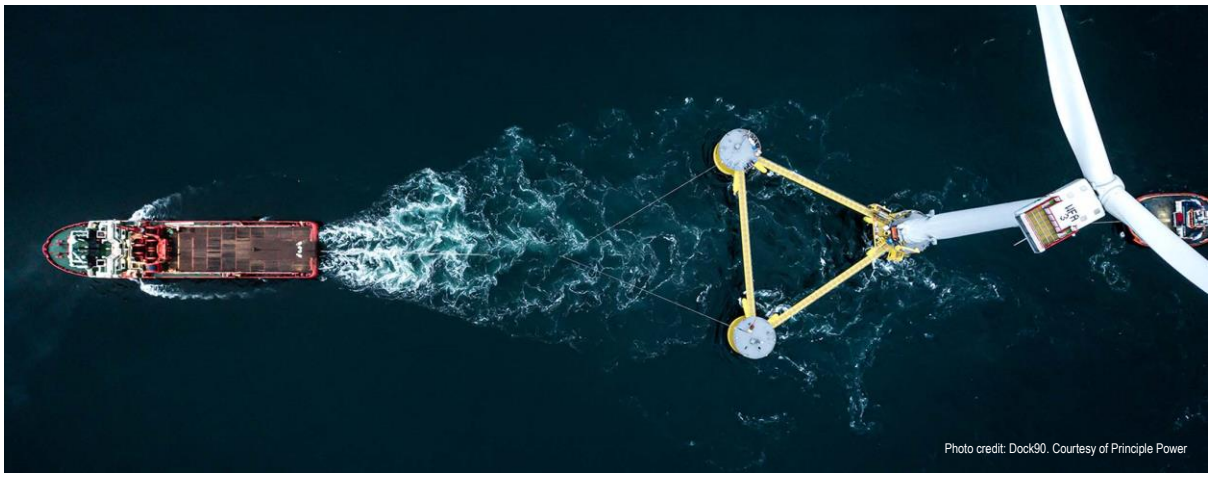

Project Erebus Environmental Statement
Chapter 3: Site Selection and Alternatives

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Acronyms

Term	Definition
AfL	Application for Lease
BGW	Blue Gem Wind
BLB	Blue Line Boundary
BPEO	Best Practicable Environmental Option
CCS	Carbon Capture and Storage
CCW	Countryside Council for Wales
CfD	Contract for Difference
CO2	Carbon Dioxide
CUSC	Connection and Use of System Code
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESAS	European Seabirds at Sea
FAME	Future of the Atlantic Marine Environment
FID	Final Investment Decision
FLOW	Floating Offshore Wind
GCR	Geological Conservation Review
GHG	Greenhouse Gases
GPS	Global Positioning System
GW	Gigawatt
IS	In Service
HDD	Horizontal Directional Drilling
Hs	Significant Wave Height
HSE	Health and Safety Executive
JNCC	Joint Nature Conservation Committee
LPA	Local Planning Authority
MCA	Maritime and Coastguard Agency
MCAA	Marine Coastal Access Act 2009

Term	Definition
META	Marine Energy Test Area
MHPA	Milford Haven Port Authority
MoD	Ministry of Defence
MW	Megawatt
NGESO	National Grid Electricity System Operator
NGT	National Grid Transmission
nm	Nautical Mile
NRW	Natural Resources Wales
O&M	Operation & Maintenance
OWF	Offshore Wind Farm
PCC	Pembrokeshire County Council
PCNPA	Pembrokeshire Coast National Park Authority
PDE	Project Design Envelope
PDZ	Pembrokeshire Demonstration Zone
PEDW	Planning and Environment Decisions Wales
PINS	Planning Inspectorate
PPI	Principle Power Inc.
RADMAPP	Resource Analysis and Digital Mapping Application
RIGS	Regionally Important Geological Site
RPL	Route Position List
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SAS	Seabirds at Sea
SBE	Simply Blue Energy
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
START	Seabird Tracking and Research
TCE	The Crown Estate
TNUoS	Transmission Network Use of System

Term	Definition
UKHO	UK Hydrographic Office
WFD	Water Framework Directive
WNMP	Welsh National Marine Plan
WPD	Western Power Distribution
WTG	Wind Turbine Generator

Chapter 3 Site Selection and Alternatives

3.1 Introduction

3.1.1.1 The Project is a demonstration scale Floating Offshore Wind (FLOW) development in the Celtic Sea region. The Applicant, Blue Gem Wind (BGW), is a joint venture between Simply Blue Energy (SBE) and Total; set up to create a new low carbon offshore energy sector in the region that contributes to climate change targets, supply chain diversification and energy security.

