineering Laboratory, a combined wind-wave simulation basin with tow carriage and variable depth floor. This facility is equipped with a high-performance rotatable wind machine over a multidirectional wave basin. The facility can accurately simulate towing tests, variable water depths, and scaled wind and wave conditions that can represent extreme storms. This facility assists businesses in developing products for the marine economy while offering hands-on training for students. These products include improved boat and ship hulls; ocean energy devices such as wind, wave and tidal energy; aquaculture technology; oil and gas structures; waterfront infrastructure such as bridges, piers, docks and port facilities; as well as systems to protect coastal cities from effects of erosion and storms.

Sandrine Aubrun, Professor at the Ecole Centrale of Nantes in the Laboratory of Research on Hydrodynamics, Energetics and Atmospheric Environment (LHEEA), provided examples of wind-turbine-oriented aerodynamic challenges with a focus on two projects funded by WEAMEC. These projects are designed to optimize wind turbines to increase their performance and their lifetime. The two projects include the FLOATEOLE project, which seeks to optimize floating wind turbines operation by studying the consequences of the wave/wind/structure coupling on the performance and durability of the wind energy converters subjected to harsh and non-deterministic operating conditions and the ASAPe project, which seeks to mitigate loads through the

implementation of sensor and actuator add-ons for the dynamic adaptation of the blade aerodynamics.

Natalia Castro Casas is a Research Engineer at D-ICE Engineering. Her presentation focused on D-ICE Engineering's developments concerning control of floating offshore wind turbines. She first discussed different control strategies implemented and the process to tune controllers and then discussed wind estimators designed and developed by D-ICE. Finally, she discussed the D-ICE's objectives and future goals, including summaries of two of their R&D projects on software in the loop basin testing and generic numerical simulation tools.

Panel #2: Risk, Regulation and Insurance of Floating Infrastructure

*Abstract:* Floating infrastructure is at risk to multiple sources of physical damage and business interruption that can occur during construction, installation and operational conditions. These factors contribute significantly to the cost of energy. Insurance, regulation and surveying play a critical role in understanding and mitigating these risks, especially for new floating technology. This panel will discuss these issues from the perspectives of insurance, marine warranty surveying, regulation, monitoring, and risk analysis. This session was moderated by Andrew Myers, Associate Professor of Civil and Environmental Engineering at Northeastern University.

Faris Nimri, Senior Engineering Underwriter with Swiss Re, discussed why insurance is so important for floating infrastructure. He noted several factors leading to increased risk including that that the lack of testing of floating technology so far, the remote locations where floating technology is expected to be installed, the additional strains to cables and wind turbine generator equipment for floating technology. He also noted several factors leading to decreased risk including that the majority of assembly can be done onshore/nearshore, floaters can be moved back to shore for maintenance/repair, and smaller vessels can be used for installation, repair, etc. He also noted that, for the offshore wind energy industry generally, the dominant category of claims involve damage to export and array cables.

Lars Samuelsson, Manager of the American Bureau of Shipping's global offshore department, discussed the importance of classing a floating offshore wind turbine installation and stated that experience with other floating structures is key. He mentioned that ABS has issued a guide for building and classing floating offshore wind turbine installations and summarized ABS' involvement in current floating projects, floating standard development and floating project certification. He concluded by highlighting the importance of standards in establishing norms and requirements in regards to technical systems.

Maxime Bellorge, Project Manager at AKROCEAN described challenges in terms of ocean data collection for floating wind projects because of their relatively immature technology and because they tend to be located in deeper water where ocean monitoring on fixed structures is not possible. He recommended the development of standard data collection plans and the use of high technology measurement technology (e.g., sonar, radar, lidar) to accelerate the development of floating offshore wind technology. AKROCEAN develops a floating platform equipped with a lidar, wave radar, sensors for air climatic parameters and current meters.

Bruno Geschier, Chief Sales & Marketing Officer at IDEOL, suggested that the floating wind industry is the combination of two mature technologies: bottom fixed offshore wind and floating oil and gas. He noted how the insurance market has demonstrated an appetite for floating wind projects and how the competitiveness of the insurance policy depends on design safety and redundancy. He emphasized that redundancy and conservatism are key at this stage of development for the floating wind energy industry.

R.V. Ahilan, Joint Group Chief Executive at LOC Group, highlighted the advantages of floating wind technology including mobility, installation farther away at sea leading to less disruption and view pollution, access to better winds, and the potential for larger turbines. He described LOC Group's experience with the FloatGen project in France and noted several challenges specifically for floating wind projects including: need to adapt local port infrastructure and vessels for installation and O&M, development of an "offshore" culture among local players to follow established standards for design and operations at sea, and the development of floating specific regulations by national authorities. He concluded by noting ten challenges to scale floating wind technology to a cumulative capacity of 500 MW.

Panel #3: Innovations in Floating Technology

*Abstract:* Innovative floating concepts are evolving quickly and reaching higher levels of technology readiness. Floating wind energy platforms and substations have design requirements that are distinct from other floating technologies such as those employed by the oil and gas industry. This panel will provide a summary of several promising concepts developed by leading floating technology designers in France and the U.S. This session was moderated by Jerome Hajjar, Professor and Chair of the Civil and Environmental Engineering Department at Northeastern University.

Kyle Beattie, a Naval Architect at Glosten, discussed the suitability of tension leg platforms (TLPs) for deep water offshore wind farms. He described how Glosten has modified the traditional TLP design from the oil and gas industry to optimize a lower cost of energy for commercial scale offshore wind farms. The modified design has five arms to lower the center of mass. The design also includes a robust and stiff mooring to improve wind turbine efficiency. The vertical cable mooring system allows a cleaner seabed in a multiple unit offshore wind farm.

Jeff Kehne, the Chief Development Officer and General Counsel of Magellan Wind, presented a project developer's perspective on emerging floating foundation technology. He noted how opportunities in California present high demand for renewable energy and stiff price competition with land-based wind and solar. He noted how Magellan Wind is interested in the Tetra foundation designs by Stiesdal Offshore Technologies because (1) construction from wind tower sections realizes cost savings from existing industrialized production process, (2) pinned assembly reduces time and cost of quayside work, (3) no specialized vessels are required, and (4) deployment is possible by tugboat.

Pascal Heisel, the Head of research and development for the MAREAL/CETEAL group, presented on the XCF concept, a concrete semi-submersible floating concept. He noted that security of the floater, of the people, and of the production are what lead to reduced costs and easier financing. He also noted how adaptability (i.e., ability to be compatible with multiple turbines) and potential for mass production are also key factors in reducing costs. He emphasized the uncertainty of the offshore environment and used that as motivation for simplicity in the design of floating wind structures.

Arnaud Salou, Head of Technical Offshore Department of ATLANTIQUE Offshore Energy, stated how the development of cost-effective solutions for floating electrical station platforms is a key challenge common to any commercial offshore wind farm and that this might become a serious bottleneck to the advancement of the industry. He presented a series of topside lessons learned from fixed commercial wind farms and identified lever arms and associated innovations to meet cost reduction targets necessary for the commercial deployment of floating technology. He emphasized the importance of a modular approach in the design of floating substations.

