FIVE ESTUARIES
OFFSHORE WIND FARM

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VOLUME 9, REPORT 3: OFFSHORE PROJECT DESIGN PRINCIPLES

Application Reference	EN010115
Application Document Number	9.3
Revision	A
AFPF Regulation	5(2)(q)
Date	March 2024

Project	Five Estuaries Offshore Wind Farm
Sub-Project or Package	Other Documents
Document Title	Volume 9, Report 3: Offshore Project Design Principles
Application Document Number	9.3
Revision	A
Document Reference	005023919-01
APFP Regulation	5(2)(q)

Revision	Date	Status/Reason for Issue	Originator	Checked	Approved
A	Mar-24	ES	VEOFWL	VE OWFL	VE OWFL

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DEFINITION OF ACRONYMS

Term	Definition
AEZ	Archaeological Exclusion Zone
CCUS	Carbon Capture Usage and Storage
CSIP	Cable Specification and Installation Plan
DCO	Development Consent Order
ECC	Export Cable Corridor
ES	Environmental Statement
ESCA	European Subsea Cables Association
IMO	International Maritime Organisation
LAT	Lowest Astronomical Tide
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
MMO	Marine Management Organisation
MoD	Ministry of Defence
MW	Megawatts
NIP	Navigation Installation Plan
NPS	National Policy Statement
NRA	Navigational Risk Assessment
OREI	Offshore Renewable Energy Installations
OSP	Offshore Substation Platform
SAR	Search and Rescue
SoS	Secretary of State
TSS	Traffic Separation Scheme
VE	Five Estuaries Offshore Wind Farm
VEOWFL	Five Estuaries Offshore Wind Farm Limited
WSIs	Written Schemes of Investigation
WTG	Wind Turbine Generator

GLOSSARY OF TERMS

Term	Definition
DCO Application	An application for consent to undertake a Nationally Significant Infrastructure Project made to the Planning Inspectorate who will consider the application and make a recommendation to the Secretary of State, who will decide on whether development consent should be granted for a proposed development.
Decommissioning	The period during which a development and its associated processes are removed from active operation.
Environmental Impact Assessment (EIA)	The written output presenting the full findings of the Environmental Impact Assessment.
Impact	The changes resulting from an action.
Mitigation	Mitigation measures, or commitments, are commitments made by the project to reduce and/or eliminate the potential for significant effects to arise as a result of the project.
Nationally Significant Infrastructure Project (NSIP)	Nationally Significant Infrastructure Projects are major infrastructure developments in England and Wales which are consented by DCO. These include proposals for renewable energy projects with an installed capacity greater than 100MW.
Secretary of State	The authority who makes the decision to grant development consent.

1 INTRODUCTION

1.1.1 Five Estuaries Offshore Wind Farm Ltd (VE OWFL or the Applicant) plans to submit an application to the Planning Inspectorate on behalf of the Secretary of State, for a Development Consent Order (DCO) for the Five Estuaries Offshore Wind Farm (herein referred to as VE).

1.1.2 VE is the proposed extension to the operational Galloper Offshore Wind Farm located 37km off the coast of Suffolk and comprises both offshore and onshore infrastructure within the administrative area of Essex Country Council. VE will have an overall capacity of greater than 100 Megawatts (MW) and therefore constitutes a Nationally Significant Infrastructure Project (NSIP) under the Section 15 (3) of the Planning Act 2008. Such projects require a Development Consent Order (DCO) to be granted by the relevant UK Secretary of State (SoS).

2 PURPOSE OF THE DOCUMENT

2.1.1 There are many factors that influence the final Wind Turbine Generator (WTG) array layouts for any offshore wind farm, including technical constraints, safety considerations, wind resource assessments, stakeholder feedback and legislative or policy requirements. The final layout will only be known post-consent, once detailed geophysical and geotechnical surveys have been completed and the offshore infrastructure, including WTG model, foundation type and size, and cable routing, have been fixed. The proposed final layout will be submitted to the Marine Management Organisation (MMO) for approval, following consultation with relevant statutory stakeholder including the Maritime and Coastguard Agency (MCA) and the Ministry of Defence (MoD).

2.1.2 This document sets out the considerations and constraints that have and will influence the final WTG array layout for VE. It focuses on the array area and therefore concerns specifically the WTGs, Offshore Substation Platforms (OSPs) and inter-array cables, whilst the design of the export cable with the Export Cable Corridor (ECC) is considered in the Outline Cable Specification and Installation Plan (CSIP) (Volume 9, Document 9.12) and the Navigation and Installation Plan (NIP) (Volume 9, Document 9.20).