3.1.1.2 This chapter presents a description of the site selection process and consideration of reasonable alternatives for the entire Project (marine and terrestrial components). It includes details of the key stages of design refinement and information on the reasonable alternatives considered. The chapter also considers the need for renewable energy and the role FLOW has in contributing to national and international carbon reduction targets,

3.1.1.3 The site selection process is presented in chronological order, from project inception through to the current Project Design Envelope (PDE) assessed within this EIA and upon which relevant consent applications are based. Where alternatives have been considered, including spatial, technological, and operational elements, these are presented within the context of design refinement.

3.1.1.4 Details are also presented with respect to how stakeholder consultation has influenced the site selection process, including spatial, technological (design) and operational decisions. Details are presented of the iterative process by which comprehensive and continuing stakeholder engagement has been reflected in the final PDE and EIA process.

3.1.1.5 The Project development has been based on electrical, engineering, environmental and socio-economic appraisals which have resulted in stages of refinement and design updates.

3.2 Legislation and Guidance

3.2.1.1 The site selection process has been informed by legislative requirements and available best practice guidance documents.

3.2.1.2 The site selection process was undertaken in accordance with the statutory procedures set out in the following regulations, namely:

- The Electricity Works (Environmental Impact Assessment) (England and Wales) Regulations 2017 (the Electricity Works EIA Regulations); and
- The Marine Works (Environmental Impact Assessment) Regulations 2007 (the Marine Works EIA Regulations).

3.2.1.3 Specifically, Regulation 17(1)(d) and Schedule 4, paragraph 2 of the Electricity Works EIA Regulations and Schedule 3, paragraph 6 of the Marine Works EIA Regulations outline the requirements for alternatives to be considered with an Environmental Statement (ES). Schedule 4, paragraph 2 of the Electricity Works EIA Regulations requires the following:

> *"a description of the reasonable alternatives (for example, in terms of development design, technology, location, size and scale) studied by the developer that are relevant to the development and its specific characteristics and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects"*

3.2.1.4 Similarly, Schedule 3, paragraph 6 of the Marine Works EIA Regulations requires the following:

> *"An outline of the main alternatives studied by the applicant and an indication of the main reasons for the applicant's choice, taking into account the environmental effects of those alternatives and the project as proposed"*

3.2.1.5 Further details on policy and legislation are available in Chapter 5: Policy and Legislation.

3.3 The Need for the Project

3.3.1.1 The need for the project is outlined in Chapter 1: Introduction Section 1.4.8. To summarise, renewable energy is seen as a primary method of achieving the UK Government's net zero by 2050 goal via reducing emissions of greenhouse gases (GHG), in particular carbon dioxide (CO_2).

