Leading Light Wind

Attachments to Section 16

Attachment 16.1

COWI Decommissioning Strategy and Sequence Report

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INVENERGY

CONCEPTUAL STUDY FOR BLOCK OCS-A 0542

DECOMMISSIONING STRATEGY AND SEQUENCE REPORT

PROJECT NO.	DOCUMENT NO.				
A240810	A240810-DR-10281				
VERSION	DATE OF ISSUE	DESCRIPTION	PREPARED	CHECKED	APPROVED
C03	2023-07-27	Issued for information	CHBT	SOSU	FALK
C02	2023-05-26	Issued for information	CHBT	SOSU	FALK
C01	2023-04-28	Issued for review	CHBT	MTLD	FALK

CONTENTS

APPENDICES

1 Introduction

1.1 Outline of the project

An overview of the current offshore wind farm project is described below.

- Project name: Leading Light Wind
- Client: Invenergy
- Foundation engineer: COWI
- Location: US lease area OCS-A 0542
- Turbine specification: [redacted]
- Number of turbines: [redacted]

1.2 General

Invenergy has contracted COWI to provide a conceptual study of foundations for a range of WTG sizes and offshore substation(s).

The purpose of the study is to support Invenergy in selecting the most economical and technologically suitable foundation type for their lease area in the New York Bight by performing a site-specific assessment of suitable foundation types and to estimate the associated EPCI cost.

This report outlines the scope of activities required to decommission offshore elements as well as relevant state and federal requirements. The document objective is to describe a decommissioning strategy and sequence, in line with US precedents, to support Invenergy in preparing their NJ3 bid. Estimates of activity durations and emissions are also included.

This report is prepared assuming that the WTG foundations are monopiles, while the OSS foundations are piled jackets. Refer to Ref. /5/ for further discussion of each foundation type.

1.3 Project description

Invenergy participated in the Bureau of Ocean Energy Management (BOEM) New York Bight wind energy auction on February 23, 2022 in which it secured one of the six lease areas being offered, i.e. lease area OCS-A 0542 as shown in Figure 1-1.

The lease area of 83,976 acres is in federal waters, located in the New York Bight, between latitudes 39.192°N to 39.427°N and longitudes 73.625°W and 73.305°W. The water depths at the site vary between approximately 32 and 54 m MSL.

Invenergy will be bidding in upcoming offshore wind energy solicitations for which they will be expected to submit a fixed price for their project's electricity production.

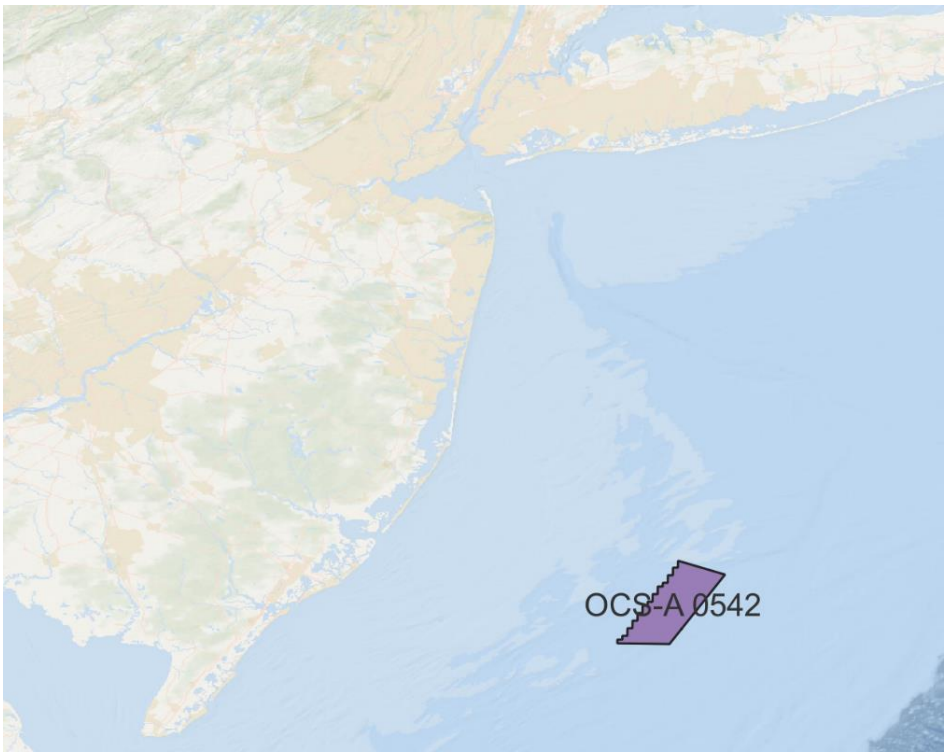

Figure 1-1: Location of Lease Area OCS-A 0542.

1.4 Revision history

In Table 1-1 a revision log for the present document is presented.

Table 1-1 Revision log.

Revision no.	Updates compared to previous revision
C01	First issue for review by the client
C02	Updated with client comments
C03	Updated with client comments

1.5 Abbreviations

Abbreviation	Definition
ACP	American Clean Power Association
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
COP	Construction and Operations Plan
CFR	Code of Federal Regulations
EPCI	Engineering, Procurement, Construction, and Installation
GAP	General Activities Plan
HVDC	High Voltage Direct Current
MSL	Mean Sea Level
OCRP	Offshore Compliance Recommended Practices
OCS	Outer Continental Shelf
OSS	Offshore Substation
SAP	Site Assessment Plan
TP	Transition Piece
USACE	United States Army Corps of Engineers
WTG	Wind Turbine Generator

2 References

2.1 Applied standards, rules and guidelines

Ref. /1/ 30 CFR Part 285 Renewable Energy and Alternate Uses of Existing Facilities on the Outer Continental Shelf, Subpart I – Decommissioning (2023).

Ref. /2/ ACP OCRP-1-2022 ACP Offshore Compliance Recommended Practices (OCRP) Edition 2 (2022).

Ref. /3/ N.J.A.C. 14:8-6.5 New Jersey Administrative Code, Title 14 Public Utilities, Chapter 8 Renewable Energy and Energy Efficiency, Subchapter 6 Qualified Offshore Wind Projects, Section 5 Application Requirements (2023).

2.2 Company documents

Ref. /4/ United States Department of the Interior, Bureau of Ocean Energy Management. Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf, Lease OCS-A 0542 (2022).

2.3 Contractor's documents

Ref. /5/ A240810-DB-10001 - Design Basis

2.4 Literature

Ref. /6/ United States Department of the Interior, Bureau of Safety and Environmental Enforcement and Bureau of Ocean Energy Management. Notice to Lessees, Grantees, and Operators of Federal Renewable Energy Leases, Right-of-Way Grants, Right-of-Use and Easement Grants, and Alternate Use Right-of-Use and Easement Grants on the Outer Continental Shelf: Reorganization of Title 30—Renewable Energy and Alternate Uses of Existing Facilities on the Outer Continental Shelf into 30 CFR Parts 285, 585, and 586 (2023).

Ref. /7/ Vineyard Wind. Draft Construction and Operations Plan, Volume 1 (September 2020).

Ref. /8/ Department of the Army, US Army Corps of Engineers. Permit No. NAE-2017-01206 (August 2021).

Ref. /9/ Atlantic Shores Offshore Wind. Construction and Operations Plan, Volume 1 (September 2021).

Ref. /10/ Empire Offshore Wind. Construction and Operations Plan, Volume 1 (June 2022).

Ref. /11/ Ocean Wind. Construction and Operations Plan, Volume 1 (June 2022).

Ref. /12/ Ocean News and Technology, April 2020 Issue. Excalibur Supports Blyth's Full Project Life Cycle.

Ref. /13/ RGL. DBB Jack-Up Services – Underwater Pile Cutting of Met Mast Monopiles. Abrasive Cold Cutting of Floating Tank Roof - Rgl (rglservices.co.uk)

Ref. /14/ Demolition & Recycling International. Three ways to demolish offshore wind farms with hydrodemolition (2021). Three ways to demolish offshore wind farms with hydrodemolition - Demolition & Recycling International (demolitionandrecycling.media)

Ref. /15/ Oil & Gas UK. The Management of Marine Growth During Decommissioning (2013).

