Maine EPSCoR FY24-29 NSF EPSCoR RII Track-1
Proposal Development Process Phase I – Research Concept Papers

1) Proposed Research Focus:	**GET-POWERED** **Global Energy Transition Powered by Floating Offshore Wind:** *Nexus of Energy, Environment, Economy and Equity*

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4) Intellectual Merit:

A. ***Need:***

Maine, our nation, and our world's historic transition to a clean energy economy is perhaps one of the most important challenges and opportunities facing society. Maine has set a goal of 100% clean energy generation by 2050. To reach this goal will require electrification of both heating and transportation in the state, along with building nearly 5GW of new renewable energy generation capacity. Floating offshore wind technology is key not only for Maine to reach this goal, but also for the US and the world. Off the US coast, there is enough offshore wind capacity to power the country 4 times over, but nearly 2/3[d] of this energy is in deep waters requiring the use of floating wind turbines.

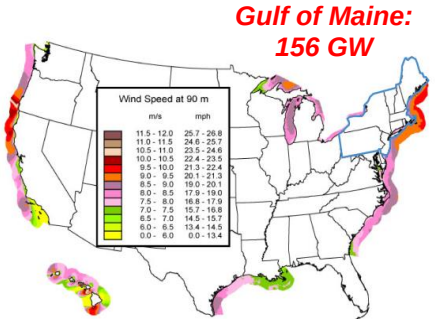

Fig. 1. The Gulf of Maine has the best offshore wind resource on the eastern seaboard, with 156 GW of capacity within 50 miles of shore. The deep waters require the use of innovative floating wind turbine technologies.

The Gulf of Maine (GOM) has 156 GW of offshore wind capacity within 50 miles of shore, one of the best quality offshore wind resources in the world. Over 90% of this resource is in deep waters, requiring the use of innovative Floating Offshore Wind Turbine (FOWT) technologies. Harnessing just 3% of this resource will allow Maine to electrify heating and transportation, attract $20 billion of renewable energy investment, and create over 10,000 jobs.

Over the past 14 years, UMaine has built a leading team in floating wind with 40 researchers, attracted over $100 million of R&D, has been issued over 70 FOWT patents, launched the US first floating turbine model in 2013, and is poised to deploy the first US commercial-scale 11 MW FOWT in 2024. This EPSCoR proposal is designed to cement Maine as a world leader in the floating offshore wind R&D, an industry that is expected to reach $1 trillion value by 2040[1].

Fig. 2. The Aqua Ventus project, an 11MW floating wind turbine 2.5 miles south of Monhegan Island, will serve as one of three living laboratories for this research initiative. This first-of its kind US project led by UMaine is funded through $50 million from the US Dept. of Energy and $100 million from industry investors.

Doing so responsibly, equitably and cost-effectively will require solving intricate scientific, technical and engineering problems around FOWT technology, understanding the impact of FOWT on the unique environmental and ecological systems in the GOM, and addressing social sciences issues. These issues include co-existence with Maine's fisheries and other traditional industries, economy impact, and new paradigms in education and training.

B. ***Research Goal & Objectives:***

The overall research goal is to help bring about a transition to 100% clean energy by 2050. We will do so through the following research objectives: (a) **Maturing the engineering** of floating offshore wind turbine technology (FOWT), (b) understanding and minimizing the related **environmental and ecological impacts**, and (c) addressing **social science** implications and strategies to achieve an **equitable wholesale-change of our energy system**, including impacts on traditional fisheries, the economy, and education and training needs.