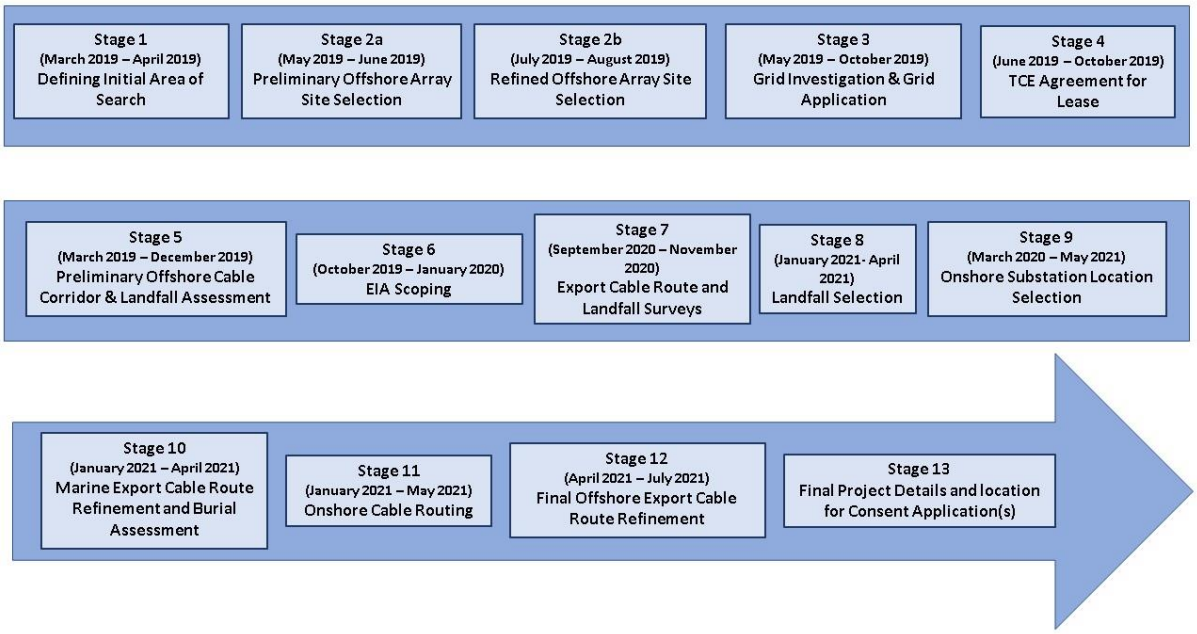
3.3.1.2 The Project will have a total generating capacity up to 100 MW. Based on the methodology and factors provided by RenewableUK (2021), assuming an offshore wind load factor of 38.5%, 3.578 MWh average annual domestic electricity use (as of December 2020) once fully operational, this will produce enough renewable energy to power 93,217 UK homes per year. With a carbon saving of 446 tonnes of CO_2 per GWh of electricity supplied, the total saving would be 151,767 tonnes of carbon emissions per year. This will assist in delivering on the UK Government and Welsh Government net zero goals, and their respective targets for FLOW to deliver 1 GW of energy by 2030 (BEIS, 2020) and for Wales to generate 70% of its electricity consumption from renewable energy by 2030 (Cabinet Secretary for Environment and Rural Affairs Statement on Energy - Plenary 26/09/2017 - Welsh Parliament (senedd.wales)) .

3.3.1.3 The purpose of the Project is to:

- Demonstrate FLOW technology at Test and Demonstration scale in the Celtic Sea;
- Maximise low carbon job creation and socio-economic impact within the local supply chain;
- Demonstrate FLOW as a practical example of:
    - COVID-19 Green Recovery
    - Response to the declared Climate Emergency
    - UK and Welsh Governments 2050 Net Zero targets
    - UK FLOW 2030 target

3.4 Site Selection and Consideration of Alternatives

3.4.1.1 A staged approach to site selection has been undertaken for both the offshore and onshore aspects of the Project. This is summarised in Graphic 3.1 with each stage discussed in detail in the subsequent sections.



Graphic 3.1 Offshore and Onshore Site Selection and Design Process

3.5 Stage 1 (March – April 2019) Defining the Initial Area of Search

3.5.1.1 The Project is founded on the UK's need for a timely demonstration of FLOW as a viable option for the next generation of offshore wind in UK waters. To date, the four Offshore Wind Farm (OWF) leasing rounds run by The Crown Estate (TCE) since 2000 have focused on conventional (fixed foundation) concepts.

3.5.1.2 Conventional OWF projects are limited in terms of water depth, with all these projects being located in water depths <60 m. To enable energy generation opportunities in water depths >60 m, FLOW projects will likely represent the most viable solution. Up to 2020, lease agreements for demonstration scale FLOW projects, up to 100 MW capacity, have been sought under TCE's Test and Demonstration process for seabed rights. This process is designed for early commercial scale leasing where an option agreement is negotiated with TCE.

3.5.1.3 There have been no pre-defined spatial constraints with respect to a site(s) proposed via this process, other than the regular conflict checks run by TCE where demonstration projects could not be sited in areas where existing infrastructure and/or future projects may be developed, e.g., the Round 4 bidding areas. TCE application process requires the developer to submit a project delivery plan, including site selection study which assesses regional energy resource, technical site parameters and appropriateness to the technology selection and practical constraints, site characteristics and uncertainties with regards to the site. However, TCE do not define bidding areas for the Test and Demonstration application process.

3.5.1.4 Therefore, at the earliest stage of the site selection process, a wide range of site options for an up to 100 MW FLOW project were available to the then lead developer, Simply Blue Energy (SBE).

