1. **Title:** Offshore wind farm contributions to a regional environmental and ecological monitoring system to address multi-user needs

2. **Investigator(s) name(s) and institution(s)**

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3. **Motivation/Objective**

The surface ocean over the continental shelf is observed regularly via satellite and shore based remote sensing. However, information on marine life (marine mammals, fish, seabirds, etc.) and subsurface conditions is incredibly sparse. Significant challenges to real time data collection include limited power supplies for marine instruments, lack of communication for data telemetry, and lack of platforms for hosting ocean and marine life monitoring systems (e.g., passive acoustics for marine mammals; camera systems for birds). These observations serve the many shared users of the marine space including the wind developers, commercial and recreational fishing, shipping industry, marine scientists, and associated marine safety, ecological monitoring, assessment, and management needs. To support the responsible implementation of offshore wind energy in the waters off New Jersey's coastline, a long-term environmental and ecological monitoring system within the New Jersey/New York Bight is required to collect the best available data to fulfill the state's mandates to protect and responsibly manage New Jersey's marine and coastal resources.

The 2019 Consortium for Ocean Leadership Industry Forum identified the need for innovative, real-time environmental monitoring solutions as a priority for U.S. offshore wind development[1]). The marine user community depends on oceanographic, meteorological, and ecological observations to support multi-use decision-making, regulation, and policy. To meet this demand for observations, there is a clear need to develop a well-defined, feasible, and built-to-purpose environmental and ecological observing system. An observatory that leverages offshore wind energy development will simultaneously address the environmental and ecological monitoring

[1] https://oceanleadership.org/wp-content/uploads/2020/05/2019_IF_Proceedings.pdf

requirements to assess impacts throughout the lifespan of the wind farm and serve the multiple demands of the broader marine user community. This proposed project will provide the Research and Monitoring Initiative (RMI) team with guidance on local to regional environmental and ecological monitoring. Task 1 will recommend language that describes appropriate environmental and ecological requirements for individual wind energy projects responding to NJBPU offshore renewable energy credit (OREC) solicitations. Task 2 will engage the broad stakeholder community to develop a conceptual plan outlining individual wind farm contributions to a regional environmental and ecological monitoring system that would meet the needs of the offshore wind developers, a diversity of marine user community and stakeholder groups, and inform the mitigation of use conflicts.

This project will directly address and be guided by the New Jersey RMI framework. Laid out principles include: the need to be transparent; balance New Jersey's environmental goals; further the scientific understanding; produce credible, scientifically rigorous data, analysis, and reporting; and be adaptive. This project will establish an adaptable framework for future offshore wind research and monitoring efforts through consultation with key partners who have an interest in conducting rigorous, hypothesis-based, and scientifically defensible monitoring and research with results that are reproducible and statistically robust.

4. Proposed Research

Given the solicitation timeline the research will be conducted in two phases. The first task will be completed in November 2022, prior to the anticipated third solicitation release. The development of a Conceptual Plan for regional monitoring (Task 2) will be completed prior to the end of the project in the summer of 2023. Engagement with key stakeholders will be specific to each task and the level of input required, including but not limited to those identified in the table below.

Task 1 Stakeholder Engagement	**Task 2 Stakeholder Engagement**
• NJBPU • NJDEP • Wind developers (NJ specific) • Turbine Manufacturers • Turbine Foundation Manufacturers • BOEM • NYSERDA	• NJ BPU • NJDEP Environmental Resources Offshore Wind Working Group • Wind developers • BOEM and other federal entities • NYSERDA and other state entities • IOOS • Regional Wildlife Science Collaborative • ROSA • Fishers and other ocean users • eNGOs

Task 1 – Provide recommended language on monitoring requirements/guidance to be included in the third NJ OREC solicitation.