C. ***Research Actions:***

The research is organized into four integrated thrust areas as shown in Fig. 3, and would take advantage of a two FOWT research projects planned to be built off the Maine coast in 2024 and 2027, valued at $650 million (Fig. 4):

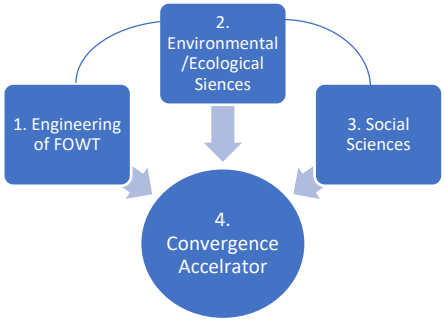

Fig 3. Four Research Thrusts

Thrust 1: Engineering of Optimized Floating Offshore Wind Turbine Systems. This research aims to optimize floating offshore wind turbine systems to minimize life-cycle costs and environmental impacts while enabling local manufacturing, and includes six sub-thrusts: a) FOWT modeling and design; b) Turbines/blades/towers innovations & controls; c) Anchors & mooring systems innovations; d) Manufacturing and scale-up methods; e) Tow-out and installation methods; f) Grid integration including inter-array, dynamic and export cables, and floating substations; g) Operations and Maintenance (O&M) including use of digital twins, Artificial Intelligence (AI), and remote and drone monitoring to reduce costs and injuries.

Thrust 2: Environmental & Ecological Sciences. The research will focus on how marine ecosystems, including fish and wildlife, respond to floating offshore wind turbines. While European research provides a solid base of understanding of how the ecosystem may respond to offshore wind, the studies have been focused on fixed bottom technology and substantial questions remain on how the ecosystem may be affected by floating turbines. In addition, fixed foundations tend to be in shallow waters (<50 m) while floating is proposed for much deeper waters where local ecosystems are different. This Thrust will take advantage of the planned 11 MW Aqua Ventus single-turbine project (2024) and the 150 MW MeRA 10-turbine project (2027) (Fig. 4).

Thrust 3: Social Sciences: In keeping with the integrated socio-environmental systems framework that guides this project, the third research pathway will focus on the Human Dimensions of Floating Offshore Wind Development. This pathway will leverage and grow transdisciplinary sustainability science research and workforce-relevant skills and training programs in the state. This pathway also will build capacity for applications of human dimensions and social-environmental systems knowledge to decision making and business development and acceleration through collaborative research in partnership with the fishing and shipping industries, other seafood-related sectors, port and municipal authorities, and other key stakeholder groups.

Thrust 4: Convergence Accelerator: The objective is to develop multidisciplinary teams from the other Research Thrusts to tackle complex problems. Some of the Convergence Accelerator targets will be exploring the potential for co-location of offshore wind and aquaculture, the creation of an Offshore Wind Research Consortium with representatives from multiple components of the blue economy, the development of technology to monitor and mitigate impacts to wildlife, and the development of turbine array configurations that minimize fishing conflicts.

Fig 4. With a Fall 2024 start, this NSF EPSCoR Project will take advantage of two unique research assets planned to be built off the Maine coast, with a combined value of about $650 million: the 11MW New England Aqua Ventus 1 floating turbine ($150million) and the 150 MW MeRA research array ($500 million. It is a world-class opportunity for Maine to lead in the floating wind research space.

D. ***Priority:***

The research will support the priorities outlined in NSF's 2022 Budget Request and the its three research pillars: *1. Advancing the frontiers of research into the future; 2. Ensuring accessibility and inclusivity; and 3. Securing global leadership in science and technology*, by advancing fundamental and applied research on the frontier of clean energy, enhancing the U.S. role as a global leader in floating offshore wind technology, an emerging technology predicted for exponential global growth by 2030. According to DNV, floating offshore wind is prepared to expand from about 100MW today to more than 10 GW in 2030 and 250 GW in 2050[1]. This research will also support four of the five national priorities from the White House 2021 R&D memo: *tackle climate change, catalyze research and innovation in critical and emerging technologies, innovation for equity, and STEM education*, through innovations in renewable floating offshore wind technologies. Further, this clean energy research will support the White House 2021 R&D priority of *national security and economic resilience* by decreasing U.S. dependence on foreign fuels. The State of Maine has been unequivocal about the benefits to Maine jobs and economic development from investments in offshore wind technology and infrastructure[2].