3.5.1.5 The broad area of interest for the initial early site selection stage of the Project focused on the Celtic Sea region, see Volume 2, Figure 3.1, where SBE has been a strong advocate for the development of innovative marine renewable energy projects. SBE has supported the development of the Celtic Sea Alliance, a collaborative agreement to progress FLOW projects and deliver at least 1 GW of floating wind turbines in the Celtic Sea before 2030 (Catapult, 2017).

3.5.1.6 Developing FLOW in the Celtic Sea presents significant opportunities to maximise the local supply chain. However, to avoid a similar scenario to Scotland, where pilot projects such as HyWind contributed relatively limited value to the local economy (Catapult, 2017), research suggests this should be developed via a stepping-stone approach. This approach is encapsulated in Welsh Government policy, specifically the Welsh National Marine Plan (WNMP). The WNMP supports future opportunities for offshore wind development, including floating wind (ELC_01: Low Carbon Energy (supporting) Wind), by supporting demonstration projects to progress the testing of floating wind technology. The WNMP specifically identified the "the deeper waters of the outer Bristol Channel and Celtic Sea cited as possible sites for deployment" (Welsh Government, 2019).

3.6 Stage 2a (May – June 2019) Preliminary Offshore Array Site Selection

3.6.1.1 Building on Welsh Government support for demonstration-scale FLOW projects in the Celtic Sea region, SBE, partnered with Principle Power Inc. (PPI) to demonstrate the technological and engineering capabilities of the WindFloat™ system and test innovations in platform design. The WindFloat™ technology was first deployed via WindFloat 1 in 2011 (with associated 2 MW WTG); then, in 2019, the WindFloat Atlantic was deployed with an 8.3 MW WTG. The Kincardine FLOW project off east Scotland has now deployed five WindFloat™ platforms, with 9.5 MW turbines, completed September 2021.

3.6.1.2 For the FLOW sector to become competitive against conventional (fixed foundation) projects, significant cost and time gains must be made in the design and manufacturing phases of floating structures. The Project intends to demonstrate the technology in the largest floating array globally, and test innovations in platform design twinned with larger WTGs.

3.6.1.3 The technological requirements of the WindFloat™ system were fundamental parameters to site selection, allowing the Project to test and demonstrate the versatility of the WindFloat™ in challenging metocean conditions. These requirements were incorporated into the Applicant's plan led approach to site selection, with key parameters grouped under technical, commercial and environmental considerations.

3.6.1.4 The preliminary array site selection process (Stage 2a) was undertaken, on behalf of SBE, by Aquatera. The spatial extent of Stage 2a covered the Celtic Sea region, as defined above, and was based on review and assessment of specific technological criteria for the WindFloat™ platform alongside key spatial constraints and cost parameters, set out in Table 3.1.

Table 3.1 Stage 2a parameters used to inform refined site selection modelling

Parameter	Constraint
Technical	▪ Water depth; ▪ Wave height; ▪ Engineering stress (water depth / wave height); ▪ Tidal current speeds;

Parameter	Constraint
	▪ Exposed bedrock; ▪ Sediment type; ▪ Quaternary sediment depths; and ▪ Wind speeds.
Spatial	▪ Charted cables; ▪ Shipping lanes; ▪ Fishing areas; ▪ Military exercise areas; ▪ Locations of key bird sensitivities; ▪ Designated nature conservation areas; and ▪ Existing TCE leases.
Cost	▪ Distance to grid supply point (with capacity); ▪ Transmission Network Use of System (TNUoS) grid access charging zones; ▪ Distance from installation port (Tow Out); and ▪ Distance from suitable O&M port.

3.6.1.5 Analysis was undertaken using a GIS-based site suitability model, Resource Analysis and Digital Mapping Application (RADMAPP) (Aquatera, 2019), which assigned a suitability score for the parameters detailed above. The scores assigned were based on criteria selected and weighted using established industry and expert engineering input. Stage 2a modelling screened the Celtic Sea broad search area, using those parameters identified above, to determine preliminary areas for further investigation.

3.7 Stage 2b (July – August 2019) Refined Offshore Array Site Selection

3.7.1.1 Following completion of Stage 2a, and the identification of a number of development site options in the Celtic Sea region, SBE commissioned MarineSpace to undertake a peer review of the outputs. Analysis of these outputs was undertaken which identified parameters, specifically environmental and other user constraints, that would benefit from further data collation and review, in order to refine the offshore array site selection process.