Subtask 1.1: Synthesis of existing needs assessment resources specific to offshore environmental and ecological monitoring

Under this subtask, the investigators will complete a thorough review of existing resources to identify specific environmental and ecological variables most relevant to development of an ocean observing network within offshore wind energy areas designed to inform offshore wind development and serve multiple marine user communities. These variables will inform multiple marine user communities and stakeholder needs including those most pertinent to environmental effects, oceanographic observations (with implications for wind resource assessment and operational forecasting), the ecology of marine species, and the understanding of impacts across the entire lifespan (20+ years) of an offshore wind farm. The available sources include the scientific literature, workshop reports, Integrated Ocean Observing System (IOOS) focus areas, and existing guidance from programs underway related to environmental monitoring for offshore wind development from the United States and around the world. This task will consider ecological and environmental monitoring over a broad range of focus areas including ocean surface and subsurface physics, ocean-atmospheric boundary layer, seabed, food webs, various wildlife species (e.g., birds, bats, marine mammals, fishes, and sea turtles), and benthic habitat. In addition, we will review existing federal and state solicitation guidance to identify any language specific to environmental and ecological monitoring systems. Specific sources included in the work proposed under this subtask include:

- Partners in Science Workshop Reports
- Synthesis of the Science Workshop Reports
- State of the Science Workshop Reports
- Crown Estate
- DOE-funded SEER educational research briefs
- MARACOOS Focus Areas
- ROSA Research Priorities
- RODA Research Priorities 2022
- BSEE Ocean Current Monitoring NTL - oil and gas monitoring analogues
- NYSERDA Solicitations
- Relevant BOEM Reports

Subtask 1.2: Consultation with RMI steering team, wind developer community, and turbine manufacturers

Consultation with the RMI steering team, wind developer community, and turbine manufacturers will ensure that the guidance included in the solicitation is feasible and addresses the needs of the multi-use marine user community and the research priorities set by RMI, while recognizing the regionalized nature of both the needs and impacts. Project investigators will coordinate with RMI representatives and use our existing and established partnerships to target our engagement. Through this approach, we will seek RMI input to ensure the solicitation language that will be practicable, achievable, and best support multi-use decision-making, including environmental monitoring and oceanographic observing that will contribute to ongoing efforts to persistently monitor the ocean ecosystem in support of baseline and environmental impacts studies

(Partners in Science Report, 2021). One on one consultation with the wind developers will draw on their technical expertise to assist in defining feasible deployment and maintenance strategies. They will contribute specific information that will allow us to provide guidance for a monitoring requirement that is comprehensive, integrated with existing monitoring and observing activities, utilizes the latest proven ocean and ecological sampling technologies, anticipated to the extent possible technology development, and can be safely deployed and readily maintained to deliver high quality data that will be available to the multiple marine user communities.

Given the short timeline, we will target this consultation with the RMI Steering team and the following core representatives from the wind developer community:

- Ørsted Ocean Wind
- Equinor
- Atlantic Shores
- Companies who recently secured leases for the additional WEAs off the NJ coast
- Turbine Manufacturers
- Turbine Foundation Manufacturers

These institutions have the expertise required to represent the wind developer and manufacturer perspective in the review of our draft solicitation language. The final submission to NJBPU will include the recommended solicitation language and, where possible, estimated costs for implementation of guidance to entities responding to the solicitation.

Task 1 Deliverables:

1. Draft solicitation language
2. Final solicitation language recommendation submitted to BPU in November 2022

Task 2 – Develop a Conceptual Plan for individual wind energy area contribution to a Regionally-Based Environmental and Ecological Monitoring System

The outcome of Task 1 will provide a foundation for the development of a conceptual plan for an environmental and ecological monitoring and observing system to be deployed within and around offshore wind farms. This network design will be consistent with the requirements included in the guidance output of task 1. It will serve the needs of the offshore wind developers deploying the wind farms, monitor environmental and ecological conditions during the planning, deployment and operation, and serve the needs of other marine users utilizing the same ocean spaces.