Ref. /16/ GROW. Project in the spotlight: HyPE-ST. https://grow-offshorewind.nl/newsitem/project-in-the-spotlight-hype-st

Ref. /17/ CAPE Holland. Monopile Decommissioning. Monopile decommissioning - CAPE Holland

Ref. /18/ US Department of Energy, Office of Energy Efficiency & Renewable Energy. Carbon Rivers Makes Wind Turbine Blade Recycling and Upcycling a Reality with Support from DOE (2022). Carbon Rivers Makes Wind Turbine Blade Recycling and Upcycling a Reality With Support From DOE | Department of Energy

Ref. /19/ Heerema Marine Contractors. Topsides removal a significant milestone in decommissioning of Dunlin Alpha. Topsides removal a significant milestone in decommissioning of Dunlin Alpha (heerema.com)

Ref. /20/ Asian Journal of Engineering and Technology. Decommissioning Plans for Fixed Offshore Platforms: A Brief Revision (2021).

Ref. /21/ E.ON Energy UK. Blyth wind farm decommissioning – timelapse. Blyth wind farm decommissioning - timelapse - YouTube

Ref. /22/ Great Lakes Dredge & Dock Company, LLC. Mechanical Dredges. Mechanical Dredges | Mechanical Clamshell Dredges | GLDD

Ref. /23/ Pile Buck. Dredging Equipment Guide (2017). Dredging Equipment Guide - Pile Buck Magazine

Ref. /24/ Kaiser, Mark & Snyder, Brian. Modeling the decommissioning cost of offshore wind development on the U.S. Outer Continental Shelf (2012). Marine Policy, 36(1), pp. 153–164. doi: 10.1016/j.marpol.2011.04.008.

Ref. /25/ United States Department of the Interior, Bureau of Ocean Energy Management. Offshore Wind Energy Facilities Emission Estimating Tool Technical Documentation (2017).

Ref. /26/ Marine Technology News. Need a Survey? There's a USV for That (2021). Need A Survey? There'S A USV For That (marinetechnologynews.com)

3 Decommissioning Requirements

The following subsections identify relevant contractual, federal and state requirements relating to decommissioning.

3.1 Lease requirements

Lease requirements for decommissioning can be found in Section 13 of Ref. /4/:

> *"Unless otherwise authorized by the Lessor, pursuant to the applicable regulations in 30 CFR Part 585, the Lessee must remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on the leased area, including any project easements within two years following lease termination, whether by expiration, cancellation, contraction, or relinquishment, in accordance with any approved SAP, COP, or approved Decommissioning Application, and applicable regulations in 30 CFR Part 585."*

3.2 Federal requirements

Federal decommissioning requirements are found in Ref. /1/. The organization of these requirements into Part 285 is a result of the recent reorganization of federal agencies as discussed in Ref. /6/. Oversight responsibilities of OCS renewable energy activities relating to safety and the environment were transferred from BOEM to BSEE. Therefore, documents issued prior to January 2023 (including the lease requirements in the preceding section) reference 30 CFR Part 585 rather than 30 CFR Part 285. Relevant requirements from Ref. /1/ are summarized in Table 3-1.

Table 3-1 Decommissioning requirements from 30 CFR Part 285, Subpart I.

Section Number and Heading	Text
§ 285.902 What are the general requirements for decommissioning for facilities authorized under my SAP, COP, or GAP?	(a) Except as otherwise authorized under § 285.909, within 2 years following termination of a lease or grant, you must: (1) Remove or decommission all facilities, projects, cables, pipelines, and obstructions; (2) Clear the seafloor of all obstructions created by activities on your lease, including your project easement, or grant. (b) Before decommissioning the facilities under your SAP, COP, or GAP, you must submit a decommissioning application to, and receive approval from, BSEE. (c) The approval of the decommissioning concept in the SAP, COP, or GAP is not an approval of a decommissioning application. However, you may submit your complete decommissioning application to BSEE simultaneously with the SAP, COP, or GAP, so that it may undergo appropriate technical and regulatory reviews at that time. (d) Following approval of your decommissioning application, you must submit a decommissioning notice under § 285.908 to BSEE at least 60 days before commencing decommissioning activities.

Section Number and Heading	Text
	(e) If you, your subcontractors, or any agent acting on your behalf discovers any archaeological resource while conducting decommissioning activities, you must immediately halt bottom-disturbing activities within 1,000 feet of the discovery and report the discovery to us within 72 hours. BOEM will inform you how to conduct investigations to determine if the resource is significant and how to protect it in accordance with 30 CFR 585.702. You, your subcontractors, or any agent acting on your behalf must keep the location of the discovery confidential and must not take any action that may adversely affect the archaeological resource until we have made an evaluation and told you how to proceed. (f) Provide BOEM with documentation of any coordination efforts you have made with the affected States, local, and Tribal governments.
§ 285.904 Can I request a departure from the decommissioning requirements?	You may request a departure from the decommissioning requirements under § 285.103.
§ 285.905 When must I submit my decommissioning application?	You must submit your decommissioning application upon the earliest of the following dates: (a) Two (2) years before the expiration of your lease. (b) Ninety (90) days after completion of your commercial activities on a commercial lease. (c) Ninety (90) days after completion of your approved activities under a limited lease on a ROW grant or RUE grant. (d) Ninety (90) days after cancellation, relinquishment, or other termination of your lease or grant.
§ 285.906 What must my decommissioning application include?	You must provide one paper copy and one electronic copy of the application. Include the following information in the application, as applicable. (a) Identification of the applicant including: (1) Lease operator, ROW grant holder, or RUE grant holder; (2) Address; (3) Contact person and telephone number; and (4) Shore base. (b) Identification and description of the facilities, cables, or pipelines you plan to remove or propose to leave in place, as provided in § 285.909. (c) A proposed decommissioning schedule for your lease, ROW grant, or RUE grant, including the expiration or relinquishment date and proposed month and year of removal.

Section Number and Heading	Text
	(d) A description of the removal methods and procedures, including the types of equipment, vessels, and moorings (*i.e.,* anchors, chains, lines, *etc.*) you will use. (e) A description of your site clearance activities. (f) Your plans for transportation and disposal (including as an artificial reef) or salvage of the removed facilities, cables, or pipelines and any required approvals. (g) A description of those resources, conditions, and activities that could be affected by or could affect your proposed decommissioning activities. The description must be as detailed as necessary to assist BSEE in complying with the NEPA and other relevant Federal laws. (h) The results of any recent biological surveys conducted in the vicinity of the structure and recent observations of turtles or marine mammals at the structure site. (i) Mitigation measures you will use to protect archaeological and sensitive biological features during removal activities. (j) A description of measures you will take to prevent unauthorized discharge of pollutants, including marine trash and debris, into the offshore waters. (k) A statement of whether or not you will use divers to survey the area after removal to determine any effects on marine life.
§ 285.908 What must I include in my decommissioning notice?	(a) The decommissioning notice is distinct from your decommissioning application and may only be submitted following approval of your decommissioning application, as described in §§ 285.905 through 285.907. You must submit a decommissioning notice at least 60 days before you plan to begin decommissioning activities. (b) Your decommissioning notice must include: (1) A description of any changes to the approved removal methods and procedures in your approved decommissioning application, including changes to the types of vessels and equipment you will use; and (2) An updated decommissioning schedule. (c) BSEE will review your decommissioning notice and may require you to resubmit a decommissioning application if BSEE determines that your decommissioning activities would: (1) Result in a significant change in the impacts previously identified and evaluated; (2) Require any additional Federal permits; or (3) Propose activities not previously identified and evaluated.

Section Number and Heading	Text
§ 285.909 When may facilities remain in place following termination of a lease or grant?	(a) In your decommissioning application, you may request that certain facilities authorized in your lease or grant remain in place for other activities authorized in this part, elsewhere in this subchapter, or by other applicable Federal law. (b) Except as provided in paragraph (c) of this section, if BOEM authorizes facilities to remain in place, the former lessee or grantee under this part remains jointly and severally liable for decommissioning the facility unless satisfactory evidence is provided to BOEM showing that another party has assumed that responsibility and has secured adequate financial assurances. (c) In your decommissioning application, identify facilities authorized by BOEM to be converted to an artificial reef or otherwise toppled in place.
§ 285.910 What must I do when I remove my facility?	(a) You must remove all facilities to a depth of 15 feet below the mudline, unless otherwise authorized by BSEE. (b) Within 60 days after you remove a facility, you must verify to BSEE that you have cleared the site.
§ 285.912 After I remove a facility, cable, or pipeline, what information must I submit?	(a) A summary of the removal activities, including the date they were completed; (b) A description of any mitigation measures you took; and (c) If you used explosives, a statement signed by your authorized representative that certifies that the types and amount of explosives you used in removing the facility were consistent with those in the approved decommissioning application.

3.3 Offshore Compliance Recommended Practices (OCRP)

The American Clean Power Association (ACP), in collaboration with the U.S. offshore wind industry and several federal agencies, publishes the Offshore Compliance Recommended Practices (OCRP) document (Ref. /2/) as a "best practices" guideline for offshore wind development. Although the document itself is not a requirement, it is intended to be used as a framework by regulators and therefore should be consulted to facilitate project success.