3.7.1.2 The opportunity was taken to engage with key stakeholders including Natural Resources Wales (NRW), the Joint Nature Conservation Committee (JNCC), and regional commercial fisheries organisations, in order to identify and potentially acquire additional spatial data to inform the site selection process. Details of additional data identified and collated to inform Stage 2b are provided in Table 3.2, plus further information on stakeholder consultation undertaken during this stage (Section 3.7.3).

3.7.2 Seabirds and Marine Mammals

3.7.2.1 At this early stage of site selection, seabirds were identified as a key EIA receptor due to the proximity of the site options identified following Stage 2a to the Skomer, Skokholm and Seas off Pembrokeshire Special Protection Area (SPA) and Grassholm SPA; and importance of the region for migratory seabird species. The following additional sources of data were accessed including information on foraging ranges and modelling densities for breeding and non-breeding seasons:

- NRW Seabird Data (Lle, 2019a);
- Royal Society for the Protection of Birds (RSPB) Future of the Atlantic Marine Environment (FAME) and Seabird Tracking and Research (START) Seabird Data (RSPB, 2019);
- Thaxter et al. (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas;
- European Seabirds at Sea (ESAS), (JNCC, 2019);
- Seabirds at Sea (SAS) (sitting and flying) (Lle, 2019b) and
- Seabird Monitoring Programme (JNCC, 2019).

3.7.2.2 In addition to accessing open-source data sets, attempts were also made to contact known ornithological research projects to enquire if data from Global Positioning System (GPS) tracking of seabirds from the Pembrokeshire Islands were available to help inform the site selection. No responses were received during Stage 2b.

3.7.2.3 The Thaxter et al (2012) foraging range data showed that the ranges for three SPA species; Atlantic Puffin and Manx Shearwater (Skomer, Skokholm and Seas off Pembrokeshire SPA) and Gannet (Grassholm SPA), overlapped with some of the potential development areas identified via the Stage 2a modelling. Further analysis of this data was undertaken, and a data set was created identifying areas of higher density seabird records for the three species. The ESAS and SAS data sets were also analysed, and densities combined for the breeding season and combined for the non-breeding season. Summary outputs from the seabird mapping are shown in Volume 2, Figure 3.2.

3.7.2.4 In addition to seabird data, additional marine mammal data were sourced to reflect the importance of the region and proximity of site options to West Wales Marine Special Area of Conservation (SAC) and Bristol Channel Approaches SAC. Several additional data sets were identified for use under an NRW Licence, including:

- Bottlenose dolphin monitoring in Cardigan Bay 2014-2016 (NRW Evidence Report 191) (Lohrengel et al, 2018);
- Bottlenose dolphin and harbour porpoise monitoring in Cardigan Bay & Pen Llŷn a'r Sarnau Special Area of Conservation 2011-2013 (NRW Evidence Report 4) (Feingold et al, 2013);
- Seal Sites in Wales (CCW Report 131) (Baines et al, 1995);
- Atlas of Marine Mammals of Wales (CCW MM Report 68) (Baines et al, 2012); and
- Wales' grey seal photo-identification database: EIRPHOT (1992-2016) (Lle, 2019b).

3.7.2.5 These data sets were incorporated into Stage 2b modelling and did not identify any significant areas of marine mammal activity, specifically harbour porpoise and grey seal, within the search area of interest.

3.7.3 Early consultation

3.7.3.1 Stakeholder consultation formed a key part of the Project approach to early site selection, with engagement with regulatory authorities and stakeholders undertaken to inform the process.

3.7.3.2 While initial GIS-based modelling and site selection was ongoing, meetings were held with key stakeholders including PINS (now PEDW), Welsh Government Planning Directorate, NRW Marine Licence Team, the Local Planning Authorities (LPA) (Pembrokeshire County Council (PCC) and Pembrokeshire Coast National Park Authority (PCNPA)), and the Maritime and Coastguard Agency (MCA) to review the initial Project design, early-stage site selection process, potential site constraints and consenting strategy.

3.7.3.3 The opportunity was also taken to further define commercial fishing activity in the area of search, in order to consider this key offshore activity in the site selection process. Charts were issued showing the broad area of interest to a series of Welsh and Devon-based fishing organisations to gather information on fishing activity in the Celtic Sea region. Limited responses were received that translated into quantitative data; however, no responses were received that strongly identified the initial development area options as significant, high-intensity fishing grounds.

