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RFI Entangled Debris Monitoring for Floating Offshore Wind Infrastructure

Additional submitted attachment is included below.

RFI Response to California Energy Commission: Entangled Debris Monitoring for Floating

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Revision History			
Rev	**Date**	**Purpose**	**Updates**
00	9/6/2024	Submission to the California Coastal Commission	

1 Introduction

Golden State Wind ('GSW') is a 50-50 joint venture Offshore Wind Project owned by Ocean Winds North America LLC (the 'Company' or 'OW'), and Reventus Power. OW is a global offshore wind developer committed to the principles of sustainability and the goals of the Paris Climate Agreement to realize a net-zero carbon future. OW itself is the result of a 50-50 joint venture between EDPR and ENGIE, with a portfolio of offshore wind projects in 8 national energy markets including the United States.

GSW was successful in the December 2022 Bureau of Ocean Management (BOEM) California Offshore Wind (PACW-1) Lease Auction, winning the Morro Bay lease area OCS-P 0564 (LA). The successful development of the LA and associated export cable routes (ECR) will require a safe, streamlined, and creative approach that generates high quality data to support feasibility assessments, permitting requirements, and engineering design.

We appreciate the opportunity to participate in this RFI and look forward to continued discussions on these and other topics related to the emerging floating offshore wind industry in the United States.

2 Objective

The objective of this document is to respond to the Request for Information (RFI) proposed by the California Energy Commission (CEC) regarding Entangled Debris Monitoring for Floating Offshore Wind Infrastructure. It is important to note that the operations and maintenance (O&M) strategy for GSW is still being developed. Therefore specifics regarding activities, equipment, vessels, personnel, and associated cost and schedule implications cannot be defined at this time.

3 Questions/Answers

1. **What technologies, equipment, and types of inspection could detect entanglement on FOSW infrastructure? What research is needed to advance these technologies? Please provide details on sensor accuracy, potential cost of the technology, and any additional hazards or conditions that can be detected/monitored.**

Traditionally, inspections are carried out using remotely operated vehicles (ROVs) to examine potential entanglement on mooring lines, anchors, cables, and other structures, whether floating or fixed on the seabed. However, this method is not particularly cost-efficient due to the significant time and expense required to complete all the inspections necessary. Additionally, optimal seawater conditions are necessary to ensure clear imagery during underwater ROV operations. As a result, adopting new techniques that can detect abnormal conditions related to entanglement in real time would be valuable for early identification in mooring lines or floating cables.

Therefore, research must focus on developing sensors calibrated to normal operational conditions that can identify abnormal conditions, such as changes in loading and movement, that could result from entanglement. Integrating these sensors into a digital twin model of an entire wind farm would allow for "real-time monitoring" and reporting. Research should prioritize development of prototypes to assess how these sensor-based systems detect and respond to abnormal conditions.

2. **What types of structural integrity or environmental monitoring technologies would be practical and cost effective to couple with detecting entanglement? What research is needed to advance these technologies? For example, continuous condition monitoring of electrical array cables, export cables, or mooring line integrity. Please provide as much detail as possible on the accuracy and cost of each technology and specify which parameters or conditions can be detected/monitored.**

   Gauges have traditionally been the most common method for measuring tensions in the mooring lines and cables. However, these gauges can be fragile in highly variable marine environments and can result in calibration issues and higher susceptibility to breakage. In response, modern techniques are increasingly utilizing inclinometers to monitor mooring line tensions. Inclinometers will serve to measure the line inclinations and by means of acoustic signals, provide the readings to the software managing system. This system will process all the inputs and act accordingly when abnormal readings are manipulated.

   This shift in the industry toward inclinometers and advance tension monitoring systems is gaining traction, with various companies focusing on this technology. While the primary goal of these systems is to proactively detect potential line failures, it could also be adapted to detect abnormalities associated with debris entanglement. Given this industry trend, research efforts should prioritize the testing and refinement of these systems to site specific environmental conditions. Given the nascency of this technology, integrating systems into the O&M strategy of offshore wind developers will involve a significant investment.

3. **How does biofouling impact the accuracy and reliability of environmental and structural integrity monitoring sensors? What technologies can detect and monitor biofouling on FOSW infrastructure? What research is needed to advance these technologies? Please provide details on sensor**

accuracy, potential cost of the technology, and any additional hazards or conditions that can be detected/monitored.

Biofouling is indeed a critical factor to consider for the reliability of mooring lines and cables. The additional weight from marine growth, coupled with an increased drag coefficient, poses challenges for designers. These factors lead to mooring and cable loading that varies over age of the wind farm. Given the impact of biofouling, monitoring systems must be trained to recognize this added weight as part of normal tension behaviour and calibrated to account for inter and intra annual variability based on site specific conditions. By incorporating this understanding into the system, a well-trained monitoring system should account for all relevant variables and accurately distinguish between expected changes due to biofouling and actual impacts as a result of entanglement.

4. **What are the costs associated with deploying specialized vessels, remotely operated vehicles (ROVs), and autonomous underwater vehicles (AUVs) for inspections and maintenance of FOSW platforms, mooring lines, anchors, inter-array cables, export cables, and substations? If possible, please provide assumptions about the activity performed, equipment used, vessel type, number of personnel, etc.**

   As described above, remote sensor-based inspections supplemented with equipment and staff deployed to the site to remedy detected problems will be the most efficient approach.

5. **To what extent are permanent FOSW infrastructure-mounted sensors more cost effective than deploying specialized vessels or equipment such as ROVs and AUVs? Please take into consideration the differences in sensor accuracy and the travel time of vessels from port to the FOSW farm.**

   If the software managing sensor readings is well-trained—capable of accurately identifying, distinguishing, and classifying any abnormal system functions—it will more cost-effective than offshore operations that require vessel mobilization and associated operational costs for each inspection (typically every six months or a year). The costs associated with the sensor-based strategy are anticipated to generally include equipment installation, license acquisition, maintenance fees, and repair costs.

   Although a detailed cost comparison is necessary, this new digital twin technology, which aims to simulate the entire wind farm with near real-time data, is promising.

6. **Please describe the FOSW farm structural integrity and/or environmental inspections that must be conducted by ROVs and AUVs. Are there additional technologies that could supplement the use of ROVs and AUVs to minimize deploying specialized vehicles?**

Traditional inspection technologies like ROVs and AUVs will likely continue to be used for routine O&M activities for the components listed below. Entanglement inspections using ROVs and AUVs could be integrated into typical O&M regimes but supplemental real time observations of entanglement utilizing remote sensing should be considered. During offshore operations and installations, developers should recognize that these vehicles are crucial for verifying the correct installation of systems and equipment, and their presence will remain necessary.

- FOSW Platforms: This includes platforms for wind turbines and substations and refers to the underwater part of the structure, with drafts up to 20m. Key aspects to monitor include marine growth, structural integrity, and corrosion. Particular attention should be paid to export and inter-array cable attachment points.

- Moorings: Inspections should focus on connection points, in-line tensioners, and mooring elements subject to corrosion such as chains. Corrosion must be evaluated, along with a comprehensive structural performance check. Marine growth should be carefully assessed, as it can add extra weight and increase tension on the mooring lines.

- Anchors: Pre and post construction inspections are conducted to verify the final anchor position and their penetration into the seafloor.

- Inter-array Cables & Export Cables: A thorough performance check is required, considering additional components that may be incorporated into final designs including buoyancy elements, tether clumps, and bend stiffeners. Marine growth should be assessed to account for additional weight, which could affect cable tension. For surface laid cables, pre and post construction inspections are conducted to verify the final position of the cable on the seabed.

7. **What are the biggest challenges in integrating permanently mounted sensors for structural integrity monitoring or environmental monitoring onto FOSW infrastructure? Please describe any current limitations with regards to sensor placement on platforms, mooring lines, electrical cables, or anchors.**

The biggest challenge to installing such equipment is ensuring that the software can accurately distinguish between normal and abnormal system responses. This will require calibration that considers site specific conditions and project specific infrastructure to provide precise feedback on condition of equipment.

Although the industry has made significant advancement in remote sensing technology for mooring lines, cables, and floating foundations, anchors have received less attention. This is because anchor behaviour is generally less dynamic, and any potential issues with entanglement or otherwise are likely to be detected through mooring line monitoring.

8. **What fishing gear, trash, or other ocean debris is most likely to become entangled in FOSW equipment installed in California wind energy areas? Please provide references or a strong justification.**

   When considering the types of fishing gear, trash, or other ocean debris that are most likely to become entangled in floating offshore wind equipment in California wind energy areas, the focus should be on the types of materials commonly found in these waters and how they may be anticipated interact with the equipment.

   Fishing gear (either derelict or actively fishing) prone to entanglement on floating foundations, mooring lines, anchor systems, and suspended or surface laid cables includes gillnets (drift or set), longlines (surface or mid water), traps and pots, and their associated buoys and lines.

   Ocean debris prone to entanglement on floating foundations, mooring lines, anchor systems, and suspended or surface laid cables includes buoyant and semi buoyant plastics and other large debris passively drifting at the surface or in the water column.

9. **In addition to cetaceans, pinnipeds, and marine reptiles, are there additional organisms that could be particularly at risk for entanglement from FOSW infrastructure?**

   GSW has not yet performed project-specific analyses to understand the potential risk associated with entanglement. However, we direct the CEC to BOEM's Final Environmental Assessment for the Morro Bay Lease Areas (available at: Final EA: Commercial Wind Lease and Grant Issuance and Site Assessment Activities of the Pacific Outer Continental Shelf, Morro Bay WEA, California (boem.gov)) for an initial review of potential entanglement risks in the Morro Bay WEA which includes consideration of mooring systems associated with met buoys.

10. **Please provide any other questions or information the CEC should consider for research on entanglement with FOSW infrastructure that is not otherwise covered by the questions above.**

    The questions included herein are primarily focused on monitoring for entanglement. Additional research could include solutions for avoiding and minimizing the risk of entanglement.