Marc Guyot is the Founder of EOLINK. He emphasized that upsizing is a key for competitiveness and noted that upsizing leads to design complications in terms of fatigue, resonance and blade stiffness. He suggested that key differences in floating wind compared to fixed-bottom wind warrant a total redesign of wind turbine architecture. He introduced a concept based on a total redesign. The concept is free-yawing and includes a patented pyramidal structure to support a wind turbine with a high power/weight ratio. He presented an update on EOLINK's scaled sea trials and their full-scale design for a 12 MW turbine.

Panel #4: Structural-Geotechnical Interaction of Moorings of Floating Systems

*Abstract:* Anchoring systems are key components of the support structure of floating platforms and their design includes many opportunities for innovation and challenges to delivering reliable performance. Mooring systems are known in the oil and gas industry to be a potential source of reduced reliability, and implementation of mooring systems for floating platforms will require deeper understanding of the interaction of structural and geotechnical behavior. Among the challenges to the design of new mooring systems, the following are prioritized for discussion in this panel: cyclic loading and soil uncertainty, optimization of mooring architecture, and mooring and anchor design for intermediate and shallow water depths. This session was moderated by Sanjay Arwade, Professor of Civil and Environmental Engineering at the University of Massachusetts Amherst.

Franck Schoefs, Professor for the Institute for Civil and Mechanical Engineering Research at the University of Nantes, and CEO of the Sea and Littoral Research Institute (IUML) addressed the interdisciplinary challenges inherent to understanding reliability of mooring lines. Mooring line failure was responsible for a significant portion of offshore failures observed in the 2000s and there is no real solution for monitoring. Solutions require coupled multi-disciplinary research between hydrodynamics for wave-line interaction, structural mechanics for non-linear behavior, understanding of material degradation, biology for biofouling, physics for monitoring and geotechnics for anchor behavior. He presented a summary of the key challenges for development of structural health monitoring techniques and the assessment and modeling of marine growth effects. Based on a total of 8 programs and 6 years working on this topic, he emphasized the importance of the development of protocols for biofouling assessment and reliability-based inspection and maintenance optimization.

Thomas Langford, Director for Offshore Energy at the Norwegian Geotechnical Institute, addressed the status of the floating wind industry with respect to suction anchoring systems, including experience so far and the large pool of knowledge already available in the offshore sector. He then summarized the most important technical needs where industry and academia should focus in terms of providing cost reductions and optimization for new floating wind projects. He summarized several anchoring concepts appropriate for floating wind structures and emphasized the importance of structural health monitoring.

Matthieu Dujon is the Head of export markets for Le Béon Manufacturing, a designer and producer of connectors for anchoring and mooring of floating structures. He presented an overview of Le Béon Manufacturing and its involvement in the marine renewable energy industry. He presented lessons learned from the Floatgen project and the organizational principles necessary for good control of the mooring of a floating wind turbine project. Those principles include direct and open communication with centralizing flows, geographical proximity among the team, planning for worst-case scenarios, opportunities for upstream comments of technical specifications, and clear coordination with the classification society.

Pierrick de Bélizal is the Head of structural analysis of Marine Renewable Energy units at INNOSEA. His presentation described the process of mooring system design through dynamic coupled simulations. He also presented two case studies. The first discussed nonlinear calculation used to optimize the design of mooring line clump weights to offset the vertical force against the anchor and limit the lateral offset of the floater. The second related to a tool developed by INNOSEA as part of a collaborative research project that aims to assess the impact of cyclic monopile loading on soil behavior.

Leopoldo Bellow is Vryhof's Managing Director. He presented a summary of the typical elements involved in a mooring line configuration including winches and fairlead, top chain, main mooring line, bottom chain, additional clump weights, connectors, and anchor. He discussed the three categories of mooring design: catenary, taut and semi-taut leg, and tension leg platform. He listed a series of design challenges including (1) mooring line cost and complexity, (2) anchor cost and complexity, (3) onsite installation capabilities of local facilities, (4) decommissioning and maintainability, (5) water depth independence, reduced sensitivity to soil conditions, and (6) minimum footprint versus cost.

Charles Aubeny is a Professor of Civil and Environmental Engineering at Texas A&M University. He presented on considerations for the selection of anchors for floating structures. He organized the considerations into (1) the type of mooring system, (2) multiline systems, (3) soil conditions and loading, (4) efficiency and transport, and (5) installation. For each of these factors, design options were presented along with a summary of the tradeoffs for each.

Panel #5: Legal, Economic and Technical Issues for Multi-Use Offshore Development

*Abstract:* The limited availability of coastal spaces, combined with the need for these spaces to serve multiple uses (e.g., fishing, energy production, environmental preservation and tourism) means that offshore wind energy development must be planned carefully, considering multiple and diverse stakeholders. Multi-use floating platforms can provide opportunities to leverage limited coastal spaces. This panel will focus on the legal, economic, and technological potential of several multi-use concepts along with their potential effects on public acceptance of floating energy systems. This session was moderated by Jennie Stephens, Director of the School of Public Policy & Urban Affairs and Dean's Professor of Sustainability Science & Policy at Northeastern.

Krish Sharman, Professor of Mechanical and Industrial Engineering at the University of Massachusetts Amherst, stated how offshore wind turbines need to be spaced apart for optimal performance and how this this creates space in between that can be restricted for other marine activities, e.g. fishing and trawling. He noted how this presents an opportunity to develop aquaculture farms in the space and that these can share infrastructure with the wind farm and be a source of revenue for the community and the farm operator. He emphasized the potential of this idea, but also noted several technological challenges with sharing infrastructure and power needs using the North Hoyle wind farm as a case study. These challenges include government permitting, adaptation of operational practice for the aquaculture farmer, and consideration of unfamiliar processes, with implications for health and safety and for scheduling for the wind farm operator.

Gaëlle Guéguen-Hallouët is a Professor of Public Law for the Center for the Law and Economics of the Sea at the University of Western Brittany (Brest). She discussed the important role of the legal framework in the development of renewable energy projects at sea. She noted how the development of ocean renewable energy resources helps to fulfill international and European commitments aiming at reducing greenhouse gas emissions and contributing to the ecological transition and how the Energy Transition for Green Growth Act of has now set out to increase the

share of renewable energies to 32% of final energy consumption and 40% of electricity production by 2030. She noted that, despite the huge potential of the offshore wind resource in France, there has been minimal development so far. She noted how difficulties related to the complexity of the law and administrative procedures are a major part of this situation. Even though France's territorial waters and Exclusive Economic Zone (EEZ) cover an area of over 10 million km², no offshore generating capacity is currently being exploited commercially. Floating offshore wind turbines are promising because of higher capacities, less restrictions, less cost, and further locations from the coast; Overall, floating technology could be less impacting and therefore more socially acceptable. It will nevertheless remain subject to difficulties related to the complexity of the law and administrative procedures. She noted that the French government has gradually defined a special legal framework adapted to the challenges and specificities of ocean renewable energies. The main goals of this framework are to ensure participatory governance, simplify the legal framework, and improve the legal and financial security projects.

Alison Bates, Lecturer for the Department of Environmental Conservation at the University of Massachusetts Amherst, presented on the use of marine spatial planning to minimize conflicts between commercial fishing and offshore wind power. She noted how a key component of offshore wind planning includes existing uses of the marine environment, in order to optimally site wind farms while minimizing conflicts. Commercial fisheries comprise an important stakeholder group and may be one of the most impacted stakeholders from offshore wind development. Concern of the fishing industry stems from possible interference with productive fishing grounds and access within wind farms, resulting in costs from increased effort or catch reductions. She presented a quantitative, economic-based marine spatial planning approach can be used to engage stakeholders and select low-conflict areas for offshore wind development.