3.7.3.4 Consultation was also undertaken with Milford Haven (MHPA) regarding port facilities and services, supply chain development and potential cable routes within the jurisdictional boundary of the Port Authority.

3.7.4 Re-run of RADMAPP modelling

3.7.4.1 Using the additional data collated in Stage 2b plus feedback from the early-stage stakeholder consultation, the parameters identified and used in Stage 2a modelling were further refined and a subsequent round of modelling undertaken. Stage 2b parameters are listed in Table 3.2.

Table 3.2 - Stage 2b parameters used to inform refined site selection modelling

Parameter	Constraint
Technical	▪ Water depth ▪ Wave height (annual mean Hs) ▪ Engineering stress (Water Depth / Wave Height) ▪ Tidal current speeds (annual mean spring peak) ▪ Sediment type ▪ Exposed bedrock ▪ Quaternary sediment depth ▪ Wind speed
Cost	▪ Distance to grid supply point with capacity (straight line) ▪ TNUoS grid access charging zones ▪ Distance from port (O&M) ▪ Distance from port (Tow Out)
Environmental	▪ Distance from Marine Protected Area (Marine Conservation Zone, Ramsar, SAC and SPA)

Parameter	Constraint
	▪ *Seabird sensitivities (summer)* * ▪ Seabird sensitivities (winter) ▪ Seabird suitability (breeding) ▪ Seabird suitability (winter) ▪ Marine mammal (including grey seal and harbour porpoise ▪ Visibility – distance from designated landscape
Other sea users	▪ Airport buffer ▪ Cable crossings ▪ Other TCE leases ▪ Radar stations buffer ▪ Other radar buffers (line of sight) ▪ Ministry of Defence (MoD) designated areas ▪ Fishing effort ▪ Shipping route clearance
Engineering and Environment No Go Areas	▪ Charted cables + 250 m buffer ▪ Shipping Lanes + 0.5 nm buffer ▪ TCE leases + 5 km buffer ▪ Proposed Greenlink RPL + 250 m buffer

* Additional parameters developed for Stage 2b modelling shown in *italics*.

3.7.4.2 The updated Stage 2b RADMAPP model identified two potential development areas suitable for demonstration (<100 MW) and pre-commercial (<300 MW) scale FLOW projects. Additional potential development areas were identified but were judged to be unsuitable for a demonstration scale project due to the distance from grid connection. These were discounted from further analysis.

3.8 Stage 3 (May – October 2019) Grid Investigation and Grid Application

3.8.1.1 In combination with technological requirements, an important parameter in the identification of a suitable array area was the distance to substation. During Stage 1, 2a, and 2b, the Project had not secured grid connection and the modelling assigned weighting to distance from 132 kV or 400 kV Western Power Distribution (WPD) or National Grid Transmission (NGT) substations within 50 km, 50-100 km, or >100 km.

3.8.1.2 Preliminary electrical studies suggested that the single offshore export cable should be a 66 kV cable, which limited the overall length of the export cable to a maximum distance of 80 km (including onshore export cable). These design parameters were informed by a Grid Connection Strategy (Billcliff Energy Consulting, 2019), supported by Cable Route Assessment (JJFMS, September 2019b), Route Assessment and Array Design (JFMS, September 2019a), Electrical System Outline Design (JFMS, September 2019c), and Substation and Electrical Systems Outline Design (EDS High Voltage Group, 2019) studies, undertaken during Stages 2a and 2b.

3.8.1.3 The distance to substation was a significant limitation as a grid connection over 80 km from the array area would necessitate the inclusion of a floating substation, resulting in increased costs associated with a longer export cable, and a higher number of cable crossings. The financial and environmental implications of this would undermine the principle of a demonstrator project and render the Project unviable. A grid connection within 80 km would negate the need for an offshore substation and reduce the overall length, and associated costs and environmental impacts, of a longer export cable.

3.8.1.4 The identified connection points are noted below, including the distance from the array area to connection point:

- Pembroke Power Station (45 km);
- Alverdiscott Grid Supply Point (109 km);
- Swansea Bulk Supply Point (114 km);
- Indian Queens Grid Supply Point (123 km);
- Hayle Bulk Supply Point (137 km); and
- Plymouth Bulk Supply Point (150 km).