2.1.3 The process of determining the location and design of the array area itself is set out in detail in the Site Selection chapter of the Environmental Statement (ES) (Volume 6, Part 1, Chapter 4), which describes the need for the project and the constraints that have led the project boundary, as shown in Figure 1. This document focuses on the considerations for design within the array area, rather than site selection of the area itself.

3 LEGISLATION, POLICY AND GUIDANCE

The relevant legal and policy tests that apply to the design and site selection of VE are set out in application documents, in particular the Site Selection ES chapter (Volume 6, Part 1, Chapter 4), Seascape, Landscape Visual Impact Assessment ES chapter (Volume 6, Part 2, Chapter 10) and the Planning Statement (Document 9.1). Those specifically relevant to the design of the WTG array are described below.

3.1 NATIONAL POLICY STATEMENTS

3.1.1 The National Policy Statements (NPS) for Energy have recently been revised and came into force in January 2024.

3.1.2 The criteria for 'good design' for energy infrastructure is set out in NPS EN-1, section 4.7. This sets out the need for Applicants to 'demonstrate in their application documents how the design process was conducted and how the proposed design evolved' (paragraph 4.7.7).

3.1.3 NPS EN-3 states in paragraph 3.5.2 that 'Proposals for renewable energy infrastructure should demonstrate good design, particularly in respect of landscape and visual amenity, opportunities for co-existence/co-location with other marine uses, and in the design of the project to mitigate impacts such as noise and effects on ecology and heritage.'.

3.1.4 NPS EN-3 also recognises that there are a number of factors influencing site selection and design. Of those that relate primarily to turbine array design it describes at paragraph 3.8.40 that 'wind resource is critical to the economics of a proposed offshore wind farm' and at paragraph 3.8.43 that 'Water depth, bathymetry and geological conditions are all important considerations for the selection of sites and will affect the design of the foundations of the turbines, the layout of turbines within the site and the siting of the cables that will export the electricity.'. It further notes at paragraph 3.8.56 that 'There may be constraints imposed on the siting or design of offshore wind farms because of the presence of other offshore infrastructure, such as co-existence/co-location, oil and gas, Carbon Capture, Usage and Storage (CCUS), co-location of electrolysers for hydrogen production, marine aggregate dredging, telecommunications, or activities, such as aviation and recreation'.

3.1.5 With respect to seascape and visual effects, NPS EN-3 states in paragraph 3.8.281 that '…the siting layout of the turbines should be designed appropriately to minimise harm, considering other constraints such as ecological effects, safety reasons or engineering and design parameters.', demonstrating the complexity of considerations that will influence turbine array design.

3.2 ENVIRONMENTAL IMPACT ASSESSMENT AND HABITATS REGULATIONS

3.2.1 The 2017 EIA regulations and the Habitats Regulations require consideration of alternatives including with respect to design, the details of which are set out in the Site Selection ES chapter (Volume 1, Chapter 4). With specific regard to the WTG array design, these regulations place obligations on the Applicant to avoid, reduce, mitigate or compensate for impacts to protected habitats and species, and this will influence the final WTG layout.

3.3 SHIPPING AND NAVIGATION

3.3.1 Marine Guidance Note (MGN) 654 (Safety of Navigation: Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response, 2021) is published by the MCA and provides guidance on turbine layouts with respect to navigational safety and Search and Rescue (SAR). In particular, section 6.2 deals with layout design and the considerations that VE will factor into their layout assessment and safety justification. Further WTG layout considerations in relation to MGN 654 are described in the Navigation Risk Assessment (NRA) (Volume 9, Document 9.10)

3.4 MARINE ARCHAEOLOGY

3.4.1 Archaeological Written Schemes of Investigation for Offshore Wind Farm Projects, published by The Crown Estate in 2021, sets out a range of archaeological methodologies that may be required in the production of Written Schemes of Investigation (WSIs). Part of the guidance covers the use of archaeological exclusion zones that may affect WTG and cable placement within the array area. These may be applied during development where marine archaeology is identified, or during further investigation post-consent. The Project's approach to marine archaeology and the identification of Archaeological Exclusion Zones (AEZs) are set out in the Outline Marine Written Scheme of Investigation (WSI) (Volume 9, Document 9.19).