On the subject of decommissioning, the OCRP guidelines most significantly include recommendations on what to include in a decommissioning plan. These recommendations have been incorporated in this report to the greatest extent possible. The following extract from Section 9.2.2.1 of the OCRP guidelines is reproduced below:

> *"U.S. Regulation 30 CFR 585 Subpart I contains BOEM and BSEE regulations directly related to the decommissioning of offshore wind facilities in U.S. OCS waters. Refer also to Section 9.6. Other regulatory authorities are likely to have requirements for the development for a decommissioning plan.*

As part of the project development process, a decommissioning plan shall be created that addresses how the facilities will be decommissioned and removed once the facility is taken out of operation. The decommissioning plan should consider the following:

- *Regulatory requirements*
- *Lease requirements*
- *Site Environmental Management Plan*
- *Removal or decommissioning of the rotor-nacelle assembly and above-water support structure and equipment*
- *Removal or decommissioning of below-water support structure and equipment, usually to 5m below the sea floor*
- *Removal or decommissioning of offshore and onshore substations*
- *Removal or decommissioning of array cabling and systems*
- *Removal or decommissioning of export cable, including submarine cable, shore landing installation and upland cable*
- *Removal, burial, or abandonment of materials installed for seabed preparation, scour protection, or cable protection*
- *Removal, restoration, or future use of other project support infrastructure, such as onshore operations & maintenance (O&M) facility*
- *Removal, restoration, or future use of temporary support infrastructure employed during the decommissioning phase*
- *Description of vessels, equipment, and methods to be used*
- *Provisions for waste disposal, recycling, and/or use of materials for approved artificial reefs. Special attention should be given to potentially hazardous or contaminated fluids, such as lubricants or ballast.*
- *Site clearance verification*

The decommissioning plan shall address how the decommissioning process will:

- *Comply with applicable laws and regulations*
- *Be conducted safely*
- *Not unreasonably interfere with other uses approved uses, such as marine traffic, fishing, and national defense*
- *Not cause undue harm or damage to natural resources; life (including human and wildlife); property; the marine, coastal, or human environment; or sites, structures, or objects of historical or archaeological significance*
- *Use best available and safest technology*
- *Use best management practices*
- *Use properly trained personal*

Financial obligations are often required by regulatory authority for the decommissioning phase. A cost estimate should be prepared and included in the decommissioning plan. The cost estimate should use reasonable assumptions on the value of scrap substantiated by historical data, not current spot market prices. Cost for disassembly, reduction size, and breakdown of components for transport and disposal should not be neglected.

In some instances, it may be economically or otherwise beneficial to consider making artificial reefs from discarded offshore wind project components for habitat enhancement. This approach should first be approved by relevant permitting authorities before being included in the decommissioning plan.

Similarly, it may be economically or otherwise beneficial to consider modifying all or a portion of the offshore wind farm for an alternate use. The alternate use should be approved before being considered in the offshore wind project's decommissioning plan."

Section 9.6 of the OCRP guidelines addresses decommissioning immediately prior to and during the decommissioning phase and is reproduced below:

"9.6.1 Decommission Plan Update
Prior to initiating the decommissioning process, the Decommissioning Plan prepared and approved during the project development phase should be revisited. Proposed deviations from the original plan should be addressed in an amended Decommissioning Plan and submitted to the appropriate regulatory body for review and approval. Changes to the original decommissioning plan may be warranted due to changes such as revisions to regulations, introduction of new technologies, changes in best industry practices, changes to accepted environmental practices, or new science.

9.6.2 Decommission Report
A Decommissioning Report shall be prepared providing a summary of decommissioning activities, including date they were accomplished, identifying deviations from the approved decommissioning plan, if any. The report should identify any significant health, safety, or environmental issues that arose. The report should also identify where the waste and recycled materials were deposited. Confirmation of post-decommissioning site clearance should be included.

9.6.3 U.S. Regulations on Decommissioning
30 CFR 250.902, 30 CFR 250.1725, and 30 CFR 250.1752 address BOEM and BSEE requirements for decommissioning of platforms and pipelines used for extracting oil, gas, and sulfur from U.S. OCS waters, but some of their provisions may also be appropriate for offshore wind facilities.

9.6.4 Transportation and Decommissioning Operations
Decommissioning operations and transportation for decommissioning should follow the same standards, requirements, and considerations discussed in Section 7."

3.4 New Jersey requirements

Decommissioning requirements for offshore wind projects specific to the state of New Jersey are found in Section 6.5 of Chapter 8 of Title 14 of the New Jersey Administrative Code (Ref. /3/). These requirements relate to the decommissioning plan to be included in the application for a qualified offshore wind project. Item 9 of subsection (a) is reproduced below:

"A decommissioning plan for the project including provisions for financial assurance for decommissioning and which complies with any applicable State and Federal statutes and/or regulations.

i. Proposals must estimate an expected useful economic life as well as specify a project decommissioning plan for the technology and installation area proposed.

ii. The decommissioning plan must include the anticipated cost of decommissioning the project based on applicable and/or anticipated regulatory and engineering requirements

and provide for the necessary future funding. Segregated decommissioning funds shall be required;
iii. The applicant shall commit that any decommissioning costs in excess of the anticipated costs stated in the application shall not be made up by ratepayers, suppliers, or providers"

3.5 New York requirements

No decommissioning requirements for offshore wind projects specific to the state of New York were identified, other than requirements which may be included in individual requests for proposal.

4 US Decommissioning Examples

As part of this study, publicly available Construction and Operations Plans (COPs) from other US offshore wind projects were consulted. As of the date of this report, nine COPs are available on BOEM's website, including:

- Vineyard Wind Project (September 2020)
- South Fork Wind Farm (May 2021)
- Atlantic Shores Offshore Wind (September 2021)
- Empire Wind Project (June 2022)
- New England Wind (formerly Vineyard Wind South) (June 2022)
- Ocean Wind Offshore Wind Farm (June 2022)
- Revolution Wind Farm (July 2022)
- Sunrise Wind Farm Project (August 2022)
- SouthCoast Wind (formerly Mayflower Wind) (December 2022)

The decommissioning sections of all nine COPs were read and compared. Because much of the information is similar across the nine, four representative examples were selected for further analysis and used to help compile Section 5 of this report. The four examples are described briefly in the subsections below.

4.1 Vineyard Wind Project

Vineyard Wind was selected as a representative example of a decommissioning plan due to its thoroughness and, as the project with the first approved COP (Ref. /7/), it is the furthest along in the regulatory process. As such, is one of only two identified projects (the other being South Fork Wind Farm) with approved and publicly available permits issued by the US Army Corps of Engineers (USACE) under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act (Ref. /8/). This permit was the only document identified in the research of this report to include a discussion on the importance of removing scour protection from the point of view of local fisheries. The full text of the decommissioning section of the COP for Vineyard Wind, as well as the decommissioning section from the USACE permit, can be found in Appendix A.

4.2 Atlantic Shores Offshore Wind

Atlantic Shores was also selected as a representative example in part due to being one of the earlier published COPs (Ref. /9/). Additionally, Atlantic Shores is in physical proximity to the Leading Light Wind project and was awarded a power purchase agreement with the State of New Jersey. The decommissioning section of the COP is thorough, especially concerning regulatory requirements relating to decommissioning. The full text of the decommissioning section of the COP for Atlantic Shores can be found in Appendix B.

4.3 Empire Wind Project

Empire Wind was selected as a representative example of a decommissioning plan because it was one of the more thorough decommissioning sections from a COP published within the past year, thereby presumably incorporating any lessons learned from previous COPs. It was also published by a different lease owner and prepared by a different firm than the other three representative COPs selected. The table format of the decommissioning descriptions of each project element was considered to be easy to read and reference. The full text of the decommissioning section of the COP for Empire Wind (Ref. /10/) can be found in Appendix C.

4.4 Ocean Wind Offshore Wind Farm

Ocean Wind was selected as a representative example of a decommissioning plan for reasons similar to Atlantic Shores – proximity of the lease area to the Leading Light Wind project and a successful power purchase agreement award from the State of New Jersey. The content of the decommissioning section of this document also seemed unique and did not have as much overlap with the corresponding sections of the other COPs analyzed. Compared to Vineyard Wind, this project took an opposite approach to the decommissioning of scour protection – namely, leaving it in place in order to protect marine life. This COP (Ref. /11/) also commented on preferring to retire cables in place in congested areas such as pipeline crossings to minimize risks of excavation. The full text of the decommissioning section of the COP for Ocean Wind can be found in Appendix D.

5 Decommissioning Process

The decommissioning process generally resembles the reverse of the installation process. Specific activities for each system component are listed in the subsections below. These discussions are based on present-day technology, but since decommissioning will occur at least 35 years after the issuance of this technical note, it is reasonable to assume that new technologies may create a more efficient process.

In accordance with § 285.902 and § 285.905 of Ref. /1/, a decommissioning application will be submitted to BSEE for approval two years before the expiration of the lease. Requirements for the content of the decommissioning application are specified in § 285.906 of Ref. /1/. Following approval of the application, a decommissioning notice will be submitted to BSEE at least 60 days before decommissioning activities commence per § 285.908 of Ref. /1/.

During the decommissioning phase, careful inventory will be taken of all items to be removed. As items are removed from the seafloor, they will be counted and noted as removed in the inventory. The removal and clearance process will be completed within two years of the termination of the lease in accordance with the requirements of § 285.902(a) of Ref. /1/ and Ref. /4/. [redacted]

The disposal process for each component will follow a preferred hierarchy. Where possible, items will be reused. Recycling is the next preferred alternative, followed by incineration with energy recovery. Disposal at an appropriate solid waste facility will be the final resort. It is anticipated that recycling will be possible for all major components, including fiberglass blades. Although traditionally not considered recyclable, new technology from Carbon Rivers has achieved 99.9% recycled glass fiber purity from end-of-life waste streams like wind turbine blades (Ref. /18/), as shown in Figure 5-1.

Figure 5-1: Recycled glass fiber from Carbon Rivers (source: US Department of Energy).

5.1 Wind turbine generators and foundations

[redacted]

The WTGs will then be disassembled in a similar manner to the installation process using jack-up and heavy lift vessels as well as support vessels such as tugboats and crew transfer vessels. The rotor-nacelle assembly will first be disconnected and lifted onto a barge, as shown in Figure 5-2. This is followed by the tower, which may first be cut into smaller pieces to facilitate handling.

Figure 5-2: Decommissioning of Vindeby Offshore Wind Farm, Denmark (source: Ørsted).

In the case of traditional foundations using a separate transition piece, the transition piece will first be removed. If the connection is grouted, the monopile will be cut below the transition piece connection to avoid cutting through multiple layers of steel. In the case of a bolted flange connection without grout, the transition piece can be simply unbolted and removed, similar to the tower.

The monopile foundations will be drained internally of sediments to 15 ft below the mudline using suction or dredging. This will enable access to cut the monopile using a high-pressure abrasive water jet, an underwater acetylene cutting torch, or a mechanical cutting tool. If necessary, ultra-high-pressure water jets can be used to clean and prepare the surface prior to cutting. Recent monopile removals at the Blyth Offshore Wind Farm in the United Kingdom and at the Horns Rev 2 Offshore Wind Farm in Denmark were successfully executed using high pressure abrasive water jetting per Ref. /12/ and Ref. /13/. Figure 5-3 shows a typical schematic of this process as conducted by RGL Services. During the Horns Rev 2 removal, the cutting process of the 45 mm-thick, approximately 2 m-diameter monopile took 8 hours to complete.

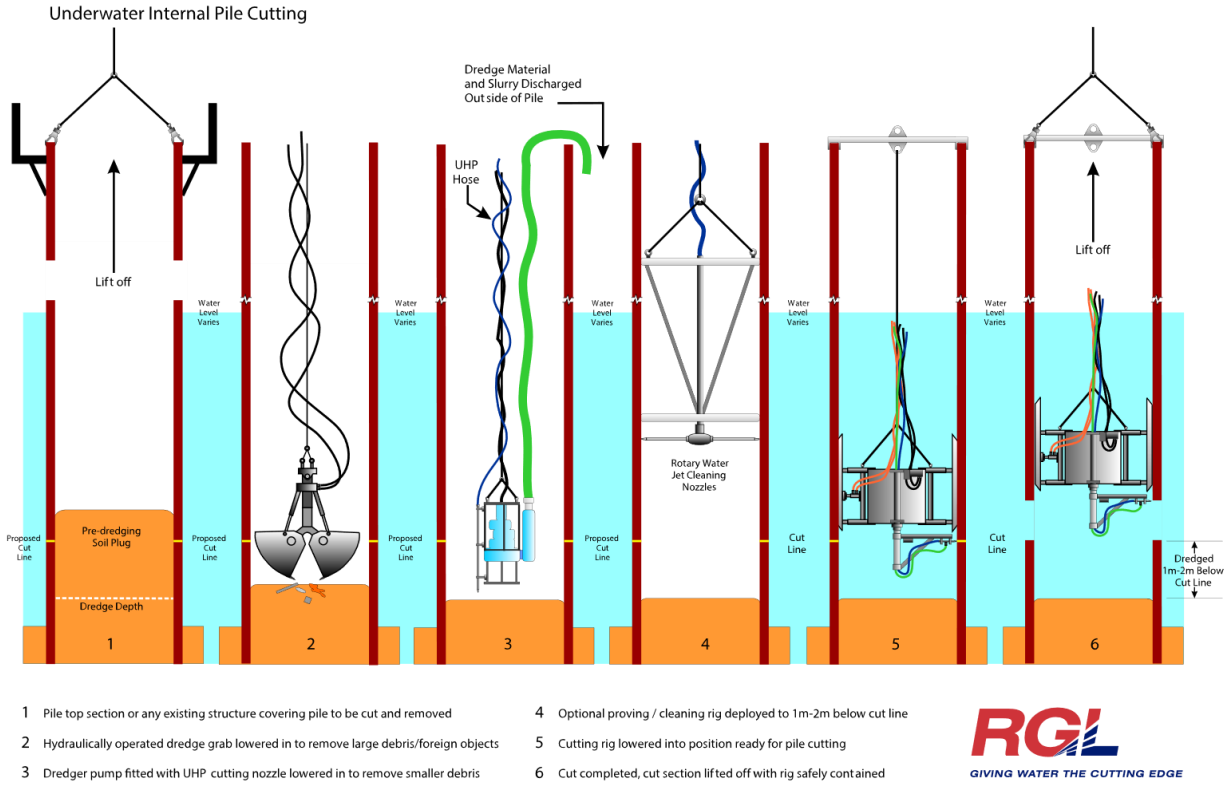

Figure 5-3: Typical process schematic for internal pile cutting and removal (source: RGL).

The portion of the foundation above the cut will be removed per the requirements of § 285.910(a) of Ref. /1/, and may be cut into smaller pieces to facilitate handling. The portion below the cut will remain in place, and the previously removed sediment will be replaced. A vacuum pump and diver-assisted or remote operated hoses may be used to minimize sediment disturbance and turbidity.

[redacted]

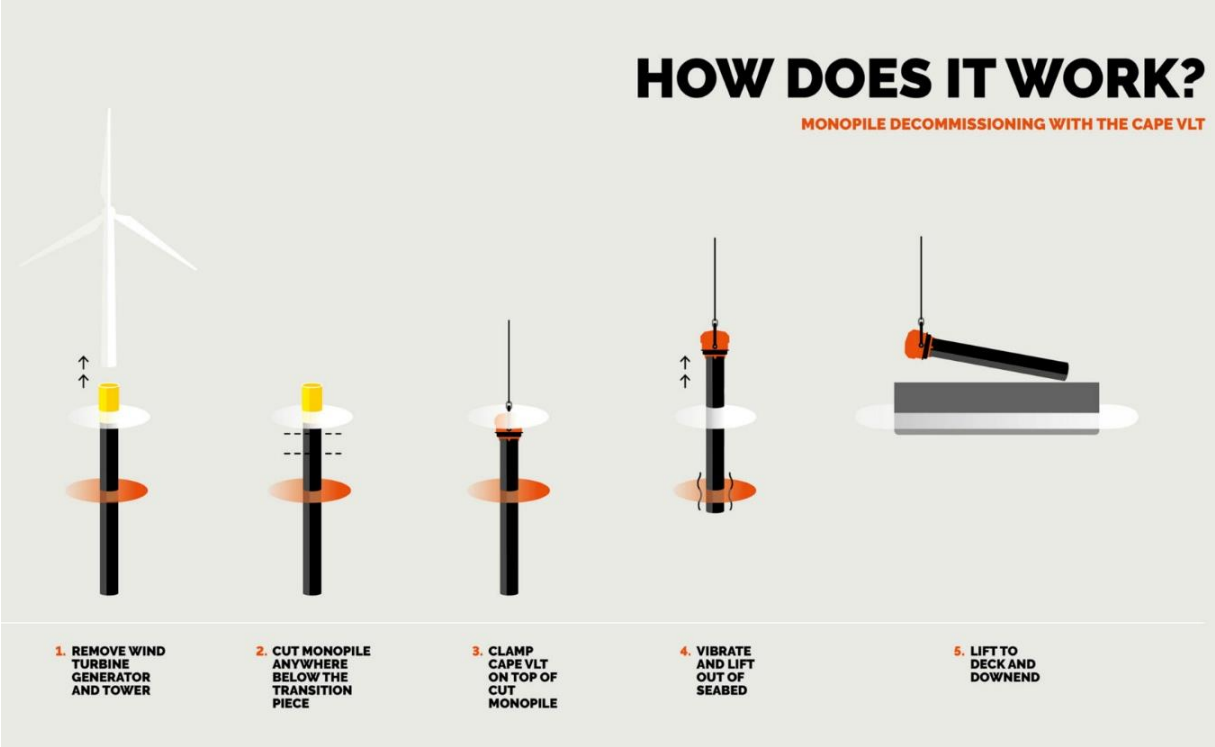

Figure 5-4: Full monopile removal process using vibratory technology (source: CAPE Holland).

Removed portions of the WTGs and monopiles will be shipped to shore on barges and recycled at an appropriate facility. Before recycling, any residual marine growth on the monopile should either be removed or allowed to fully dry out. Based on Ref. /15/, a study of marine growth during decommissioning of offshore oil and gas structures in the United Kingdom, removal onshore was found to be more efficient that removal in situ.

If approved in the decommissioning application, scour protection may be left in place to preserve any marine life in the vicinity. Alternatively, consultation with mobile gear fisheries (i.e., dredge and bottom trawl gears) may favor removal of the scour protection. If required to be removed, the scour protection will be excavated with a dredging vessel and transported back to shore for reuse or disposal.

5.2 Offshore substations and foundations

The decommissioning process of the OSSs and foundations will be similar to that of the WTGs.

The topside will then be dismantled and removed using jack-up and heavy lift vessels as well as support vessels such as tugboats and crew transfer vessels. Depending on the capacity of the crane, major electrical equipment may need to be removed first. The topside may be cut into smaller pieces to facilitate handling. The 2022 decommissioning of the Dunlin Alpha oil platform in the North Sea involved several smaller lifts of approximately 3,500 metric tons in total, followed by a record-breaking lift of the Module Support Frame at almost 12,000 tons (Ref. /19/). Figure 5-5 shows the final lift.

Figure 5-5: Partial removal of topside of oil platform Dunlin Alpha (source: Heerema).

The piles of the jacket foundation will then be cut at 15 ft below the mudline using a similar method for the cutting of the monopiles. If required, the piles or legs can be cut to provide access to the interior. The jacket will then be lifted out in a single lift or in pieces, and previously removed sediment will be replaced.

Removed portions of the OSS topsides, jackets, and piles will be shipped to shore on barges and recycled at an appropriate facility. Before recycling, any residual marine growth on the jacket should either be removed or allowed to fully dry out. Based on Ref. /15/, a study of marine growth during decommissioning of offshore oil and gas structures in the United Kingdom, removal onshore was found to be more efficient that removal in situ.

If approved in the decommissioning application, scour protection may be left in place to preserve any marine life in the vicinity. Alternatively, consultation with mobile gear fisheries (i.e., dredge and bottom trawl gears) may favor removal of the scour protection. If required to be removed, the scour protection will be excavated with a dredging vessel and transported back to shore for reuse or disposal.

5.3 Inter-array cables

[redacted]

5.4 Export cables

[redacted]

6 Recommended Strategy

Given that the decommissioning process will take place more than 30 years from the date of this report, it is not recommended to develop an exact and detailed decommissioning plan at this time. However, the general process outlined in Section 5 is recommended as a baseline, which can be updated as required with evolving technology, regulations, and industry standards.

When a detailed decommissioning plan is under development, it is recommended to minimize the amount of time spent offshore by large jack-up and heavy lift vessels. This is assumed to be the largest driver of the economic cost of decommissioning. With this in mind, the following points should be considered in the years leading up to the development of the final decommissioning plan:

- Recycling: Identify steel recycling plants on the waterfront close to site with enough capacity and deep enough water for the appropriate vessels to unload. Stay up to date with the emerging blade recycling industry and verify that blades can be recycled at scale. Identify cable recycling options.

- Monopiles: [redacted] Currently, this is the industry standard and will mean that less handling of material will be required, saving time and vessel capacity. [redacted]

- OSS topsides and jackets: [redacted]

- Inter-array and export cables: As the cables are by default required to be removed, requests to retire them in place will be subject to BSEE approval following environmental and stakeholder reviews. For preliminary planning purposes, it should be assumed the cables will be removed. During the detailed decommissioning planning phase, the scrap value of the cables should be compared to the cost of removal. If cable removal is a net economic cost, retirement in place should be preferred.

- [redacted]

- Federal and state regulations should continue to be monitored for any changes affecting the decommissioning plan.

- As more pioneering international wind farms enter the decommissioning phase, note the process and technology used and compile lessons learned.

7 Estimated Task Duration

This section presents a high-level estimate of the duration of each decommissioning task. A summary table is presented below, followed by underlying assumptions for each element.

[redacted]

Table 7-1 Estimated duration for each decommissioning task, per unit.

Task	[redacted]

[redacted]

7.1 WTG and monopile removal assumptions

- [redacted]
- [redacted]
- [redacted]

7.2 OSS and jacket removal assumptions

- [redacted]
- [redacted]
- [redacted]

7.3 Cable removal assumptions

[redacted]

[redacted]

7.4 Site clearance survey assumptions

[redacted]

8 Decommissioning Emissions Estimates

Estimates of emissions of CO_2, SO_2, NO_x, and $PM_{2.5}$ released during the decommissioning phase in approximate years are included in Table 8-1 below. The total amount of estimate emissions is distributed assuming a two-year decommissioning campaign in accordance with § 285.902 of Ref. /1/.

Table 8-1 Estimated emissions released during the decommissioning phase.

Year	Estimated Emissions (Tons)			
	CO_2	SO_2	NO_x	$PM_{2.5}$
2059	[redacted]			
2060				

Key assumptions made in producing the estimates are as follows:

- Emission factors for vessels are BOEM Default factors per Ref. /25/.
- BOEM Default load factors and vessel characteristics for main engines and auxiliary engines were used per Ref. /25/.
- [redacted]
- All vessel trips are made to and from the New Jersey Wind Port.
- Durations of vessels on site were assumed in alignment with Section 7 of this report.
- Vessel capacity and decommissioning methodology were assumed based on present day technology. Little to no reduction in emissions was assumed to account for supposed technological improvement.

Appendix A Vineyard Wind Project Extracted Sections from COP and Department of the Army Permit

[Extract from COP]

As noted in Section 3.2.6, helicopters may be used to supplement crew transport and for Project support during the O&M period.

4.4 Decommissioning & Site Clearance Procedures

4.4.1. Decommissioning Plan Requirements

BOEM's decommissioning requirements are stated in Section 13, "Removal of Property and Restoration of the Leased Area on Termination of Lease," of the April 15, 2015 Lease for Area OCS-A 0501. Unless otherwise authorized by BOEM, pursuant to the applicable regulations in 30 C.F.R. Part 585, Vineyard Wind is required to "remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on the leased area, including any project easements(s) within two years following lease termination, whether by expiration, cancellation, contraction, or relinquishment, in accordance with any approved SAP, COP or approved Decommissioning Application and applicable regulations in 30 CFR Part 585."

4.4.2. Decommissioning Time Horizon

The WTGs, ESPs, the supporting cabling, and the onshore substation infrastructure will be robustly designed and carefully maintained. As is typical of utility-grade generation and transmission infrastructure, the Project's equipment is expected to have a physical life expectancy of up to 30 years.

The first commercial-scale European offshore wind energy installation was constructed in 1991. Approximately 13,000 MW of offshore wind capacity has been installed in European waters over the past 25 years, and with a single exception,[17] all of this capacity remains in commercial operation. Accordingly, the following discussion outlines decommissioning procedures and methods that would be most appropriate given today's technology. However, it is reasonable to expect that by the end of the Lease term and beyond, experience in the European offshore wind industry and, more generally, technological advances in methods and equipment servicing the offshore industry, may result in some increased level of efficiencies as well as a reduced level of environmental impacts.

[Extract from COP]

4.4.3 General Decommissioning Concept

Before ceasing operation of individual WTGs or the entire Project and prior to decommissioning and removing Project components, Vineyard Wind will consult with BOEM and submit a decommissioning plan for review and approval. Upon receipt of the necessary BOEM approval and any other required permits, Vineyard Wind would implement the decommissioning plan to remove and recycle equipment and associated materials.

As currently envisioned, the decommissioning process is essentially the reverse of the installation process. Decommissioning of the Project is broken down into several steps:

- Retirement in place or removal of offshore cable system (e.g., 66 kV inter-array and 220 kV offshore export cables).
- Dismantling and removal of WTGs.
- Cutting and removal of monopile foundations (and/or jackets) and removal of scour protection.
- Removal of ESPs.
- Possible removal of onshore export cables.

It is anticipated that the equipment and vessels used during decommissioning will likely be similar to those used during construction and installation. For offshore work, vessels would likely include cable laying vessels, crane barges, jack-up barges, larger support vessels, tug boats, crew transfer vessels, and possibly a vessel specifically built for erecting WTG structures.

For onshore work, subject to discussions with the host town(s) on the decommissioning approach that best meets the host town's needs and has the fewest environmental impacts, the onshore cables, the concrete encased duct bank itself, and vaults would be left in place for future reuse as would elements of the onshore substation and grid connections. If onshore cable removal is determined to be the preferred approach, removal of cables from the duct bank would likely be done using truck mounted winches, cable reels and cable reel transport trucks.

4.4.4 Decommissioning Plan and Procedures

The offshore cables could be retired in place or removed, subject to discussions with the appropriate regulatory agencies on the preferred approach to minimize environmental impacts. If removal is required, the first step of the decommissioning process would involve disconnecting the inter-array 66 kV cables from the WTGs. Next, the inter-array cables would be pulled out of the J-tubes or similar connection and extracted from their embedded position in the seabed. In some places, in order to remove the cables, it may be necessary to jet plow

[Extract from COP]

the cable trench to fluidize the sandy sediments covering the cables. Then, the cables will be reeled up onto barges. Lastly, the cable reels will then be transported to the port area for further handling and recycling. The same general process will likely be followed for the 220 kV offshore export cables. If protective concrete mattresses or rocks were used for portions of the cable run, they will be removed prior to recovering the cable.

Prior to dismantling the WTGs, they would be properly drained of all lubricating fluids, according to the established operations and maintenance procedures and the OSRP. Removed fluids would be brought to the port area for proper disposal and / or recycling. Next, the WTGs would be deconstructed (down to the transition piece at the base of the tower) in a manner closely resembling the installation process. The blades, rotor, nacelle, and tower would be sequentially disassembled and removed to port for recycling using vessels and cranes similar to those used during construction. It is anticipated that almost all of the WTG will be recyclable, except possibly for any fiberglass components.

After removing the WTGs, the steel transition pieces and foundation components would be decommissioned. Sediments inside the monopile could be suctioned out and temporarily stored on a barge to allow access for cutting. The foundation and transition piece assembly is expected to be cut below the seabed in accordance with the BOEM's removal standards (30 C.F.R. 250.913). The portion of the foundation below the cut will likely remain in place. Depending upon the available crane's capacity, the foundation/transition piece assembly above the cut may be further cut into several more manageable sections to facilitate handling. Then, the cut piece(s) would then be lifted out of the water and placed on a barge for transport to an appropriate port area for recycling.

The steel foundations would likely be cut below the mudline using one or a combination of: underwater acetylene cutting torches, mechanical cutting, or a high pressure water jet. The sediments previously removed from the inner space of the pile would be returned to the depression left once the pile is removed. To minimize sediment disturbance and turbidity, a vacuum pump and diver or ROV-assisted hoses would likely be used.

As described in Section 3.1.3, each of the WTGs and ESPs would have stone and/or rock scour protection. Vineyard Wind would propose that the scour protection be removed. The stone and/or rock would likely be excavated with a dredging vessel, set on a barge, and transported to shore for reuse or disposal at an onshore location.

The ESPs will be disassembled in a similar manner as the WTGs, using similar vessels. Prior to dismantling, the ESP would be properly drained of all oils, lubricating fluids, and transformer oil according to the established operations and maintenance procedures and OSRP. Removed fluids would be brought to the port area for proper disposal and / or recycling. Similarly, any SF6 in gas insulated switchgear would be carefully removed for reuse. Before removing the ESPs, the 220 kV offshore export cables would be disconnected from the ESP and removed, as discussed for inter-array cables above.

[Extract from COP]

The substation platform itself would then be removed from its supporting monopile or jacket foundation, and placed on a barge for transport to port. Depending on the crane capacity available and design of the substation, some of the major electrical gear could be removed first, followed by the platform itself. The ESP foundation piles will likely be removed according to the same procedures used in the removal of the WTG foundations described above.

During decommissioning activities, a careful inventory of all Project components to be removed would be made. This inventory would include the WTGs, ESPs, foundations, offshore export cables, inter-array cables, inter-link cables, cable protection system, and so forth. As they are removed from the site, Project components would be counted and noted as removed in the inventory. This careful reporting system will ensure that all Project components are removed. No additional site clearance work or surveys are anticipated to be required to confirm site clearance.

The environmental impacts from these decommissioning activities would be generally similar to the impacts experienced during construction.

As noted above, the extent of the decommissioning of onshore components, such as the onshore export cable, will be determined in consultation with the host towns, as many of the onshore components could be retired in place or retained for future use. If decommissioning of the Landfall Site, transition vault, and onshore export cable components is required, the process will consist of pulling the cables out of the duct bank, loading them onto truck-mounted reels, and transporting them offsite for recycling or possible reuse. The splice vaults, conduits, and duct banks will likely be left in place, available for reuse. This approach will avoid disruption to the streets.

In addition, decommissioning of the offshore facilities would require the involvement of an onshore recycling facility with ability to handle the large quantities of steel and other materials from the Project. Such facilities currently in operate in New England. One example is the Prolerized New England, Inc. facility on Boston Harbor in Everett Massachusetts. The Everett facility is located in a heavy industrial area and has deep water access, allowing for the foundations, WTGs, and other large components to be directly offloaded from the barges, cut into manageable sections, shredded into smaller pieces, and then shipped to end-users as scrap metal. This facility also routinely handles large volumes of scrap metal from auto recycling and a variety of demolition projects.

Currently, the fiberglass in the rotor blades has no commercial scrap value. Consequently, it is anticipated that the fiberglass from the blades would be cut into manageable pieces and then disposed of at an approved onshore solid waste facility.

[Extract from USACE Permit]

from BOEM to operate the proposed project for 30 years. For purposes of the maximum-case scenario and to ensure impacts are evaluated if BOEM grants such an extension, BOEM analyzes a 30-year operations term. Although the proposed Project has a designed life span of 30 years, some installations and components may remain fit for continued service after this time. Vineyard Wind would have to apply for an extension if it wished to operate the proposed Project for more than 30 years. This consultation does not consider operation of the proposed Project beyond the 30-year designed life span. Vineyard Wind would monitor operations primarily from the Operations and Maintenance Facilities in Vineyard Haven on Martha's Vineyard and a 24-hour a day / seven days a week control center on the mainland.

Crew transfer vessels and helicopters would transport crews to the proposed offshore Project area during operations and maintenance. During the operations phase, there would be trips by crew transport vessels (CTV) (about 75 ft. [22.3 m] in length), multipurpose vessels, and service operations vessels (SOV) (260 to 300 ft. [79.2 to 91.4 m] in length), with larger vessels based at the MCT and smaller vessels based at Vineyard Haven. Vineyard Wind anticipates that on average fewer than three operations and maintenance vessels will operate in the WDA per day for regularly scheduled maintenance and inspections. In other maintenance or repair scenarios, additional vessels may be required, which could result in a maximum of three to four vessels per day operating within the WDA. Consequently, Vineyard Wind anticipates that there would be a maximum of three to four daily trips from New Bedford Marine Commerce Terminal and/or Vineyard Haven. This equates to a maximum of 124 vessel trips per month from either port. Helicopters may also be used for access and/or for visual inspections. The helicopters would be based at a general aviation airport near the Operations and Maintenance Facilities.

WTG gearbox oil is anticipated to be changed after 5, 13, and 21 years of service. Additional operations and maintenance information can be found in COP Section 4.3.

3.2.4. Decommissioning

According to 30 CFR part 585 and other BOEM requirements, Vineyard Wind would be required to remove or decommission all installations and clear the seabed of all obstructions created by the proposed Project. All facilities would need to be removed 15 feet (4.6 meters) below the mudline (30 CFR § 585.910(a)). Absent permission from BOEM, Vineyard Wind would have to complete decommissioning within two years of termination of the lease and either reuse, recycle, or responsibly dispose of all materials removed.

Offshore cables may be retired in place or removed. In consideration of mobile gear fisheries (i.e., dredge and bottom trawl gears), Vineyard Wind has stated that it is committed to removing scour protection during decommissioning.

Vineyard Wind would drain WTG and ESP fluids into vessels for disposal in onshore facilities before disassembling the structures and bringing them to port. Foundations would be temporarily emptied of sediment, cut 15 feet (4.6 meters) below the mudline in accordance with BOEM regulations (30 CFR § 585.910(a)), and removed. The portion buried below 15 feet (4.6 meters) would remain, and the depression would be refilled with the sediment that had been temporarily removed.

[Extract from USACE Permit]

By maintaining an inventory list of all components of the proposed Project, the decommissioning team would be able to track each piece so that no component would be lost or forgotten. The above decommissioning plans are subject to a separate approval process under BOEM. BSEE will review decommissioning plans and provide recommendations to BOEM as part of the approval process. This process will include an opportunity for public comment and consultation with municipal, state, and federal management agencies. Vineyard Wind would require separate and subsequent approval from BOEM to retire any portion of the Proposed Action in place. Regulations default to complete site clearance.

During decommissioning, Vineyard Wind estimates the level of trips to be about 90 percent of those occurring during construction, or a maximum of approximately 990 trips per month from New Bedford, 90 trips per month from Brayton Point, Montaup, Providence, or Quonset, and 45 trips per month from Canada. Assuming that decommissioning is essentially the reverse of construction, except that offshore cables remain in place and Project components do not need to be transported overseas, Vineyard Wind anticipates decommissioning activities will require approximately 4,800 vessel trips (approximately 240 vessel trips may originate from Canada).

Appendix B Atlantic Shores Offshore Wind Extracted Sections from COP

6.0 Decommissioning

Decommissioning will broadly occur in the reverse order of construction and will be conducted in accordance with the applicable requirements discussed in Section 6.1.

6.1 Decommissioning Requirements

The Atlantic Shores Project Companies will follow the decommissioning requirements stated in Section 13, "Removal of Property and Restoration of the Leased Area on Termination of Lease," of the December 4, 2018 Lease Agreement for Lease Area OCS-A 0499. Pursuant to the applicable regulations in 30 CFR §585.902, and unless otherwise authorized by the Bureau of Ocean Energy Management (BOEM) under 30 CFR §585.909, Atlantic Shores Project Companies will be required to remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seabed of all obstructions created by activities on the leased area, including any project easements(s). Removal or decommissioning activities must be completed within two years after lease termination (whether by expiration, cancellation, contraction, or relinquishment) in accordance with an approved Site Assessment Plan (SAP), Construction and Operations Plan (COP), or approved Decommissioning Application and applicable regulations in 30 CFR Part 585. Per 30 CFR §585.910(a), all offshore facilities must be removed to 15 feet (ft) (4.5 meters [m]) below the mudline, unless otherwise authorized by BOEM.

Atlantic Shores Project Companies will submit a Decommissioning Application to BOEM prior to decommissioning any Projects' facilities. BOEM's process for reviewing and approving this plan will include consultations with municipal, state, and federal agencies, other stakeholders, and the public.

6.2 Decommissioning Activities

The anticipated decommissioning process for each Project component is described in the following sections. Vessels used to complete offshore decommissioning activities will likely resemble those used during installation and could include jack-up vessels, heavy-lift vessels, and support vessels such as tugboats and crew transfer vessels (CTVs) (see Section 4.10.1). For onshore decommissioning activities, equipment will likely include truck-mounted winches, cable reels, and cable reel transport trucks.

When possible, the Projects' components removed during decommissioning will be recycled (e.g., steel foundation components). However, some materials may have no scrap value or capability to be recycled (e.g., fiberglass wind turbine generator [WTG] components); these materials would be broken down and disposed of at an approved onshore solid waste facility.

After the Projects' offshore facilities are removed, Atlantic Shores Project Companies will verify site clearance in accordance with 30 CFR §585.910(b).

6.2.1 WTGs

WTG components will be drained of any fluids and chemicals according to the established operations and maintenance (O&M) procedures and the Oil Spill Response Plan (OSRP) (see Section 1.5.3.2), which will be collected and properly disposed of or recycled. Before removing the WTGs, inter-array cables will be disconnected. WTG components will then be disassembled and removed from their foundations, shipped to shore, and recycled or scrapped. Removing the WTG blades, rotor, nacelle, and tower will involve the use of vessels with cranes that are similar to those utilized for installation and assembly.

6.2.2 Offshore Substations

Similar to WTGs, before offshore substation (OSS) decommissioning activities commence, any export cables, inter-array cables, and inter-link cables will be disconnected from the OSS. The OSS topsides will then be disassembled and removed from their foundations using cranes, shipped to shore, and recycled or scrapped. In accordance with the OSRP, OSS equipment will be drained of any fluids and chemicals, which will be collected and then properly disposed of or recycled. Any sulfur hexafluoride (SF_6) in gas-insulated switchgear will be carefully removed for reuse.

6.2.3 WTG and OSS Foundations

The procedures used for decommissioning the WTG and OSS foundations will depend on the type of foundation:

- **Piled foundations:** These foundation types will be cut below the mudline and will be completely removed above that cut. To facilitate cutting, any sediment within the piles will be suctioned out and collected; after foundation removal, any collected sediment will be placed in the depression left after removal using a vacuum pump and diver or remotely-operated vehicle (ROV)-assisted hoses to minimize turbidity. Cutting steel foundations will likely be accomplished with underwater acetylene cutting torches, mechanical cutting, and/or a high-pressure water jet. Once cut, a crane will lift the foundation onto a vessel for transport to port; a foundation may be cut into multiple sections for ease of transport.
- **Suction bucket foundations:** Injecting water into the suction buckets will essentially reverse the installation process, pushing them back out of the seabed sediment and enabling complete removal of these foundations.
- **Gravity foundations:** Ballast within the foundations will be removed and the foundations will be floated away from the installation site. If it is not possible to re-float the gravity foundation, it will be disassembled on-site, and all components will be removed.

It is possible that, pending environmental assessment and regulatory approval, some foundations may be left in place as artificial reefs. In addition, scour protection around foundations may be removed or left in place pending future environmental assessment. If it is determined that scour protection needs to be removed, it will be excavated with a dredging vessel or removed by vessel's crane and transported to port for reuse or disposal.

6.2.4 Offshore Cables

Export cables, inter-array cables, and inter-link cables (if present) will either be retired in place or removed from the seabed. The decision regarding whether to remove these cables and any overlying cable protection will be made based on future environmental assessments and consultations with federal, state, and municipal resource agencies. For example, if cable protection is functioning as reef habitat, it may be less disruptive and more beneficial to leave such structure undisturbed on the seabed.

If it is determined that offshore cables should be removed from the seabed, any overlying cable protection will need to be removed first, then the cables will be extracted from the seabed. Where these cables are buried in dense sediments, it may be necessary to fluidize overlying sediments before extracting the cables. Cables freed from the seabed will be coiled onto reels or cut into manageable lengths and transported to port for recycling.

6.2.5 Met Tower

Similar to WTGs and OSS topsides, the meteorological (met) tower will be disassembled and removed from its foundation using cranes, shipped to shore, and recycled or scrapped. Decommissioning of the met tower's foundation will follow the steps outlined in Section 6.2.3.

6.2.6 Onshore Facilities

Depending largely on future consultations with state and municipal agencies, onshore facilities (e.g., onshore substations and buried duct banks) will either be retired in place or reused for other purposes. For example, because removing buried concrete duct banks would require excavations similar to those involved with installation, leaving these conduits in place for other infrastructure could be less disruptive and beneficial. Even if duct banks are left in place for future use, the onshore cables will likely be removed from the conduits and recycled accordingly.

6.3 Financial Assurance for Decommissioning

Financial assurance for the Project will be provided in accordance with the terms and conditions required by BOEM in the Lease Agreement for Lease Area OCS-A 0499 and applicable requirements under 30 CFR Part 585, Subpart E.

Appendix C Empire Wind Project Extracted Sections from COP

3.6 Decommissioning Activities

In accordance with 30 CFR Part 585 and other BOEM requirements, Empire will be required to remove and/or decommission all Project infrastructure and clear the seabed of all obstructions. The decommissioning process for the wind turbines, foundations, and offshore substations is anticipated to be the reverse of installation, with Project components transported to an appropriate disposal and/or recycling facility. All foundations/Project components will need to be removed 15 ft (4.6 m) below the mudline (30 CFR § 585.910(a)), unless other methods are deemed suitable through consultation with the regulatory authorities, including BOEM. Submarine export and interarray cables will be retired in place or removed in accordance with a Decommissioning Plan; Empire would need to obtain separate and subsequent approval from BOEM to retire any portion of the Proposed Action in place. Project components will be decommissioned using a similar suite of vessels, as described in **Table 3.4-1**. Environmental impacts are anticipated to be similar to those experienced during construction and installation activities, as described in **Section 3.4**. Onshore components will be decommissioned in accordance with a plan developed with and approved by the appropriate parties (i.e. landowners, local and state agencies). Although EW 1 and EW 2 have an assumed a lifetime of approximately 35 years for the purposes of this COP, some installations and components may remain fit for continued service after such time, where Empire may seek to repower such installations if extension is authorized by BOEM. Upon initiation of decommissioning activities, Empire will complete decommissioning within two years of termination of the Lease and either reuse, recycle, or responsibly dispose of all materials removed, unless otherwise authorized by BOEM. Decommissioning activities will be detailed in a Decommissioning Plan, which is subject to an approval process that includes public comment and government agency consultation. The Decommissioning Plan will be developed based on a factor-based approach, utilizing the environmental and socioeconomic factors to determine a strategy and methodology that is appropriate at the time. As part of this plan, Empire will compile an inventory of Project components and detail the methods proposed to decommission the Project components. As Project components are decommissioned, Empire will record and remove from the inventory list, to facilitate confirmation that Project components have been properly removed from the seafloor and that the Project Area is cleared of obstructions. This inventory will include those described in **Section 3.3**.

The types of vessels and total vessel trips required for decommissioning are expected to approximately the same as or less than construction, as the decommissioning process is anticipated to be the reverse of installation. Surveys are not anticipated to be required for decommissioning. If surveys are required to support decommissioning activities, the equipment used for these surveys will be similar to those permitted for the completed surveys to support construction and will be subject to applicable permitting prior to the initiation of survey.

Table 3.6-1 provides additional detail on likely removal methods and assumptions that would be applicable based on present day understanding of available decommissioning approaches.

Table 3.6-1 Summary of Decommissioning Methods and Assumptions

Item	Removal Method	Comments and Assumptions
Wind turbine	Removal of the wind turbines are done using a reversed installation method. Oils, greases, and fuels will be removed in accordance with the Oil Spill Response Plan (OSRP) and relevant safety requirements before the wind turbines are disassembled. Decommissioning of the turbines and towers is assumed to include removal of the rotor, nacelle, blades and tower to be removed in the revers installation order.	Materials brought onshore to U.S. port for recycling and disposal. Steel in the tower is assumed to be recycled. The blades are assumed to be disposed at an approved location.
Monopile foundation and TP	Removal of the monopile TP foundations are done using a reversed installation method. Sediments inside the monopile will be removed by suction prior to cutting, if necessary, and replaced in the depression once the monopile is removed. Diver-assisted or remote-operated hoses may be used to reduce sediment disturbance. Removal of the monopile is assumed to be cut off 15 ft (4.6 m) below the mudline and be lifted off by a heavy lift vessel to a barge prior to decommissioning.	Monopile to be cut below mudline and transported to U.S. port for recycling. Monopiles are assumed to be cut using mechanical cutting, high-pressure water jet, and/or cutting torches designed for underwater use. No pile driving will be required for decommissioning. Steel is assumed to be recycled.
Offshore substation topside	Removal of the topside is done using a reversed installation method. Oils, greases, and fuels will be removed in accordance with the OSRP and relevant safety requirements before the offshore substation topside is removed. The offshore substation topside is assumed to be lifted off in one piece by a heavy lift vessel to a barge prior to decommissioning.	Transported to Europe or U.S. port for recycling and disposal. Removed fluids would be brought to U.S. port for recycling and disposal. Steel from the topside is assumed to be recycled.
Jacket with piles	The piles are assumed to be cut 15 ft (4.6 m) below the mudline, before the jacket is lifted off in one section by a heavy lift vessel to a barge prior to decommissioning.	Cut below mudline and transported to U.S. port for recycling. Piles are assumed to be cut using mechanical cutting, high-pressure water jet, and/or cutting torches designed for underwater use. No pile driving will be required for decommissioning. Steel from the jacket and piles is assumed to be recycled.
Offshore cables	The submarine export cables and interarray cables are assumed to be lifted out and cut into pieces or reeled in onto barges for transport. Cables be disconnected from wind turbines and the offshore substation before removal. J-tubes will be removed.	Total removal of cable and transported to Europe or U.S. port for recycling. In some places, jet plowing may be used to loosen sediment above the cable. Core material to be recycled.

Table 3.6-1 Summary of Decommissioning Methods and Assumptions (continued)

Item	Removal Method	Comments and Assumptions
Onshore substation	Removal of the buildings and equipment, unless suitable for future use.	Materials to be recycled. To be demolished and recycled unless suitable for future use. Site to be prepared for future use. Disassembly of the onshore substation and preparation of the site for future use is assumed to use similar vehicles and equipment as construction.
Onshore cables	Removal of the cable is assumed to be limited to disconnecting and cutting at the fence site below ground level, this on both sides. The onshore export and interconnection cables and the duct banks are assumed to be retired in place.	Remaining cable capped off and earthed. Removal of termination points and cut of cable 3 ft (0.9 m) below ground level.
Scour protection and rock filling	Alternatives: • Removal of scour protection and rock filling. • Leave scour protection in place, as undisturbed as possible.	Assumed to be removed unless leaving in place is deemed appropriate through consultation with the authorities. Removal of scour protection is assumed to use a dredging vessel. Removed material would be re-used, if possible, or transported to U.S. port for disposal.

Appendix D Ocean Wind Offshore Wind Farm Extracted Sections from COP

6.3 Decommissioning Plan

At the end of the operational lifetime of the Project, Ocean Wind will decommission the Project in accordance with 30 CFR § 585.902 and 30 CFR §§ 585.905 through 585.912. The process will start with the submission of a decommissioning application in accordance with 30 CFR § 585.905. It is anticipated that all structures above the seabed level or aboveground will be completely removed. The decommissioning sequence will generally be the reverse of the construction sequence, will involve similar types and numbers of vessels, and will use similar equipment.

Although decommissioning may not require the same level of precision and care as the initial installation, it will nonetheless be undertaken in the same controlled manner and in accordance with an approved risk management plan to ensure the highest levels of safety.

6.3.1 Offshore Decommissioning

The dismantling and removal of the turbine components (e.g., blades, nacelle, and tower) will largely be a "reverse installation" process subject to the same constraints as the original construction phase. Using today's technology, dismantling the turbine components requires a jack-up vessel to ensure adequate control of the demolition process and to manage the high lifts and high crane hook loads.

It is anticipated that the monopile foundations will be cut below the seabed level in accordance with standard practices at the time of demolition. The exact depth will depend on seabed conditions (e.g., dynamics and site characteristics) and developing industry best practices. The cutting process is likely to be via mechanical cutting, water-jet cutting, or other common industry practices.

If deployed, the scour protection placed around the base of each monopile will be left in situ as the default option in order to preserve the marine life that may have established itself on this substrate during the period of operation. If it is necessary to remove the scour protection, then the removal will proceed according to the best practices applicable at the time of decommissioning.

The offshore substation will be decommissioned by dismantling and removing its topside and foundation (substructure). As with the turbine components, this operation will be a reverse installation process subject to the same constraints as the original construction phase.

Offshore cables will either be left in situ or removed, or a combination of both, depending on the regulatory requirements at the time of decommissioning. It is anticipated that the array cables will be removed using controlled flow excavation or a grapnel to lift them from the seabed. Alternatively, depending on available technology, a ROV may be used to cut the cable so that it can be recovered to the vessel. The export cables will be left in situ or wholly/partially removed. Any cable ends will be weighed down and buried if the cables are to be left in situ to ensure that the ends are not exposed or have the potential to become exposed post-decommissioning. Cables may be left in situ in certain locations, such as pipeline crossings, to avoid unnecessary risk to the integrity of the third-party cable or pipeline.

6.3.2 Onshore Decommissioning

Onshore cables generally will be abandoned in place. Some components of the onshore electrical infrastructure may still have substantial life expectancies at the time of decommissioning. Hence, the potential reallocation of some or all of these assets may be investigated with PJM, the onshore grid operators. The future disposition of this infrastructure will depend in part on these discussions.

Any cable ends will be buried if the cables are to be abandoned in situ to ensure that the ends are not exposed or have the potential to become exposed post-decommissioning. If buried cables are removed in most locations, they may be left in situ in certain specific locations such as road or railroad crossings to avoid unnecessary risk to the integrity of the surrounding infrastructure. Onshore cables installed overhead may either be used for other projects or be removed depending on the need at that time.

Offshore wind turbines have a large amount of material that must be removed after the structures are decommissioned. Disposal will be according to decommissioning industry best practices and the applicable regulations at the time of decommissioning. The appropriate waste hierarchy will also be followed: reuse is considered first and maximized when possible, followed by recycling, incineration with energy recovery, and lastly, disposal.