3.8.1.5 The output of the James Fisher Marine Services Limited (JFMS) background reports (see Section 3.8.1.2) recommended a grid connection point closest to the array area. Having identified the preferred array area, the closest connection point to this site was located at Pembroke Power Station.

3.8.1.6 Early discussions were held with WPD and NGT on capacity and connection options at Pembroke Power Station, and it was confirmed 150 MW of headroom was allocated to renewable generation with options for connection via WPD and NGT at 132 kV. Based on proximity to the preferred array area and available capacity, Pembroke Power Station was, therefore, confirmed as the preferred grid connection point.

3.8.1.7 Subsequently, an application for the grid connection at Pembroke Power Station for up to 100 MW array was submitted to NGT on 4th October 2019 and the formal grid connection offer was executed on 18 March 2020.

3.8.2 Offshore Array Area Site Identification

3.8.2.1 Following a process of initial site selection via GIS-based modelling, a peer review of this process, collation of additional data, early-stage stakeholder consultation, refined GIS-based modelling, and discussion on grid connection options, the location and extent of the Project array area was established for the basis of subsequent assessments.

3.9 Stage 4 (June – October 2019) The Crown Estate Agreement for Lease

3.9.1.1 In 2019, when SBE was undertaking the early-stage project planning and development phases, TCE offered an option to secure a seabed lease for Test and Demonstration scale offshore wind projects up to 100 MW capacity. Specifically, this leasing process permitted the developer to carry out “offshore wind test and/or demonstration activities, for the purposes of data collection and monitoring in order to facilitate the development of a product” (TCE, 2019).

3.9.1.2 The Project has been developed to demonstrate the technical, practical and commercial viability of floating wind foundations twinned with appropriate WTGs. Therefore, the Applicant identified this leasing option as the most appropriate to progress the Project on a timeframe that would achieve eligibility for the 2023 Contract for Difference (CfD) auction and enable firm commitment to reach Final Investment Decision (FID) by 2024.

3.9.1.3 The Applicant engaged with TCE throughout 2019 and an Application for Lease (AfL) for up to 100 MW demonstration scale FLOW project was submitted in October 2019. The 43.5 km^2 lease area applied for was identified following the various stages of refinement as detailed above and informed by the Energy Density Requirements, set out below:

- Option agreement applications must be in areas no greater than that required for a capacity to area ratio of 2 MW/km^2; and
- When requesting a lease, the site will be reduced to result in an area no greater than that required for a capacity to area ratio of 3 MW/km^2.

3.9.1.4 The AfL for the site was approved on 17th August 2020.

3.10 Stage 5 (March 2019 – December 2019) Preliminary Landfall Assessment and Offshore Export Cable Corridor Development

3.10.1 Preliminary Landfall Assessment

3.10.1.1 The application for grid connection to NGT at Pembroke Power Station proved the main driver for identifying a landfall location along the Pembrokeshire coast. A range of potential offshore export cable routes from the array area to landfall were considered as part of early-stage feasibility work.

3.10.1.2 An initial study had been undertaken by JFMS on behalf of SBE in 2019 (JFMS, 2019a). The first part of this study focused on initial electrical system studies to provide confidence that the main input assumptions were valid (e.g.: 'is a single offshore export cable to shore possible or is a second export cable required?').

3.10.1.3 The second part of this study built on these initial outcomes and involved a more thorough assessment of electrical design options, spatial layout configurations, export cable corridor definition and operational methodologies.

3.10.1.4 This study identified a long list of 13 potential landfall sites, listed in Table 3.3, and their respective associated offshore cable route options, ranging from Broad Haven to the north and Freshwater East to the south, see Volume 2, Figure 3.3. These options were assessed with a multi-constraints approach including electrical, installation, civil engineering, economic, environmental and other users.