3.5 CABLES AND PIPELINES

3.5.1 Guidance on WTG offset distances from subsea electrical and telecommunications cables can be found in European Subsea Cables Association (ESCA) Guideline No.6 – The Proximity of Offshore Renewables Energy installations & Submarine Cable Infrastructure in UK Waters (2016). The Project has considered these guidelines in engaging with detailed proximity and crossing design discussions with telecoms operators for assets within the array area. Further details can be found in the Other Marine Users ES chapter (Volume 6, Part 2, Chapter 12), the Outline Cable Specification and Installation Plan (Volume 9, Document 9.12) and the Outline Navigation and Installation Plan (Volume 9, Document 9.20)

3.5.2 Safety zones for oil and gas infrastructure including pipelines are set out under section 23 of the Petroleum Act (1987), however no such infrastructure has been identified within the VE array areas.

4 OFFSHORE DESIGN CONSTRAINTS

4.1.1 The site selection process, as set out in the Site Selection and Alternatives ES chapter (Volume 1, Chapter 4), considered a number of restrictions on development (or 'hard constraints') in defining the array boundary including:

- Location of other wind farms
- The Sunk Traffic Separation Scheme (TSS)
- Environmental constraints
- Disposal sites;
- Aggregate extraction sites;
- Oil and gas infrastructure;
- Surface structures with helipads;
- International Maritime Organisation (IMO) shipping routes;
- Bathymetric contours (5 m intervals);
- Consented and/ or operational developments;
- Wrecks;
- Active pipelines; and
- Active cables

4.1.2 Whilst every effort was made to avoid these restrictions where practicable, the requirement of The Crown Estate's extensions leasing process to be adjacent to the Galloper Wind Farm array boundary has meant some hard constraints have been identified within the VE array area, as shown in Table 1. These known hard constraints will restrict the flexibility of WTG array design.

Table 1: Hard constraints on WTG array design

Constraint	Potential Impact	Layout consideration
Marine archaeology (wrecks)	Installation of WTGs and inter-array cables have the potential to damage marine archaeology including wreck sites.	Where wrecks have been identified (either as charted by the UKHO or through site specific geophysical surveys) an appropriate Archaeological Exclusion Zone (AEZ) will be agreed to protect the asset. Identified AEZs are set out in the Outline Marine WSI (Volume 9, Document 9.19). In general AEZs apply up to 50m from identified extent of the wreck, however this may vary depending on certainty, likely impact and value of the asset.
Submarine cables	Installation and maintenance of WTGs has the potential to damage marine infrastructure. A	Typically a minimum 250m buffer from subsea cables is assumed, subject to commercial discussions with the operators. VE is engaging with all

Constraint	Potential Impact	Layout consideration
	number of cables (or cable routes) have been identified within the northern array area.	cable operators and agreement in principle for proximity and crossings has been reached, in line with relevant guidance. The final agreed distance must consider not only the location of the WTG but also proximity of Jack-up barge legs and/or vessel anchor spreads, therefore in reality WTGs may end up being further away from these restrictions. Further details regarding impacts on other marine users are described in the Other Marine Users ES Chapter (Volume 6, Part 2, Chapter 12).

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LEGEND

- Scoping Array Areas
- Pilot Boarding Place
- Open Disposal Sites
- Wrecks
- Existing OWF Cables
- SeaLink Interconnector

Subsea Cable:

- Power - Active
- Power - Proposed
- Telecom - Active
- Telecom - Disused

Ship Routeing Areas:

- Navigational Precautionary Areas
- Traffic Separation Scheme Lanes
- Traffic Separation Zones

Aggregates Areas:

- Exploration and Option Area
- Production Agreement Area

Offshore Wind Farms (Status):

- Operational
- Consented

0 2.5 5 10

Kilometers

Data Source:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

PROJECT TITLE:

FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:

Key Constraints

VER	DATE	REMARKS	Drawn	Checked
1	13/03/2024	For Information	BPHB	MB

DRAWING NUMBER: 4.1

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:300,000	A3	WGS84	UTM31N

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5 OFFSHORE DESIGN CONSIDERATIONS AND PRINCIPLES

5.1.1 In addition to the hard constraints listed in Table 1, there are a number of factors which will influence the final WTG layout.

5.1.2 As set out in Section 3.1, the NPSs recognise the myriad considerations for offshore wind design, all of which must be balanced with the benefits of the project in terms of capacity and providing an economically viable source of renewable energy. Table 2 below sets out the primary considerations or principles that will influence the turbine array design, all of which will be factored into the final layout for submission to the MMO for approval. These are further described in Section 1.5 of the Offshore Project Description ES Chapter (Volume 6, Part 2, Chapter 1).

Table 2: Design considerations and principles for WTG array

Consideration	Potential Impact	Layout consideration / design principle
Wind resource	WTG array design will have a major effect on the efficiency of the wind farm, the electricity generated and ultimately the cost of energy. NPS EN-3 supports the importance of this consideration at paragraph 3.8.40 stating that 'Available wind resource is critical to the economics of a proposed offshore wind farm.'	The WTG layout will be modelled to take into account wake effects from other offshore wind farms and VE's WTGs, with the proximity of WTGs to each and orientation of WTG rows being critical factors in designing an efficient wind farm. Furthermore, the DCO sets out the minimum distance between WTGs as 830m.
Seabed conditions	Unsuitable seabed conditions may make turbine installation unfeasible or require significant amounts of seabed preparation with the associated potential for environmental effects.	The WTG layout will consider the bathymetry, water depth and geological conditions based on detailed pre-construction surveys. The influence of these factors will also depend on the chosen foundation type, with different technologies being more or less sensitive to seabed conditions such as slopes or geology. The sandwaves within the array area are expected to have a significant influence on the final array design.
Benthic habitats	Temporary or permanent loss of habitat	The ES (Volume 6, Part 2, Chapter 5) describes the potential effects on benthic habitats within the array area and concludes a minor adverse impact.

Consideration	Potential Impact	Layout consideration / design principle
		As such it is not expected that benthic habitats will significant constraint on array layout design.
UXO	Permanent Threshold Shift (PTS) / Disturbance from UXO clearance	The primary mitigation for UXO impacts will be to avoid identified UXO through careful WTG micrositing and cable routing. Where this is not possible due to other constraints, the Project will apply for a separate Marine Licence for the clearance of any identified UXO.
Seascape and landscape	Impacts of the WTGs on seascape or landscape character, the special qualities of designated landscapes and on visual receptors or views.	The Seascape, Landscape Visual Impact Assessment ES chapter (Volume 6, Part 2, Chapter 10) sets out a number of embedded measures are included in the project design including limiting WTG tip height to 399 m above LAT. In compliance with the NPSs, the final layout will consider impacts to seascape and landscape, within the context of other considerations.
Shipping and Navigation	Impacts to navigational safety and SAR operations.	As set out in the Navigation Risk Asessment (Volume 9, Document 9.10), the final WTG layout will be compliant with the requirements set out in MGN 654. VE will discuss and agree with the MCA and Trinity House a layout which meets the requirements of navigational safety and allows for appropriate SAR within the array itself. WTG array layout considerations will include the shape and orientation of array boundaries and rows of WTGs, proximity to existing shipping lanes and the Traffic Separation Scheme, and space within the array for SAR operations. The same minimum spacing will be applied in both the northern and southern arrays. The final layout may use dense borders (perimeter weighed) but will not breach the minimum spacing

Consideration	Potential Impact	Layout consideration / design principle
		distance (830m between WTGs, 500m between OSP and the nearest WTG). In each array area there will be a minimum of a single set of SAR lanes, which will be on a consistent bearing and at least 500 m wide (measured tip to tip between the WTGs). The SAR lane orientation may vary between the northern and southern arrays. Where possible substations will be placed in line with WTG lines, but they may be offset provided SAR lanes are not compromised. With regard to the neighbouring Galloper OWF there will be either: > One nautical mile setback (measured tip-to-tip) between VE and Galloper WTGs if there is no alignment of SAR lanes between VE and Galloper as per statutory guidance requirements. This will allow a search and rescue asset to safely exit one array without entering the other; or > Spacing as described above, but an alignment of the orientation of a VE SAR lane with one of the Galloper SAR lane orientation.
Marine Archaeology	Direct and indirect impacts to marine archaeological features	All intrusive activities undertaken during the life of the project will be routed and microsited to avoid identified marine heritage receptors pre-construction, with AEZs applied as detailed in the Outline Marine WSI (Volume 9, Document 9.19), unless other mitigation is agreed with Historic England and the MMO.

6 SUMMARY

6.1.1 There are a multitude of design considerations and principles that will inform the final WTG layout for VE. The final design will consider environmental and social impacts, technical constraints, project economics and compliance with relevant legislation and guidance before being submitted to the MMO for approval.

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