Mathilde Touzé is a student enrolled at University of Nantes in the Laboratory of Economics and Management Nantes Atlantique (LEMNA). She presented an analysis of the economics of offshore wind power, showing the benefits for each stakeholder. Her analysis showed that the energy operator captures only a limited share of the benefit, while society overall benefits the most from clean energy, local jobs and energy independence. High investment costs reveal the relative immaturity of the offshore wind sector but also translate into a permanent feature of the French context where administrative procedures are long, technologies become obsolete before being installed, and the lack of experience may increase the financial risk premium. She cautioned that, ultimately, the transaction costs could overtake the economies of scale of large offshore wind farms, suggesting that small projects could be viable first in France. She noted how multi-use of the sea could bring auxiliary benefits, but that different legal provisions are to be foreseen for multi-use sites. She concluded that multi-disciplinarity, including economics, engineering, sociology, law and political science, is needed more than ever for this industry to advance.

David Cash is the Dean of the John W. McCormack Graduate School of Policy and Global Studies at University of Massachusetts Boston. He discussed synergies and conflict in offshore wind governance in linked local, state, national and international contexts. He stated that developing offshore wind in the coastal waters of the U.S. will necessitate successfully navigating regulatory, legal, economic and political dynamics from the local to the federal levels. Sometimes synergies across these levels facilitate development, but, in other times, conflicting frameworks across levels can create serious roadblocks. He noted how the dynamics of international climate governance add another level of complexity. He explored these dynamics using case studies from Massachusetts and New England, where industrial-scale offshore wind projects are expected to start in the near future.

Breakout #1: Accelerating the Cycle of Innovation

This breakout session was led by Jerome Hajjar, CDM Smith Professor and Department Chair of the Department of Civil and Environmental Engineering at Northeastern University, and Natalia Castro Casas, Research Engineer at D-ICE Engineering.

The discussions for this session were organized into opportunities and technical topics. For the former, several opportunities for French-American collaboration were identified including: WEAMEC (in particular a program that provides 200K Euro for two year projects to French researchers with co-funding in the U.S.), the Massachusetts Clean Energy Center and NYSERDA, The European Union Horizon H2020 on renewable energy, academic exchanges and professional exchanges, private investment from companies especially oil and gas companies who are transitioning to renewable energy, the Offshore Wind Energy Innovation Prize in the U.S., and the CIR French Tax, which is geared to partnering French and American industries for research. IUML is extensively involved in providing expertise to the French National Research Agency-ANR and some of its researchers are members of the Scientific Committee for Evaluation. Every year this Agency funds international projects under the name "*PRCI: Projets de recherche collaborative – International'*: Jointly Funded International Collaborative Projects." Preliminary proposals for these project are due in October, with full proposals due in March/April, if invited. For technical topics, the following were identified: aerodynamics, hydrodynamics, monitoring (including predictive maintenance and optimization to minimize redundancy), mooring line grid complexity, fatigue life and its relation to control, welding processes, and non-destructive testing.

In addition to these topics, the need for benchmarks that can validate and standardize models was discussed, as was the need to share data and information to provide a repository for field experiences. Regarding the latter point, some examples were cited including DesignSafe, the data repository for the U.S. National Science Foundation's Natural Hazard Engineering Research Infrastructure and the Medin Platform and the Marine Data Exchange. Companies that were potentially interested in exchanges included IDEOL, the France Energy Marine society, and Ørsted. Other opportunities include the development of a series of international technical committees like the current IEA Task groups, potentially led by a group like EAWE or NAWEA, and the development of a Wiki for floating offshore wind. It was also highlighted that there is a need for writing a series of state-of-the-art papers and this is challenging in highly interdisciplinary fields, like this. Finding a mechanism to write these papers and selecting the topics should be a short-term deliverable of this workshop. The DNA of IUML is an interdisciplinary institute that could quickly gather a team for achieving this goal.

Breakout #2: Structural-geotechnical Interaction of Moorings of Floating Systems

This breakout session was led by Sanjay Arwade, Professor of Civil and Environmental Engineering at the University of Massachusetts Amherst, and Franck Schoefs, Professor in the Institute for Civil and Mechanical Engineering Research and CEO of the Sea and Littoral Research Institute (IUML) at the University of Nantes.

This discussion focused on potential collaborations related to water/soil/structure dynamics, focusing on ideas discussed in the panel and on mechanisms to support collaborative projects. One issue relates to how the power cable interacts with the shore and how the array cable behaves dynamically far offshore in deep water. Issues related to navigation and layout of mooring lines are also important. The potential of multiline layouts was discussed including its implications for redundancy. The high rate of mooring line failures noted during Panel #2 was cited as motivation for greater monitoring and instrumentation of mooring line and dynamic cables and potentially

greater redundancy, for better modeling of cable and mooring line dynamic behavior including effects of marine growth, and for cable testing to understand limit states and to validate models. Regarding redundancy, it was emphasized that it's important to consider mooring line redundancy in the context of overall system reliability. There is important work to be pursued on modeling the mooring systems to find weak points and to better understand the many non-linearities. It was noted how a floating wind turbine is one system and should be modeled as such, despite current practice to model components individually. It was noticed that these challenges should be extended to the specific context and issues of Offshore Floating Substations for which the requirements for reliability and availability are higher. Challenges of finding coordinated funding between Europe and the U.S. were discussed including issues with intellectual property. The Massachusetts government was mentioned as having a role to play in forging international collaborations. Possible mechanisms for funding included support from the U.S. National Science Foundation as part of the PIRE (Partnership for International Research and Education) program, WEAMEC, the French National Research Agency's support of International Collaborations through the PCRI program, and the French CNRS (National Centre for Scientific Research).

Breakout #3: Risk, Regulation, Legal, Economic, and Technological Issues for Multi-Use Offshore Development

This breakout session was led by Andrew Myers, Associate Professor of Civil and Environmental Engineering at Northeastern University, Gaëlle Guéguen-Hallouët, Professor of Public Law for the Center for the Law and Economics of the Sea at the University of Western Brittany (Brest), and Jennie Stephens, Director of the School of Public Policy and Urban Affairs and Dean's Professor of Sustainability Science and Policy at Northeastern University.

The overarching theme of this breakout group was a discussion on the context beyond the technology for advancing the floating offshore wind energy industry. The conversation centered on understanding what currently limits the bankability of floating wind energy projects, as, ultimately, a large floating wind energy project will have to convince a bank to invest large sums of money to support development. Several factors that currently limit banks from having the confidence to invest were identified, including (1) lifetime extension (especially related to mooring lines, export cables, floaters and the transition piece), (2) certification, regulation and standards development, (3) uncertainty in the future of subsidies (i.e. tax credits, productions credits, renewable energy credits) and how these relate to overall project risk, (4) difficulties operating and maintaining power generation infrastructure offshore, (5) clarity among various stakeholders in responsibility for "insuring" various risks at various stages of the project and operation, (6) more accurate resource and site characterization and clear definitions for who is responsible for what, (7) uncertainty in permitting, (8) a lack of history of performance for floating wind technology, (9) involvement of all stakeholders, especially local communities, to increase public acceptability of projects, and (10) identification of leadership and funding to overcome these and a plan to market the outcomes.

Another point of discussion related to the integration of technological and social components to advance a floating wind farm project. The experience in France, where many community events were held, but were ultimately not effective, was discussed as an example. The problem was that participation in these events was not diverse and involved the same demographic every time. In fact, these events ended up coalescing resistance to offshore projects. Solutions to this problem included better scheduling of events and diversification of the mechanisms for engagement. Some specific ideas included the creating of site-specific education/information centers involving museums and tours, the development of educational programs for schools, and reframing of the

situation to include the benefits of decentralizing the energy system in addition to renewable energy.

The discussion emphasized the importance of not only generating new data/measurements/understanding but also communicating this understanding through regular engagement with industry and local communities. Demonstration projects were cited as an essential part of making projects bankable and increasing acceptability. They also can serve as an educational component for the public and for students. The importance of flaunting projects through eco-tourism was also highlighted so the communities can see the benefits of these projects firsthand. Demonstrations help with both communication and normalization, as studies alone do not build public support.

# 4 CONCLUSIONS AND NEXT STEPS

The opportunities for harvesting offshore wind energy with floating technology are vast and compelling, but important technical, economic, social, financial, regulatory, and policy challenges must first be overcome before these opportunities can be realized. France and the U.S. have extensive and relevant experience and highly active communities working to overcome these challenges; this workshop provided a comprehensive overview of the activity in these two countries as floating technology ideas advance to commercialization. The workshop emphasized the breadth of expertise needed to advance this industry quickly and effectively. The industry needs innovation and continued research and development from a broad spectrum of stakeholders, including engineers, physical scientists, social scientists, financiers, economists, developers, regulators, and policy makers, among others. The workshop also emphasized that the most important stakeholder of all is the public. Cultivation of public support and acceptance is an essential part of the advancement of this industry, requiring immediate attention.

It was stated that floating offshore wind technology, as currently planned, can be seen as a first step for the development of more complex systems: Multi Usage Offshore Platforms (MUOP). Floating turbines are expected to be economically viable between 2025 and 2030 (Inno Energy Report, 2017). The increasing density of people in coastal areas will both increase energy demands and the pollution to air and water. The United Nations expects that 80% of the population will live within 75 km of a coast by 2050. The MUOP sector is expected to grow by 2030 (French Maritime Cluster) and is a possible solution for decreasing the environmental impacts of these changing demographics. Realizing the benefits of floating wind will require advancement in multiple fields, including social acceptability, economics, and technology.

Practitioners and researchers in France and the U.S. have much to contribute to the growing floating offshore wind energy industry and collaborative projects between these two countries can accelerate the process. Collaborative projects involving French and American industry and academia can be especially effective. Many specific project topics that are ripe for collaboration were identified in this workshop and these are listed in the Ideas and Findings summarized in Section 3 of this report. Securing funding to support these collaborations is the essential next step. One immediate opportunity to forge such collaborations is a program organized by WEAMEC. This program provides 200K Euro of funding for two-year projects that require international collaborations and involve a laboratory in the Pays de la Loire Region in France and an international laboratory, in the U.S. or elsewhere. Other funding opportunities identified in this workshop include: the Massachusetts Clean Energy Center and NYSERDA, The European Union Horizon H2020 on renewable energy, private investment from companies especially oil and gas companies who are transitioning to renewable energy, the Offshore Wind Energy Innovation Prize in the U.S., the CIR French Tax, which is geared to partnering French and American industries for research., the PIRE (Partnership for International Research and Education) program run by the U.S. National Science Foundation, the French National Research Agency's support of International Collaborations through the PCRI program, and the French CNRS (National Centre for Scientific Research). In addition, the University of Nantes hosts an international event focused on Marine Renewable Energy called SEANERGY in June 2020; this event is an opportunity to launch collaborations and visit relevant French facilities.

## APPENDIX 1 – WORKSHOP PROGRAM

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UNIVERSITÉ DE NANTES

Northeastern University

# 2019 | FRENCH AMERICAN INNOVATION DAY BOSTON

# FLOATING OFFSHORE WIND ENERGY TECHNOLOGY

## Innovation to Commercialization: Engineering, Policy, and Development

MARCH 18-19, 2019
Boston, MA

# MARCH 18
## 7AM-9:30PM

2019 FRENCH AMERICAN INNOVATION DAY BOSTON

| | |
|---|---|
| 7:00 | Registration, Coffee, and Continental Breakfast |
| 8:00 | **Welcome & Introductions**<br>Andy Myers (Associate Professor, Northeastern University), Anne Puech (Scientific Attaché, Office for Science and Technology at the Consulate General of France in Boston), Franck Schoefs (Professor of Universities and CEO of IUML Sea and Littoral Research Institute) |
| 8:15 | **Opening Remarks**<br>Arnaud Mentré (Consul General of France in Boston), Jerry Hajjar (CDM Smith Professor and Department Chair, Northeastern University), Nadine Aubry (Dean of College of Engineering, Northeastern University), Bruce Carlisle (Senior Director Offshore Wind, MassCEC), Yves Frénot (Counselor of Office for Science and Technology at the Embassy of France in the United States) |
| 9:00 | **Keynote 1: The Floating Offshore Wind Energy Markets in France and in the U.S.** |
| 10:15 | Coffee/Refreshments Break<br>Poster Session 1: Facilities Equipment |
| 11:00 | Keynote 2: Demonstrations of Floating Technology |
| 12:30 | Lunch |
| 1:30 | Keynote 3: Research Initiatives & Testing Infrastructures |
| 2:45 | Panel 1: Accelerating the Cycle of Innovation |
| 3:45 | Coffee/Refreshments Break<br>Poster Session 2: Technologies |
| 4:30 | Panel 2: Risk, Regulation, and Insurance of Floating Infrastructure |
| 5:45 | Departure to La Résidence de France in Cambridge |
| 6:30 | Cocktail/Hors d'oeuvres |

NU Guest Wi-Fi - **conf338455**

# MARCH 19
## 8AM-4:15PM

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| | |
|---|---|
| 7:30 | Coffee, Continental Breakfast |
| 8:30 | Panel 3: Innovations in Floating Technology |
| 9:30 | Panel 4: Structural-geotechnical Interaction of Moorings of Floating Systems |
| 10:30 | Coffee/Refreshments Break<br>Poster Session 3: Research Projects |
| 11:15 | Panel 5: Legal, Economic, and Technological Issues for Multi-use Offshore Development |
| 12:15 | Lunch |
| 1:15 | Breakouts Session to discuss French-American partnerships |
| 2:30 | Coffee/Refreshments Break |
| 3:00 | Reports from Breakouts |
| 4:15 | Closing Remarks |

NU Guest Wi-Fi - **conf187936**

# ORGANIZERS

2019 FRENCH AMERICAN INNOVATION DAY BOSTON

## The Office for Science & Technology of the Embassy of France

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EMBASSY OF FRANCE IN THE UNITED STATES
OFFICE FOR SCIENCE & TECHNOLOGY

The Office for Science and Technology (OST), a team of 24 staff members including professors, senior researchers and engineers located in the Embassy (Washington, DC) and 6 consular offices (Atlanta - Boston - Chicago - Houston - Los Angeles - San Francisco) is dedicated to bilateral FR-US collaborations in Science and Technology.

The OST's main priorities are to monitor and report advances in Science and Technology in the US through newsletters and diplomatic channels, promote bilateral partnerships in science, technology and innovation, foster exchanges and increase mobility of researchers, doctoral students and entrepreneurs, serve as a liaison between French and American academic and scientific organizations as well as between the two countries' central governments and the European Delegation, increase the visibility of France's foremost laboratories, universities and start-ups, support young innovative companies and the internationalization of competitiveness clusters.
Close collaboration between the OST and other diplomatic divisions, such as the Economic Department, the Cultural Services of the Embassy of France as well as French Research Organizations (CNRS, Inserm, CNES, CEA), allows the OST to efficiently handle the many economic and social implications of current science and technology issues.

## The Sea and Littoral Institute

IUML
INSTITUT UNIVERSITAIRE MER & LITTORAL
FR CNRS 3473

Sea and Littoral Institute IUML is organized through a scientific and strategic project aiming at better positioning researchers and labs working locally in marine sciences on the national and European arenas (H2020, INTERREG) by promoting and encouraging interdisciplinary studies.

By its critical size (650 researchers), IUML is one of the top marine research and training clusters in France. Within the Pays de la Loire region, IUML can also cooperate with renowned maritime companies: Port Atlantique de Nantes Saint-Nazaire, STX shipyards, Bénéteau group, Naval Energy, GE, TOTAL,…

On a broader scale, IUML is member of French cluster of Universités Maritimes (European Marine Board).

# ORGANIZERS

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## The University of Nantes

UNIVERSITÉ DE NANTES

University of Nantes (UN) is a multidisciplinary higher education institution which has for main objective to strongly raise the excellence of its scientific activities and education/training activities (master and doctorate) to international standard. With 3,200 permanent and contract research staff and more than 37,000 students enrolled at UN over 2016-2017, the University of Nantes is one of the largest universities in France. Université de Nantes carries out the Sea and Litoral Research Institute. Sea and Litoral Research Institute is a multi-disciplinary research funding and performing organization gathering 19 high level research units. IUML is organized through a scientific and strategic project aiming at better positioning researchers and labs working locally in marine sciences on the national and European arenas. By its critical size (650 pers.), IUML is one of the top marine research and training clusters in France. One of the key features of this cluster lies in the spetrum of topics covered by the research units and the number of its collaborative projects between various disciplines: History, Biology, Law, Food engineering, Economics, Biotechnology, Geography, Civil engineering, Management, Flux mechanics, Earth sciences, Sociology, Pharmaceutics, Ecotoxicology, Energy, Fisheries sciences, etc.. IUML is one of the rare clusters acknowledged by two scientific departments (Engineering and Humanities) of the National Council of Scientific Research. It is controlled and funded by Ecole Centrale de Nantes, Université de Nantes, Université du Maine, Université Bretagne Sud, ENSAM, ENSM, Ifremer and CNRS. Research performed by IUML members includes engineering (civil engineering, ocean engineering, food engineering), health sciences & biology as well as social sciences & humanities. An example of a research projects carried out by IUML are the projects focussing of marine renewable energy and supported by WEAMEC (ROS3D, LEHERO-MG, MUSCAS, OWARD), FEM (OMDYN, MHM-EMR, ABIOP, LISORE), region pays de la Loire (HYDROL44, SURFFEOL, iMARECO2) or EUROPE (OCEANET, IBOCS2).

## The Civil and Environmental Engineering Department and The College of Engineering at NortheasternUniversity

Northeastern University

The Department of Civil and Environmental Engineering at Northeastern University includes 37 faculties and 15 affiliated faculties, over 400 undergraduate students, over 200 M.S. students, and 70 Ph.D. students. The Department has a range of teaching and research strengths, anchored by several multi-disciplinary, multi-institutional centers and programs that are core to the activities of the department. With a strategic focus on Urban Engineering, the department has three overarching themes, including Environmental Health, Civil Infrastructure Security, and Sustainable Resource Engineering. Northeastern University's College of Engineering has a distinguished history of accomplishment and vast potential for innovation in engineering research and education, particularly in the energy, environmental, health and security fields. With 13 multi-institutional research centers with funding by eight federal agencies, over 170 tenured/tenure track faculty engaged in interdisciplinary research and teaching, more than $59 million in annual federal funding, and thousands of loyal alumni providing support, the College of Engineering is a leader in Engineering for Society.

The Civil and Environmental Department at Northeastern University (NU) is a founding member of the Massachusetts Research Partnership (MRP) in offshore wind energy research and the Partnership of Offshore Wind Energy Research in the United States (POWER-US).
POWER-US is a uniquely qualified organization that convenes research assets in the U.S. to respond to the offshore wind energy industry's most pressing technical questions. The partnership combines industry, university, and National Laboratory expertise and provides an impartial, multidisciplinary, and international perspective that advances technology, commercializes innovations, and reduces costs and risk of the offshore wind energy industry. NU's researchers have specific expertise in structural design, large-scale testing, and risk assessment. NU also boasts significant large-scale testing capabilities at the Laboratory for Structural Testing of Resilient and Sustainable Systems.

# SCIENTIFIC COMMITTEE

2019 FRENCH AMERICAN INNOVATION DAY BOSTON

## Franck Schoefs
University of Nantes

Prof. Franck Schoefs, PhD, is Professor of Civil and mechanical Universitéde Nantes, France since 2010. Former Student of Ecole Normale Superieure de Cachan, Franck received his Ph.D. (1996) at Université de Nantes and his accreditation to supervise research (HDR) in 2007. He is the head of the TRUST Group (Monitoring, Reliability and Structural Computation at GeM), 40 people, since 2010 and CEO of the 'Sea and Littoral Research Institute' (650researchers) since 2017. He advised President of Université de Nantes about the scientific strategy of Marine Renewable Energy since 2014 and is member of the board of West Atlantic Marine Energy Community since isfoundation (2015). He is the member of the Scientific Committee of the network of French Marine Universities (16 Universities). His main research field concernsreliability, inspection and maintenance of offshore structures including themodeling of degradation processes (corrosion, biofouling, ..).

## Andrew Myers
Northeastern University

Prof. Andrew T Myers, PhD, PE is an Associate Professor of Civil and Environmental Engineering at Northeastern University and a registered professional engineer in the state of California. Prior to joining Northeastern, Andrew worked for two years at AIR Worldwide in SanFrancisco, where he consulted on site-specific natural catastrophe risk assessments. He received his M.S. (2006) and Ph.D. (2009) at Stanford University and his B.S. (2004) from Johns Hopkins University; all three degrees are in Civil and Environmental Engineering with a focus on Structural Engineering. He was awarded the 2016 CAREER award from the National Science Foundation for his work on offshore hazard modeling. His research interests include wind energy structures, multi-scale experimental testing of structures, computational mechanics-based simulation, and probabilistic modeling of structural and natural systems.

# SCIENTIFIC COMMITTEE

2019 FRENCH AMERICAN INNOVATION DAY BOSTON

**Jerome Hajjar**
Northeastern University

Jerry Hajjar is the CDM Smith Professor and Department Chair in the Department of Civil and Environmental Engineering and the Director of the Laboratory for Structural Testing of Resilient and Sustainable Systems, or STReSS Laboratory, at Northeastern University. His research and teaching interests include analysis, experimental testing, and design of steel and composite steel/concrete structures, regional modeling, and earthquake engineering, and he has published over 200 papers and authored or edited four books on these topics. Dr. Hajjar serves on the American Institute of Steel Construction (AISC) Committee on Specifications and several of its task committees, including chairing Task Committee 5 on Composite Construction.Dr. Hajjar is a Fellow of the American Society of Civil Engineers (ASCE) and the Structural Engineering Institute (SEI) and has received a number of awards for his research and teaching on steel and composite structures, structural stability, and earthquake engineering, including the 2016 ASCE Moisseiff Award,the 2010 Popular Mechanics Breakthrough Award, the 2009 ASCE Shortridge Hardesty Award, and the 2005 AISC T. R. Higgins Lectureship Award.

# 2019 FAID
## FLOATING OFFSHORE WIND ENERGY TECHNOLOGY

2019 | FRENCH AMERICAN INNOVATION DAY
BOSTON

# OBJECTIVES

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.

This French-American Innovation Day (FAID), co-organized with the Consulate of France in Boston, the Northeastern University and the University of Nantes aims to be the first of a series of international workshop on floating offshore wind energy technology (I-FOWT). It has been 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.

The 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.

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France in the United States
Consulate of France in Boston

# SPEAKERS

2019 FRENCH AMERICAN INNOVATION DAY BOSTON

## Keynote 1: The Floating Offshore Wind Energy Markets in France and in the U.S.

The global market for offshore wind energy is maturing, while the market for floating wind energy is in its infancy. France and the United States have large resources suitable for both markets. This keynote session will discuss the state of the existing markets and their evolution in France and the United States for both offshore and floating offshore wind energy.

**Franck Schoefs**
Professor of Universities and CEO of IUML
**University of Nantes**

**Walt Musial**
Manager of Offshore Wind
**National Renewable Energy Laboratory**

**Matthieu Monnier**
Head of Industry & Offshore
**French Wind Energy**

**Derek Stilwell**
Commercial Leader - North America
**GE Offshore Wind**

## Keynote 2: Demonstrations of Floating Technology

Megawatt-scale floating technology currently exists only at the demonstration level. Both France and the United States are active in demonstrating innovative floating technology. This keynote session will provide updates on the Aqua Ventus project in the Gulf of Maine of the United States and explain how the French projects of Groix Belle-Ile on the Atlantic coast and others on the Mediterranean coast contribute to the development of the floating wind industry. Industrial contractors will also share their experiences on preparing utility-scale commercialization.

**Fara Courtney**
Strategic Advisor
**Partnership for Offshore Wind Energy Research** (POWER-US)

**Emmanuel Brochard**
VP Business Development
**Naval Energies**

**Habib Dagher**
Executive Director
**University of Maine**

**Dominique Roddier**
CTO
**Principle Power Inc.**

**Thomas Choisnet**
Chief of sales & marketing
**IDEOL**

# SPEAKERS

2019 FRENCH AMERICAN INNOVATION DAY BOSTON

## Keynote 3: Research Initiatives and Testing Infrastructure

Floating wind concepts are evolving quickly and research initiatives and physical testing at multiple scales are essential to this process. Both France and the United States have significant capabilities in physical testing and active research networks. This keynote session will include updates on the research consortia led by NYSERDA in the United States and WEAMEC in France and a summary of relevant large-scale testing infrastructure in the United States.

**Sandrine Aubrun**
Professor
**École Centrale of Nantes**

**Richard Bourgeois**
Senior Project Manager
**NYSERDA**

**Philippe Baclet**
Director and CEO
**WEAMEC (Renewable Marine Energies)**

**Eric Hines**
Professor of the Practice
**Tufts University**

## Panel 1: Accelerating the Cycle of Innovation

**Matthew Lackner**
Professor
**UMass Amherst**

**James Manwell**
Professor
**UMass Amherst**

**Jean-Christophe Gilloteaux**
Researcher
**École Centrale of Nantes**

**Anthony Viselli**
Manager Offshore Testing/Design
**University of Maine**

**Sandrine Aubrun**
Professor
**École Centrale of Nantes**

**Natalia Castro Casas**
Control Engineer
**D-ICE Engineering**

# SPEAKERS

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## Panel 2: Risk, Regulation, and Insurance of Floating Infrastructure

**Andrew Myers**
Associate Professor
**Northeastern University**

**Faris Nimri**
Senior Engineer
**Swiss Re**

**Lars Samuelsson**
Manager
**ABS**

**Maxime Bellorge**
Projects & Sales Director
**AKROCEAN**

**Bruno Geschier**
Chief Sales and Marketing Officer
**IDEOL**

**R.V Ahilan**
Joint Group Chief Executive
**LOC**

## Panel 3: Innovations in Floating Technology

**Jerome Hajjar**
CDM Smith Professor and Department Chair
**Northeastern University**

**Kyle Beattie**
Senior Naval Architect
**Glosten-Pelastar**

**Jeffrey Kehne**
CDO & General Counsel
**Magellan**

**Pascal Heisel**
R&D Manager
**CETEAL**

**Arnaud Salou**
Head of offshore technical department
**Atlantique Offshore Energy Solution**

**Marc Guyot**
CEO
**Eolink**

# SPEAKERS

2019 FRENCH AMERICAN INNOVATION DAY BOSTON

## Panel 4: Structural-geotechnical Interaction of Moorings of Floating Systems

**Sanjay Arwade**
Professor
**UMass Amherst**

**Franck Schoefs**
CEO of IUML
**University of Nantes**

**Thomas Langford**
Director of Offshore Energy
**NGI**

**Matthieu Dujon**
Business Manager
**LeBéon manufacturing**

**Pierrick De Belizal**
Structural Engineer
**INNOSEA**

**Leopoldo Bello**
Managing Director
**Vryhof**

**Charles Aubeny**
Professor
**Texas A&M University**

## Panel 5: Legal, Economic, and Technological Issues for Multi-use Offshore Development

**Jennie Stephens**
Professor & Director School of Public Policy & Urban Affairs
**Northeastern University**

**Krish Sharman**
Professor
**UMass Amherst**

**Alison Bates**
Lecturer & Program Director
**UMass Amherst**

**Mathilde Touzé**
PhD Student
**University of Nantes**

**Gaëlle Gueguen-Hallouët**
Professor of Public Law
**University of Bretagne**

**David Cash**
Dean of McCormack Graduate School
**UMass Boston**

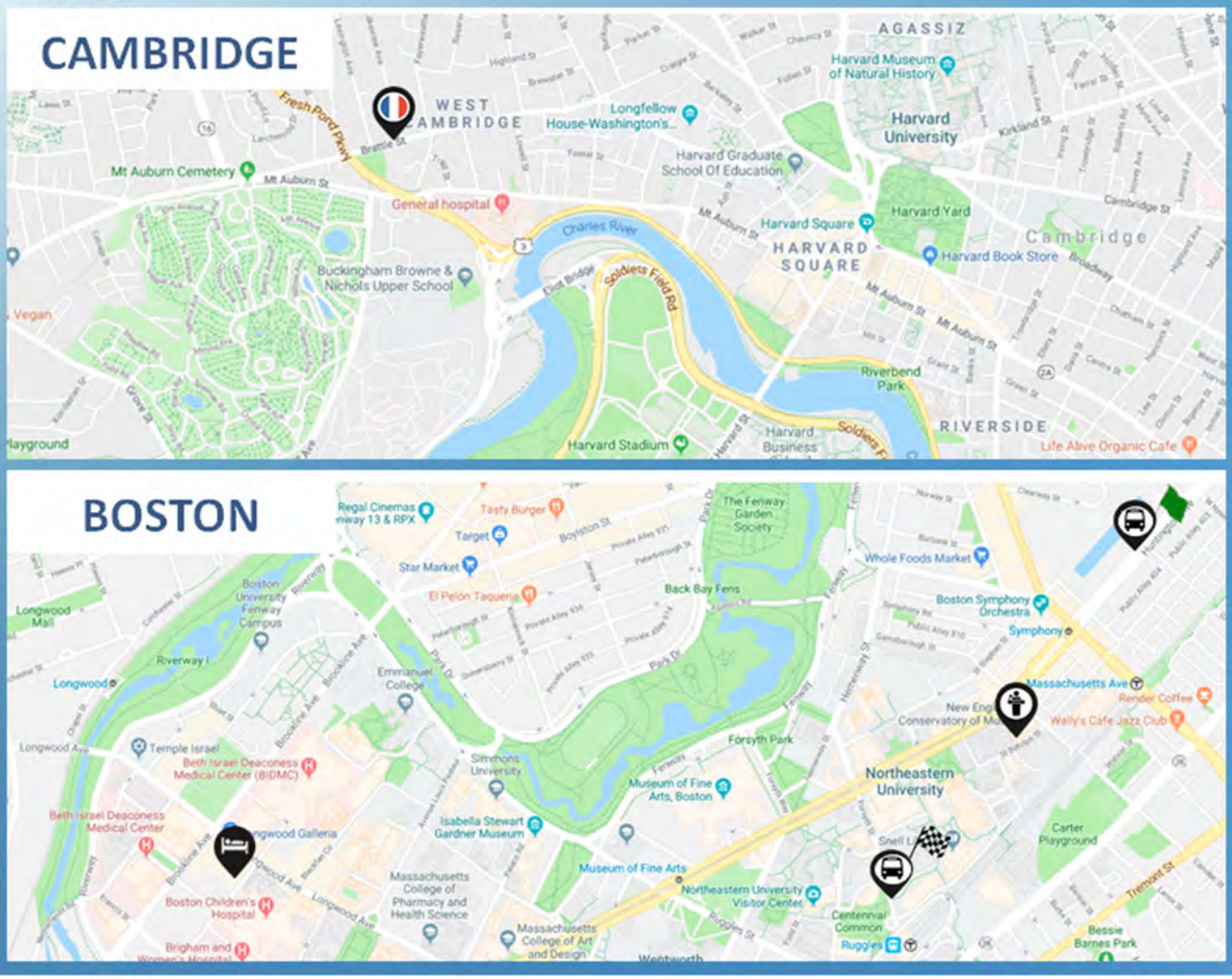
# INFORMATION

2019 | FRENCH AMERICAN INNOVATION DAY BOSTON

## REGISTRATION

Only FAID registrants will be able to take their badges. Badges will be issued on Monday morning and Tuesday morning in the lobby of the conference room.
All persons must carry their badge to enter the conference room during the two days of the FAID.

## LOCATIONS




**CONFERENCE ROOM**
Northeastern University
East Village 17th Floor
281 Saint Botolph Street
Boston, MA 02115

**HOTEL**
The Inn at Longwood
342 Longwood Avenue
Boston, MA 02115

**FRENCH RESIDENCE**
La Residence de France
194 Brattle Street
Cambridge, MA 02138

**SHUTTLE STOP #1**
177 Hutington Ave
Boston, MA 02115

**SHUTTLE STOP #2**
110 Forsyth Street
Boston, MA 02115

## SHUTTLE SCHEDULE

**Monday, March 18th**

From the hotel to the Conference room *(Inn at Longwood guests)*
Departure #1: **6:50 am**
Departure #2 : **7:10 am**

From the Conference room to the French Residence
Departure : **6:00 pm**

From the French Residence to the hotel *(Inn at Longwood guests)*
Departure : **9:30 pm**

**Tuesday, March 19th**

From the hotel to the Conference room *(Inn at Longwood guests)*
Departure #1: **7:20 am**
Departure #2 : **7:40 am**

From the Conference room to Logan Airport *(Speakers Only)*
Departure: **4:30 pm**

## CONTACTS


**Anne Puech**
Scientific Attaché
Office for Science and Technology at the
Consulate General of France in Boston
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**Franck Schoefs**
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University of Nantes, France
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**Jerome Hajjar**
CDM Smith Professor and Department Chair
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FR CNRS 3473

UNIVERSITÉ DE NANTES

Northeastern University

# 2019 | FRENCH AMERICAN INNOVATION DAY BOSTON

NU Guest Wi-Fi
Monday, March 18 – code : **conf338455**
Tuesday, March 19 – code : **conf187936**

MAKE OUR PLANET GREAT AGAIN

WEAMEC
Research, Education & Innovation in Pays de la Loire FOR MARINE ENERGY

Région PAYS DE LA LOIRE

La FRENCH TECH

BUSINESSFRANCE

Nantes Métropole

PÔLE MER BRETAGNE ATLANTIQUE

MASSACHUSETTS CLEAN ENERGY CENTER

France in the United States
Consulate of France in Boston

## APPENDIX 2 – PARTICIPANT LIST

**Participants from the Consulate General of France in Boston**

| Last name | First Name | Organization | Title |
|---|---|---|---|
| Mentre | Arnaud | Consulate General of France in Boston | Consul General |
| Puech | Anne | Consulate General of France in Boston | Attachée for Sciences & Technology |
| Benallal | Nadia | Consulate General of France in Boston | Deputy Attachée for Sciences & Technology |
| Vadillo | Sarah | Consulate General of France in Boston | Deputy Attachée for Sciences & Technology |
| Iredale | Juliet | Consulate General of France in Boston | Communication |
| Vallee | Michael | Consulate General of France in Boston | Chargé de Mission Universitaire |

**Participants from France**

| Last name | First Name | Organization | Title |
|---|---|---|---|
| Aubrun-Sanches | Sandrine | Ecole Centrale de Nantes | Researcher |
| Baclet | Philippe | WEAMEC | Director and CEO |
| Bellorge | Maxime | AKROCEAN | Project sales director |
| Blanchot | Alexandre | BF | Chargé de projet |
| Blandin | Matthieu | NEOPOLIA | VP Marine Renewable |
| Braud | Caroline | Ecole Centrale de Nantes | CNRS Researcher LHEEA (lab)ASAPE, ROTOR OPTIM Soufflerie CSTB/Soufflerie ECN bourrasque |
| Brochard | Emmanuel | Naval Energy | VP Business Development Aqua |
| Castro Casas | Natalia | D-ICE | Control Engineer |
| Chatel | Vincent | RTE | Technical Leader, HV equipment offshorefloating substations |
| Choisnet | Thomas | IDEOL | Chief of Sales and Marketing |
| Clément | Alexandre | University of Nantes | FIRMAIN Idealement |
| Da-Rocha | Luisa | Ecole Centrale de Nantes | EOS (with L. Douteau) |
| De Belizal | Pierrick | INNOSEA | Structural Engineer |
| Decurey | Benjamin | University of Nantes | Ph.D. Candidate |
| Douteau | Louis | Ecole Centrale de Nantes | Ph.D. Candidate |
| Dujon | Matthieu | Le Béon Manufacturing | Offshore & MRE Sales Dept |
| Faguet | Sylvain | D-ICE | Chief Sales Officer |
| Frenot | Yves | SST | Conseiller Scientifique |
| Geshier | Bruno | IDEOL | Chief Sales and Marketing Officer |
| Gilloteaux | Jean-Christophe | Ecole Centrale de Nantes | Researcher Engineer |
| Gueguen-Hallouët | Gaëlle | University Bretagne Ouest | Assistant Professor |
| Guyot | Marc | eolink | CEO |
| Heisel | Pascal | CETEAL | Concept XCF Structural Engineer |
| Mell | Ludovic | University of Nantes | PhD Candidate |
| Merad | Sami | BF | Chargé de projet |
| Mollard | Marie | BF | Chargé de projet |
| Monnier | Matthieu | France Energie Eolienne | Head of Offshore Department |
| Payre | Denis | Nature and People First America LLC | CEO |
| Quartier | Arthur | iBOCS | Business Developer |
| Raud | Stéphane | SST | Attaché for Sciences & Technology - Env |
| Relun | Nicolas | EDF | Research engineer - operations |
| Salou | Arnaud | Chantiers de ;l'Atlantique | Head, Offshore Technical Department |
| Schliffke | Benyamin | Ecole Centrale de Nantes | Ph.D. Candidate |
| Schoefs | Franck | University of Nantes | CEO of IUML |
| Soubra | Abdul-Hamid | University of Nantes | Researcher |
| Tanner | Robert | Nature and People First America LLC | Technical Advisor |
| Teillant | Boris | Atlanpole/Pôle Mer Bretagne Atlantique | Project Developer |
| Thorel | Luc | IFFSTAR Nantes | Centrifugeuse |
| Touzé | Mathilde | University of Nantes | M. Sc. Candidate |
| Vega | Yannine | Pays de la Loire | U.S. Delagate of the Region |
| Vince | Florent | WEAMEC | Montage de Projet |

**Participants from the United States**

| Last name | First Name | Organization | Title |
|---|---|---|---|
| Ahilan | R.V | LOC | Managing Director |
| Ahn | Jaeyoung | University of Massachusetts Amherst | Ph.D. Candidate |
| Allen | Chris | University of Maine | Research Engineer |
| Al-Shuwaykh | Ahmed | University of Massachusetts Amherst | Ph.D. Candidate |
| Alvarez-Uria | Enrique | EDP Renewables | Offshore Wind Director |
| Aoun | Joseph | Northeastern University | President |
| Arwade | Sanjay | University of Massachusetts Amherst | Professor |
| Aubeny | Charles | Texas A&M University | Professor |
| Aubry | Nadine | Northeastern University | Dean, College of Engineering |
| Bates | Alison | University of Massachusetts Amherst | Lecturer and Program Director |
| Bautista Moreno | Miguel | EDP Renewables | Head of Financial Planning |
| Beattie | Kyle | Glosten-Pelastar | Senior Naval Architect |
| Bello | Leopoldo | Vryhof | Managing Director |
| Blagdon | George | Massachusetts Clean Energy Center | Technical Manager |
| Bolgen | Nils | Massachusetts Clean Energy Center | Wind Technology Testing Center |
| Borkland | Jay | Lloyd's Register | Renewables Manager |
| Bossler | Annette | Maine International Consulting LLC | Managing Director |
| Botterud | Audun | Massachusetts Institute of Technology | Research Scientist |
| Bourgeois | Richard | New York State Energy Research and Development Authority (NYSERDA) | Senior Project Manager |
| Caracoglia | Luca | Northeastern University | Associate Professor |
| Carlisle | Bruce | Massachusetts Clean Energy Center | Senior Director Offshore Wind |
| Cash | David | University of Massachusetts Boston | Dean and Associate Professor, John W. McCormack Graduate School of Policy and Global Studies |
| Costello-Mcfeat | Greg | EDP Renewables | Project Manager |
| Courtney | Fara | Partnership for Offshore Wind Energy Research (POWER-US) | Policy / Market Intelligence / Strategic Partnerships in Clean Energy |
| Dagher | Habib | University of Maine | Director of Aqua Ventus |
| Davis | Jacob | University of Massachusetts Amherst | (UG - PhD student starting July 2019) |
| Du | Xinlong | Northeastern University | Ph.D. Candidate |
| Dupont | Bryony | Oregon State University | Assistant Professor |
| Edson | James | Woods Hole Oceanographic Institute | Senior Scientist |
| Geissbuehler | Andy | Renewable Resources International | Managing Partner |
| Goldberg | Gabriel | Northeastern University | M.S. Candidate |
| Hajjar | Jerome | Northeastern University | CDM Smith Professor and Department Chair |
| Hallowell | Spencer | University of Massachusetts Amherst | Post-doctoral Associate |
| Harris | Martha | Northeastern University | Ph.D. Candidate |
| Hines | Eric | Tufts University | Professor of Practice |
| Jafari | Mehdi | Massachusetts Institute of Technology | Ph.D. Candidate |
| Kehne | Jeff | Magellan | CDO and General Counsel |
| Kuchma | Dan | Tufts University | Professor |
| Lackner | Mattew | University of Massachusetts Amherst | Professor |
| Lanard | Jim | Magellan | CEO |
| Langford | Thomas | NGI | xx |
| Le | Viet | Northeastern University | Ph.D. Candidate |
| Leshan | Tim | Northeastern University | Vice President, Government Relations |
| Li | Shaoning | Northeastern University | Ph.D. Candidate |
| Lomonaco | Pedro | Oregon State University | Director, Hinsdale Wave Research Laboratory |
| Luo | Ning | University of Massachusetts Amherst | Post-doctoral Associate |
| Manuel | Lance | University of Texas Austin | Professor |
| Manwell | James | University of Massachusetts Amherst | Professor |
| McTiernan | Kaylie | University of Massachusetts Amherst | Ph.D. Candidate |
| Mirzaie | Fariborz | Northeastern University | Ph.D. Candidate |
| Musial | Walt | National Renewable Energy Laboratory | Manager of Offshore Wind |
| Myers | Andrew | Northeastern University | Associate Professor |
| Nguyen | Nhu (Jessica) | University of Massachusetts Amherst | Ph.D. Candidate |

**Participants from the United States (continued)**

| Last name | First Name | Organization | Title |
|---|---|---|---|
| Nimri | Faris | Swiss Re | Senior Engineering Underwriter |
| Papadopoulos | Jim | Northeastern University | Engineer |
| Park | Semyung | UMass Amherst | Ph.D. Candidate |
| Qiao | Chi | Northeastern University | Research Assistant |
| Ramirez | Marc | Berkshire Hathaway Specialty Insurance | Assistant Vice President |
| Rivard | Luke | The Crosby Group | Sales Manager |
| Roach | Sam | University of Massachusetts Amherst | Ph.D. Candidate |
| Roddier | Dominique | Principle Power, Inc | Leucate Chief Technology Officer |
| Sakti | Apurba | Massachusetts Institute of Technology | Research Scientist |
| Samuelsson | Lars | ABS | Manager |
| Sharman | Krish | University of Massachusetts Amherst | Professor |
| Smith | Chris | Berkshire Hathaway Specialty Insurance | Senior Engineer |
| Stephens | Jennie | Northeastern University | Professor and Director |
| Stilwell | Derek | General Electric | Commercial Leader Offshore Wind |
| Summerfield | Andrew | Northeastern University | Ph.D. Candidate |
| Viselli | Anthony | University of Maine | Manager Offshore Testing and Design |
| Von Vogt | Stephen | Maine Marine Composites | President and CEO |
| Whitman | Joel | Whitman Consulting Group | Principal |


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