5) Broader Impacts:

E. ***In-state collaborations****:*

Over the past 14 years, the University of Maine offshore wind team has collaborated with dozens of private and public entities in Maine and will build on this. For example, this proposal engages **four universities** (UMaine, Maine Maritime Academy, Colby College and Northern Maine Community College), five institutes and nonprofits including the Island Institute, the Biodiversity Research Institute, the Maine Center for Coastal Fisheries, The Nature Conservancy and the Maine Mathematics and Science Alliance. Within the Univ. of Maine, the project brings together four academic departments and five research institutes. The State of Maine is also heavily engaged through the Governor's Energy Office, who is leading a road-mapping effort for offshore wind in Maine[3], bringing the DECD, the DMR, IF&W, and the MDOT.

F. ***Regional/national collaborations****:*

The UMaine offshore wind team continues to collaborate with leaders in the offshore wind space, including national labs, leading universities and leading private and public entities nationally and internationally. These include for example the US Dept. of Energy who has funded over $50 million of offshore wind research at UMaine, the National Renewable Energy Laboratory, the Pacific Northwest National Laboratory, Oak Ridge National Labs, Sandia National Labs, and the National Offshore Wind Research and Development Consortium (NOWRDC), the American Bureau of Shipping and the Woods Hole Group. Collaborating universities include MIT, Virginia Tech, University of Rhode Island, UMass-Lowell. International Research collaborations include the UK's ORE Floating Offshore Wind Center of Excellence and the UK's Supergen Offshore Renewable Energy Hub. Industry collaborations include wind turbine OEMs GE, SGRE and Vestas.

G. ***Economic development****:*

In June 2019, Governor Janet Mills signed into law LD994, announcing the establishment of the Maine Offshore Wind Initiative to capture a portion of an offshore wind market estimated to be valued at $1T by 2040. Maine's 10-year Economic Development Strategy identifies offshore wind as a key component to its goal of adding 75,000 jobs to the state's economy by 2030. According to the Workforce Development Institute, these are well-paying jobs requiring technical skills and spanning 74 occupations, including direct jobs in engineering, manufacturing and construction and indirect impacts in downstream and supply chain professions. University of Maine conducted an analysis of the statewide economic impact of a commercial-scale (500MW) floating offshore wind farm in the Gulf of Maine. Such a farm would consist of nearly a $2B investment, would generate 3,077 full- and part-time jobs during construction and 1,602 O&M jobs.

H. ***Workforce Development****:*

A Maine offshore wind workforce development plan is being prepared through the state's Offshore Wind Road Mapping effort[6], which this NSF EPSCoR project will help implement. The draft plan includes the following 3 actions: Action 1: Implement opportunities for K-12 career exploration relating to the offshore wind industry. For example up to 500 middle and high-school students were brought to UMaine for the Windstorm Completion to build and test floating turbines, which will be restarted and expanded under EPSCoR[4]. Action 2: Position Maine's 27 Career and Technical Education (CTE) Centers to generate a talent pipeline by offering OSW career exploration. Action 3: Expand OSW internship, work-based learning, and Pre-Apprenticeship offerings to all secondary students.

I. ***Infrastructure****:*

This project will leverage and enhance significant existing and planned offshore wind research facilities in Maine, Specifically: (1) Establish UMaine's W2 Wind-Wave basin as the First Scale-Model Floating Turbine Wake Testing and Wind Turbulence Facility; (2) Establish both the Monhegan Island offshore wind testing facility and the MeRA Research Array Test Site as living laboratories for floating offshore wind. These two assets are valued at $650 million.

[1] DNV-GL "Floating Wind: The Power to Commercialize. Insights and reasons for confidence"

[2] https://www.maine.gov/governor/mills/news/mills-administration-announces-steps-prepare-offshore-wind-investments-maines-ports-2021-11-23

[3] https://www.maine.gov/energy/initiatives/offshorewind/roadmap

[4] https://composites.umaine.edu/student-opportunities/kleinschmidt-windstorm-challenge/