Table 3.3 - Long list of landfall locations and length of indicative routes

Landfall Location	Length of indicative offshore route (km)	Length of indicative onshore route (km)
Broad Haven (North)	64.5	19
Little Haven	64.5	18.7
Pembroke Dock	53.9	1
Angle Bay	49.0	4.3

Landfall Location	Length of indicative offshore route (km)	Length of indicative onshore route (km)
West Angle Bay	45.8	10.6
Freshwater West A	47.5	6.5
Freshwater West B	48.0	7.5
Freshwater West C	46.8	9.8
Bullslaughter Bay	49.7	11.9
New Quay	54.6	13.6
Broad Haven South	56.3	13.8
Barafundle Bay	57.6	14.1
Freshwater East	60.7	15.2

3.10.1.5 Key constraints considered in the preliminary assessment of the potential offshore export cable corridor included:

- Large sand wave features;
- Sub-tidal reef;
- Recorded wrecks;
- MoD Danger Areas (Manorbier and Castlemartin);
- Explosive dumping grounds;
- High-density shipping lanes;
- Existing subsea cables (and number of crossings) and pipelines;
- Designations (Site of Special Scientific Interest (SSSI), SAC, SPA, Heritage Coast);
- Length of indicative route; and
- Technical viability.

3.10.1.6 Desk-based analysis of those constraints listed above and consultation with key stakeholders, primarily the MoD and Milford Haven Port Authority (MHPA) was undertaken by JFMS and the Applicant and informed the screening of the original list to a short list of preferred landfall options.

3.10.1.7 Table 3.4 summaries the conclusions of this process.

Table 3.4 - Summary of landfall options and short list constraints analysis

Landfall Location	Constraints
Broad Haven (North)	The overall route length at >80 km was determined to not be viable from an electrical engineering perspective, taking into account the relatively small capacity of the Project (<100 MW). Consideration was given to introducing an intermediate reactive compensation booster station at landfall, or moving indicative onshore substation locations, but neither resolved the technical problems with the reactive power associated with a long (>80 km) offshore export cable length. A landfall north of the Milford Haven Estuary would also necessitate the crossing of the South West Gas Pipeline, the UK's largest gas pipeline, which presented cost and National Energy Security considerations. Crossing of the Milford Haven Estuary to connect back to Pembroke Power Station would also be required. This was judged to present technical and logistical difficulties and would require a second cable crossing of the high-pressure gas pipeline between the Valero oil refinery and Pembroke Power Station. Part of the offshore export cable route would be located in the Pembrokeshire Marine SAC. **On the basis of the above Broad Haven (North) was ruled out as a potential landfall.**
Little Haven	The overall route length at >80 km was determined to not be viable from an electrical engineering perspective. Consideration was given to introducing an intermediate reactive compensation booster station at landfall, or moving the onshore substation, but neither resolved the technical problems with the reactive power associated with the long (>80 km) offshore export cable length. A landfall north of the Milford Haven Estuary would also necessitate the crossing of the South West Gas Pipeline, the UK's largest gas pipeline, which presented costs and National Energy Security issues. Crossing of the Milford Haven Estuary to connect back to Pembroke Power Station would also be required. This was judged to present technical and logistical difficulties and would require a second cable crossing of the high-pressure gas pipeline between the Valero oil refinery and Pembroke Power Station. Part of the offshore export cable route would be located in the Pembrokeshire Marine SAC. **On the basis of the above Little Haven was ruled out as a potential landfall.**
Pembroke Dock	Consultation with MHPA suggested any marine export cable route within Milford Haven Waterway as far as Pembroke Dock would be very challenging due to potential impacts on core port activities and other users within the Harbour. An alternative option was to install the cable closer to the southern shoreline of the Estuary, however this would require the cable to pass under the existing oil terminal pontoons and the risks associated with this option were considered too challenging for this Project. Part of the offshore export cable route would be located in the Pembrokeshire Marine SAC.

Landfall Location	Constraints
	On the basis of the above Pembroke Dock was ruled out as a potential landfall.
Angle Bay	The offshore installation is similar to Pembroke Dock, though it avoids the Valero oil terminal and pontoons. The technical difficulties of offshore installation were unknown due to missing seabed data – additional surveys would be required to inform the cable corridor. Impacts on shipping would require further discussion with MHPA. The offshore sections of this route would require crossing of the planned Greenlink Interconnector. Part of the offshore export cable route would be located in the Pembrokeshire Marine SAC. Landfall would be located in the Pembrokeshire Marine SAC and Milford Haven Waterway SSSI which may result in installation constraints. **On the basis of the above, Angle Bay was short listed for further surveys and assessment.**
West Angle Bay	The offshore installation was considered to be more straightforward than Angle Bay as the route only enters the southernmost part of the Milford Haven Waterway. This route involved no interaction with existing port infrastructure. The offshore sections of this route would require crossing of the planned Greenlink Interconnector. