

The MOCEAN (Mission is the OCEAN) Initiative

MOCEAN is an informal group/collaborative that aims to support the responsible management of our oceans and a just energy transition through multipurpose farms and other enhancements to the marine environment.

What we do

- Run workshops; three online workshops have been conducted that have involved more than 200 unique participants; see the Workshop Tabs on the MOCEAN homepage for recordings
- Respond to requests for information and requests for proposals
- Run sessions and deliver talks at conferences, workshops, and industry events
- Encourage the investments needed to guide and drive responsible development
- Keep each other informed of opportunities, and actively build collaborations

How to participate

Share your email with us, and we will keep you informed of activities, opportunities, and MOCEAN-related events. We are always interested in learning from others and engaging in new discussions, so please also reach out to us if you wish to schedule a time for a zoom. Please email dan.kuchma@tufts.edu to be added to the email list or to schedule a call.

Recognitions, Assertions, and Beliefs

The following are views that appear to be shared by most of those who have participated in discussions associated with the MOCEAN Initiative:

- The marine ecosystem and fisheries communities are already under stress due to a loss of coral reefs, biodiversity, and habitats that are result of the changing climate and ocean management
- The creation of artificial reefs, seaweed and kelp farms, and other ocean enhancement activities have shown significant promise, but there is much to learn to do this effectively and reliably
- The underwater infrastructure that supports wind turbines can and should be designed as “Turbine Reefs” that provide long-term habitats for marine life and effectively serve society
- The offshore wind energy (OWE) resource is enormous and the cost of electricity from OWE is now affordable; responsible development practices are key to the acceptability of OWE
- The scale of the ocean’s potential contribution to the nation’s energy transition is enormous, and this could provide a multi-trillion-dollar opportunity to support disadvantaged communities
- The U.S. industry is presently unprepared to lead the development of its own OWE resource because of a lack of experience, personnel, ports, fabrication yards, and other resources
- Significant public-private partnerships will be needed to create the physical and human infrastructure that is needed to create multipurpose offshore farms
- To develop multipurpose farms that provide benefits to all key stakeholders, we must be willing to take some risks and maximize the learning through trails and public data collections
- The challenges to ocean management are complex, and a multidisciplinary approach is needed
- MOCEAN aims to support the research, work, regulation, construction, innovation, development, monitoring, modeling, financing, insuring, and other activities that are essential for the construction and operation of responsible, just, and reliable offshore farms.

The description that follows provides a more detailed description of needs and solutions.

The MOCEAN (Mission is the OCEAN) Initiative
(an extended description of how to create multipurpose farms and support a just energy transition)

MISSION STATEMENT

We are at the cusp of the large-scale development of the offshore wind energy (OWE) resource along our eastern seaboard. This brings great challenges and opportunities for the shared-use of our coastal waters. The MOCEAN Initiative is focused on advancing marine and material science, engineering practice, economic models, bluetech, policy, and data-driven frameworks that will ensure healthy oceans, a strong and diverse new blue economy, and a just energy transition.

INTRODUCTION AND INITIAL CONDITIONS

The transition to a low carbon energy economy is essential to mitigate climate change, and Offshore Wind Energy (OWE) farms can greatly contribute to this transition. The construction and operation of OWE farms also provides the opportunity to enhance marine ecosystems, grow the blue economy, and create communities around ecojustice.

The following facts provide the basis and motivation for the MOCEAN Initiative

OWE Resource and Nucleus: The OWE resource in the United States (U.S.) is enormous (>10,000 GW), and it could provide many times the electricity needs of a heavily-electrified nation. OWE is particularly well-suited for serving the needs of the 40% of the population living in coastal regions. The starting point for this industry is from the Mid to North Atlantic coastal region where about 95% of the development over the next 7-10 years is expected.

Impact of OWE on CO2 Savings and Equity: Each 100 GW of OWE would provide about 10% of the nation's current electricity demand of 4000 TWh/year (or 4% of the nation's 2050 demand after the electricity-transition). This would also reduce our CO2 emissions by 2.1% from current levels. If OWE can be developed responsibly, then perhaps 1000 GW or more could be installed by 2050. The associated cost for the development and operation of this would be approximately \$5 trillion dollars and this presents an enormous opportunity and responsibility to enhance the marine ecosystem, grow the blue economy, and accelerate ecojustice.

Cost of Offshore Wind: The cost of generating electricity from Offshore Wind farms has fallen to about \$0.07/kWh as of 2023 and further cost reductions are expected. Thus, cost is no longer a significant barrier to OWE providing a large contribution to the energy transition.

Challenges to the Ultra-Large-Scale Development of OWE Farms: Two of the key challenges are: (i) complexity and scale of infrastructure development, as well as workforce development; and (ii) ensuring positive impacts of OWE on marine habitats and coastal economies, especially endangered species and fisheries. While there are many examples of where marine structures have had a positive effect on marine ecosystems, advancements in fundamental science, technologies, design tools, infrastructure development plans, education and training, and industry practices are needed to effectively benefit marine habitats, fisheries, and coastal regions.

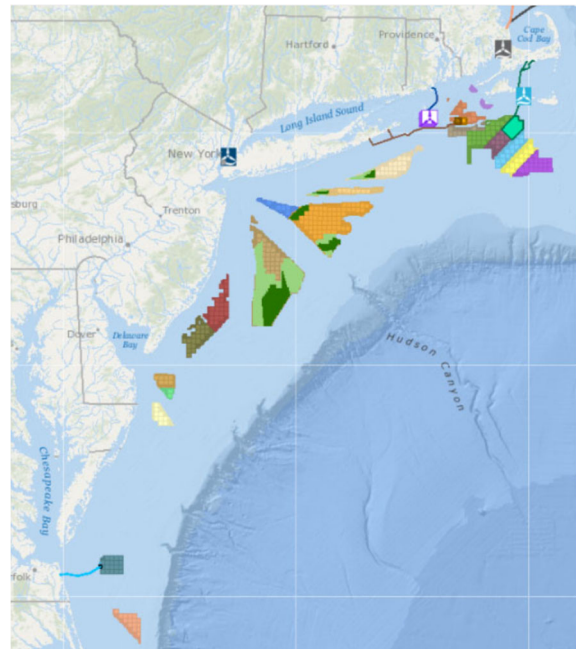
U.S. Industry Far Behind Europe and China: As of the summer of 2023, the U.S. has only seven turbines in the water compared to more than 10000 turbines worldwide. Nearly all of 30 GW of planned U.S. projects in the OWE pipeline are being developed by European companies, and most of the components and services are also being provided by European companies; this is most appropriate because Europe

has the experience, expertise, industry, and personnel to deliver well designed and constructed wind farms and the U.S. is still in a nascent phase. Over the past few years, China has grown from having very few offshore wind turbines in the water to having more capacity than the rest of the world combined. Significant investment will be needed for the U.S. to take responsibility for the development of its own offshore wind resource, and to compete globally. Public-private partnerships will be needed to develop new educational and training programs, ports, keyside yards, fabrication facilities, vessels, points of interconnect, as well as effective policies and commitments. MOCEAN’s focus is on those items pertinent to the underwater infrastructure of multi-purpose farms.

U.S. Behind Technically: The European Commission (EC) and European nations have invested billions of Euros in use-inspired research around offshore wind energy. Their flagship €175 Billion Europe Horizons program (2013-2027) has the mission of securing “Europe’s global competitiveness”. One of the five themes of the EU Horizon program is “Healthy oceans, seas, coastal & inland waters”, and two of the other themes are focused on climate change. A similar scale of investment is needed in the U.S. for the nation to be at the technical forefront of development.

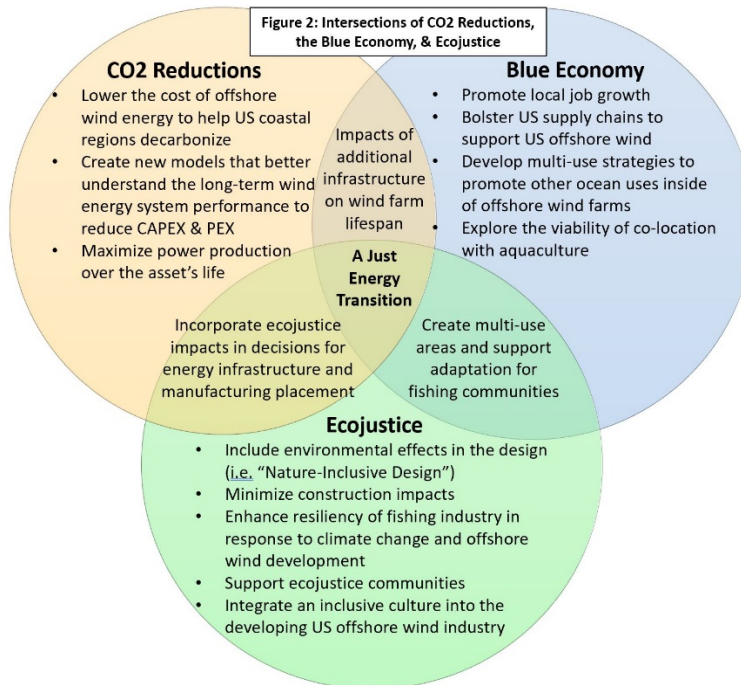
LOCATION OF U.S. OFFSHORE WIND FARM DEVELOPMENT THROUGH 2030

The U.S. offshore wind energy development over the next 7-10 years will be concentrated in the mid-to-north Atlantic region, as shown in the figure on the right. The development is expected to be approximately 30 GW which could be provided by 2000 15-MW Wind Turbines; 15-MW turbines is close to the largest available offshore wind turbines and where the blades extend out about 120 meters from the hub. This region is challenging for the large-scale development of offshore wind because the primary use of the coastline and coastal waters is for recreation, fishing, and aquaculture.



PURPOSE AND VISION OF MOCEAN

MOCEAN aims to support the creation a system-level transdisciplinary framework to advance a new paradigm in OWE development and operations; “aims to support” includes hosting webinars and workshops, participating in conferences and meetings run by other organizations, responding to requests for information and requests for proposals, the dissemination of information through m-ocean.org and other means, learning from previous and ongoing projects in the U.S. and globally, and engaging stakeholders, regulators, funding agencies, and other entities. Essential elements (use-inspired challenges) of the framework that MOCEAN anticipates in needed to develop and operate nature-inclusive multi-purpose farms are: (i) Nature-Inclusive Design; (ii) Fisheries and Mariculture Enhancement; (iii) Design-Life Optimization; (iv) Fully-Probabilistic Models; (v) Ecojustice; (vi) Economic Models and Policy; and (vii) Data Driven Framework. The figure which follows presents some key elements and their interactions, and this is followed by a description of the 7 items above.



(i) Nature-Inclusive Design (NID): A key focus of MOCEAN is to enable and drive the NID of OWE Infrastructure. This includes foundations for wind turbines, scour protection, cable protection systems, coastal ports, and fabrication yards, as well as testing laboratories and research groups that support these activities. NID is when the environmental impact of the wind energy system is considered in all aspects of design including fabrication, delivery, installation, operation, and decommissioning. MOCEAN aims to advance environmental models to enable "Nature-Inclusive Design" that are informed by field observations as well as studies that examine the influence of geometry and material properties of structures (hardened substrates) that are used in OWE on what marine organisms are recruited and what new ecosystems develop. The figure which follows illustrates some of the possibilities.

Turbine Reefs
Nature Based Design of Offshore Wind Infrastructure

Nature-based Design includes options that can be integrated in or added to the design of offshore wind infrastructure to create, expand, enhance, or restore habitat for native species or communities.

Enhanced Scour Protection Layers

A combination of large and small structures with various sized holes and/or rocks with a range of shapes and sizes increases the surface area and habitat complexity of scour protection layers. This promotes biodiversity by providing adequate shelter for large, mobile species and suitable refuge for smaller species, juvenile life stages, and attached organisms.

Mimicking Existing Complex Habitat

Habitats created by installation of offshore wind infrastructure can be optimized by mimicking naturally occurring complex habitat features.

Materials Designed to Promote Growth

Calcium carbonate (CaCO₃) or natural shell can be mixed into concrete structures to provide suitable chemical composition for larval settlement of calcareous organisms such as bivalves.

Figure 3: Example of Nature Inclusive Design
(Courtesy of work from INSPIRE Environmental and The Nature Conservancy)

Scour Protection

INSPIRE ENVIRONMENTAL & The Nature Conservancy

(ii) Fisheries and Mariculture Enhancement: The development of OWE farms will require adjustments from both OWE developers and fishing communities to make responsible use of the many resources within offshore wind farms. These adjustments are a significant concern for many. With federal and state energy policies now clearly committed to significant development of OWE, it is time to create a long-term and sustainable framework for the coexistence of fisheries with offshore wind infrastructure via mutual adaptation. MOCEAN aim to support extensive collaborations from key stakeholders and the conduct of the research needed to support cross-cutting innovation - in wind farm design, component engineering, fishing technologies, biodiversity enhancement, and maritime economics – to ensure a robust new generation of resilient fishing and mariculture industry opportunities.

(iii) Design-Life Optimization: Up until now, the design-life of foundations has been about 25 years; this is a legacy from the length of oil & gas leases. Offshore wind structures should be designed as enduring infrastructure, such as we do for hydroelectric dams. MOCEAN aims to support the conduct cost-benefit analyses to extend the design-life for each component of an OWE farm through design, material selection, and corrosion control technologies.

(vi) Fully-Probabilistic Model: The current design and operational paradigm is quite prescriptive (e.g., specified thickness of a particular coating to protect against corrosion for 10 years), as opposed to being founded on physics-based models and materials models that considers the uncertainty of design assumptions and the accuracy of underlying models. MOCEAN aims to support the development of a fully-probabilistic model of the entire OWE system that would quantify uncertainty and make Performance-Based Design (PBD) and operation possible. With PBD, the developer can optimize the design and operation for different levels of robustness, design life, and maintenance strategies. Having a fully probabilistic model would include economic considerations that give value to design decisions such as to the type of support structure and materials used on the OWE workforce, marine habitats, and other communities that may use the oceans for their livelihoods and recreation. This greater understanding would be translated into lower energy costs for OWE.

(v) Ecojustice: The expected \$1-6 trillion investment in developing and operating OWE farms provides an enormous opportunity and responsibility to accelerate ecojustice in regions near the OWE leases and along supply chain routes. MOCEAN aims to support workforce education, training, and investments that address broad Diversity, Equity, Inclusion, Access, and Justice (DEIAJ) goals. Many members of MOCEAN have recently established units and hired leaders in area of DEIAJ to help establish programs specific to underrepresented and disadvantaged groups to address long and system-hardened injustices, and to avoid new injustices such as the displacement of persons near the location of new ports and manufacturing centers that have often tended to be low-income Black and Brown communities. For example, in Massachusetts significant work has been done to identify and support environmental justice communities in places like New Bedford where a major offshore wind port is located. Leaders in the industry have also started key initiatives to address these issues. MOCEAN will aim to support leveraging existing programs and establishing new programs that bring substantive and measurable change. This will include establishing early recruitment and outreach strategies in K-12 education, extensive advertising of education and professional opportunities, creating supportive on-campus and other communities, apprenticeship programs, summer internships, lecture series, special events, and professional-development mentorship by faculty and industry leaders who are well qualified to inspire the next generation of OWE leaders.

(vi) Economic Model and Policy: States make the decisions for awarding OWE projects. Current decisions are primarily based on the “Levelized Cost of Energy” (LCoE). This is the contract purchase

price of electricity and includes the cost of site characterization, planning, design, field preparation, fabrication, installation, operation, and decommissioning. While some States and the White House stress the importance of local employment, buying U.S. products, technology transfer, and other regional benefits, these benefits are tougher to quantify and are given much less consideration than the LCoE when selecting contracts. MOCEAN aims to support the development and use of Economic Models that can quantify the full costs and benefits of OWE and calculate the Societal Cost of Energy (SCoE). The SCoE, can guide State and Federal policies and better evaluate tradeoffs.

(vii) Data Driven Framework: An enormous challenge to advancing the design, development, and operation of OWE farms has been the lack of data needed to advance general understanding, improve models, and guide use-inspired innovation. In part, this is because developers and equipment manufacturers have the resources to solve their own problems and advance innovation internally. Since the interests of the private sector do not consider all public interests (e.g. effects on marine habitats; advancement of basic science, models, regulations, and practices; value of OWE farms after the lease is over), then the data is not collected or shared to broadly advance basic science and engineering practices. MOCEAN aims to support the collection and generation of the data needed to advance models about important elements such as components lifespan, metocean data, seabed properties, environmental monitoring, local available workforce, climate data, fish populations, economic data about community benefits, and power generation from turbines.

Regional Importance and Impact

The main location of MOCEAN's focus is defined by the coastal region that is adjacent to the wind energy lease areas with inland corridors to the current and future industries and workforce. MOCEAN aims to support innovation, education, training, and other initiatives are most needed with an emphasis on disadvantaged communities and groups. A very small numbers of examples in offshore wind energy include: improved coatings and cathodic protection design to prevent corrosion; eco-friendly concrete; habitat monitoring products including eDNA; improved kelp strains; geophysical sounding technologies to identify boulders; micro-piling to improve soil stiffness; noise mitigation methods other than bubble curtains; local energy storage technologies; structural dampening technologies; repair technologies; crew transfer methods; fatigue crack growth monitoring tools; data-structuring and sharing tools.

The White House, the Secretary for the Dept. of Energy, and the Director for the Bureau of Ocean and Energy Management (BOEM) have all made public statements about how offshore wind energy can provide new high-wage employment opportunities. On June 23, 2022, the President and the Governors from 11 States shown in the first figure of this document committed to working together to drive innovation, job creation, and energy equity. MOCEAN aims to support the realization of these ambitions to as large of a scale of OWE development as can be done responsibly. 1000 GW of OWE development in the U.S. would lead to 2-4 million employed in this new field by 2050, and this presents an enormous education and training challenge where even the curriculum is nascent. MOCEAN aims to support the education and training (directly and through partnerships) the future generation of U.S. researchers, technicians, educators, trainers, innovators, modelers, big-data analysts, economists, inspectors, commercial fishers, big-data analysts, laborers, installers, manufactures, UAV specialists, other technology developers, and many others, within an environment in which recruitment, retention, advancement to achieve DEIAJ objectives is central to MOCEAN's mission.