Subtask 2.1 Develop Engagement and Facilitation Strategies

A core facilitation team (CFT) will convene, advise, and manage the engagement with the offshore wind stakeholders. The CFT will be responsible for the selection of the specific stakeholders who represent the relevant community expertise from the technologies, data science, and end-user needs. The CFT will include the following principals who have diverse and extensive experience in regional ocean management, research science, and stakeholder engagement:

1) Dr. Tom Herrington (Monmouth) is the Associate Director of the Urban Coast Institute (UCI) and serves as the NJ Sea Grant Consortium Coastal Community Resilience Specialist. As an extension specialist, he works with coastal community members on the co-production of actionable science for informed decision making to advance coastal community resilience. Dr. Herrington is a former pro bono scientist for the AGU Thriving Earth Exchange for the promotion of the co-production of community knowledge. UCI Director, Tony MacDonald will work with Dr.

Herrington serving as a liaison on the CFT with a focus on the engagement of relevant regional governing bodies and regulatory agencies.

2) Dr. Doug Zemeckis serves as the Marine Extension Agent for Rutgers Cooperative Extension and focuses on educational programming and applied research on fisheries, aquaculture, and coastal resource management. His expertise in stakeholder engagement and diverse professional network will help to build and implement the innovative engagement structure. Dr. Zemeckis and Dr. Kohut (Project lead) will serve as members of the CFT focusing on the engagement of Mid Atlantic commercial and recreational fishing communities.

3) Dr. Rebecca Green (NREL) will serve as a member of the CFT. Working with the other CFT team members, she will oversee the engagement with key partners including from the wind industry, fishing industry and other ocean users, federal and state agencies, eNGOs, and businesses, all of whom have an interest in effective monitoring of the oceans. She will help ensure that engagement is informed by existing offshore wind related monitoring efforts, including based on her DOE-funded work for the "U.S. Offshore Wind Environmental Effects Research (SEER)" project. Rebecca has worked in the marine sciences for over 25 years, developing and overseeing a range of environmental and wildlife monitoring programs (including for BOEM's Environmental Studies Program) that will help to inform this project.

4) Mike Crowley is the technical director of both the Rutgers University Center for Ocean Observing Leadership and the Mid Atlantic Regional Association Coastal Ocean Observing System (MARACOOS), a regional component of the Integrated Ocean Observing System (IOOS). In these roles Mike connects a broad range of stakeholder communities to the technical and scientific community conducting ocean observing activity in this region. His connections within RMI partner agencies, the ocean observing community, regional stakeholder communities, and developers with NJ-based interests will serve to complement and assist Dr. Green and Dr. Herrington with their engagement efforts within New Jersey. Mike will also serve to coordinate virtual and in-person meetings of the CFT and stakeholders as needed.

5) Kris Ohleth is the Director of the Special Initiative on Offshore Wind (SIOW) and has been working in the offshore wind space in the US for nearly 20 years. With a strong network of contacts across ocean community sectors, she will help connect the team to the appropriate stakeholders to get meaningful direction to and inputs for the project. In addition, the majority of her offshore wind work has been centered around New Jersey and the Mid-Atlantic region; that geographic focus will also help support the work for this project.

6) Dr. Cris Hein (NREL) is the Environmental Science Lead at NREL and an expert in bat ecology with broad expertise across wind energy-wildlife considerations. He brings a history of work in avian and bat monitoring, including understanding of monitoring and minimization technologies at wind energy facilities. He will ensure that bird and bat perspectives are appropriately addressed and corresponding stakeholders are at the table.

Task 2.2 - Community Engagement

Engagement with the relevant stakeholders will ensure that the conceptual design is feasible and meets the needs of the multi-use marine user community. We will seek expert input from the state, federal, developer, and end-user communities. We will organize this engagement to determine the priority objectives for an ecological and environmental monitoring framework most relevant to wind energy development areas off New Jersey and the Mid-Atlantic Bight and include consideration of connectivity between regions to the north and south. We will use our existing and established partnerships to engage the end-user community to identify the high-

priority variables and deployment strategies that will best support multi-use decision-making, including environmental monitoring and oceanographic observing that will contribute to ongoing efforts to persistently monitor the ocean ecosystem in support of baseline and environmental impacts studies. This will be accomplished through early and regular engagement of stakeholders and active involvement of experts from the stakeholder, scientific, and technical communities who will collectively contribute their knowledge of the fundamental and relevant science, technology, and the specific technical, management, and monitoring requirements. The exact mechanisms used for this effort will be dependent on state and individual institutional policies governing the response to the COVID pandemic. We are optimistic that these interactions will be face to face through specific focus groups, but recognize that we may need to shift to virtual one-on-one interactions.

The engagement effort will target several primary communities of experts: the wind developer community, the ocean observing community, representatives of relevant regional research and science groups (e.g. Regional Offshore Science Alliance (ROSA), Regional Wildlife Science Collaborative (RWSC)), and the broader community of marine users including fisheries, environmental managers, and other maritime activities. Engagement with the wind developers will focus on their monitoring needs and will draw on their technical expertise to inform definition of feasible deployment and maintenance strategies. The ocean observing and marine life (wildlife) communities will provide important input to ensure that the most accurate and robust sensing technologies are included in the conceptual plan and that data protocols and accessibility are consistent with the current best practices. The marine user community beyond the wind developers and ocean observing communities will provide requirements for data sampling to serve their specific needs. These uses will initially focus on commercial and recreational fishing, marine safety, and environmental and ecological monitoring. Each of these communities will contribute specific information that will allow us to collectively develop a comprehensive, integrated monitoring and observing plan that utilizes the latest proven ocean and ecological sampling technologies that can be safely deployed and readily maintained to deliver high quality data to the multiple marine user communities.

Subtask 2.3: Develop Conceptual Plan for an Environmental and Ecological Monitoring System in Offshore Wind Energy Areas

The outcome of this subtask will be a conceptual plan for instrumentation and infrastructure that can be integrated onto and/or near offshore wind facilities, including recommended sensor spacing, data interoperability and sharing, and maintenance requirements. Fixed and mobile autonomous technology solutions will be identified based on their ability to measure high-priority variables in an accurate and cost-effective manner, and allow for easy access to data through an integrated network. Where possible estimated costs for implementation of various components of the plan will also be included. The conceptual plan will include:

1) Statement of observing network objectives.
2) Description of the observing system components including the recommended variables and commercially available sensors.
3) Description of the recommended deployment methodology including technically feasible installation, sampling strategy in time and space, and maintenance procedures.
4) A description of the recommended data quality and management standards to ensure that intended end users have the access to the quality controlled data provided by the observing system.

It is envisioned that oceanographic and environmental data will be shared through existing regional ocean observing infrastructure through the Integrated Ocean Observing System (IOOS) and ecological data coordinated with other data providers including Mid-Atlantic Acoustic Telemetry Observation System (MATOS) and the Mid-Atlantic Regional Council on the Ocean (MARCO) Mid-Atlantic Ocean Data Portal to ensure it leverages and contributes to existing and future products supporting other ocean-based activities, including regional ocean planning and management extreme weather prediction, water quality monitoring, and commercial and recreational fishing. We will ensure that the conceptual plan is consistent with guidance reported by federal and state agencies including BOEM and NJBPU.

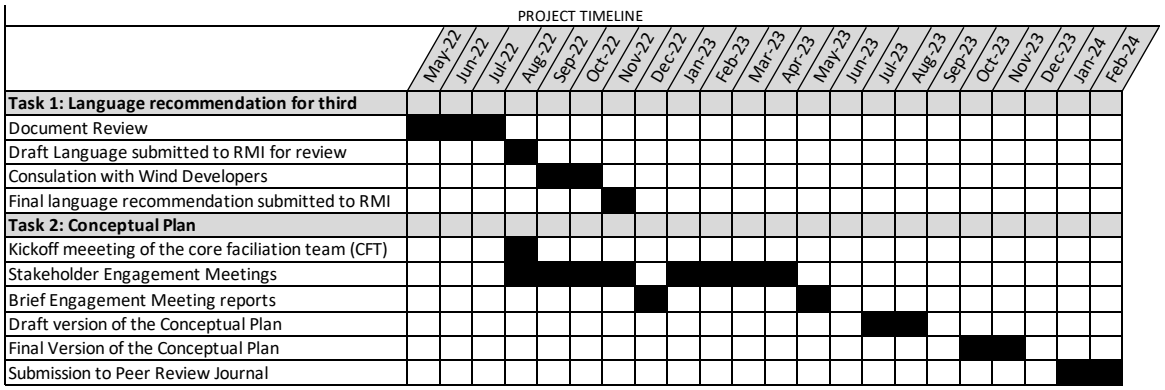
Subtask 2.4: Submit Conceptual Plan to peer reviewed literature.

Once the conceptual plan is finalized, we will incorporate appropriate content for submission in the peer-reviewed literature. It is expected we will submit the manuscript within three months of the submission of our final conceptual plan. The RMI steering team will be consulted to help identify the most appropriate journal to maximize impact across the most relevant communities.

Task 2 Deliverables:

1. Stakeholder engagement meetings
2. Draft conceptual plan
3. Final conceptual plan
4. Peer reviewed journal article submitted

Project Task Timeline



5. Total Project Budget $282,289

6. Resources: Applicant(s) must demonstrate possession of or access to sufficient resources to successfully complete the proposed work.

Rutgers, The State University of New Jersey is a leading national research university and the state of New Jersey's preeminent, comprehensive public institution of higher education. Rutgers Center for Ocean Observing Leadership (RUCOOL) and Rutgers Cooperative Extension collectively focus on the interactions between met-ocean physics and marine ecology in the world's ocean and the connections with human society. As the operational lead institution within MARACOOS, Rutgers has pioneered the application of ocean and atmosphere observing technologies to the service of a wide range of applied users by translating these datastreams to inform applications, decision-making, and management of marine resources.

National Renewable Energy Laboratory (NREL), founded in 1977 in Golden, Colorado, has 2,200 employees, including postdoctoral researchers, interns, visiting professionals, and subcontractors. Martin Keller serves as NREL's laboratory director and president of the Alliance for Sustainable Energy, LLC. The Mechanical and Thermal Engineering Sciences directorate is managed by Associate Laboratory Director Johney Green. Johney oversees multiple centers, including the National Wind Technology Center at NREL's Flatirons Campus in Boulder, Colorado, managed by Center Director Daniel Laird. The National Wind Technology Center is part of the Flatirons Campus, which is the nation's premier wind energy, water power, and grid integration research facility.

Urban Coast Institute, Monmouth University, established in 2005, serves Monmouth University and the public as a forum for research, education, and collaboration in the development and implementation of science-based policies and programs that support stewardship of healthy, productive, and resilient coastal ecosystems and communities. The UCI conducts fundamental and applied research and serves the Mid-Atlantic Ocean Data Portal for informed ocean planning, law and policy. Through its efforts, the UCI seeks to foster collaboration among citizens, watershed and community organizations, governmental agencies, business, the scientific community, and other parties interested in coastal and watershed management, conservation, and restoration.

Special Initiative on Offshore Wind (SIOW), The Special Initiative on Offshore Wind is an independent project at the University of Delaware's College of Earth, Ocean and Environment that supports the advancement of offshore wind as part of a comprehensive solution to the most pressing energy problems facing the United States. The Special Initiative on Offshore Wind provides expertise, analysis, information sharing, and strategic partnership with industry, advocacy and government stakeholders to build understanding and drive the deployment of offshore wind.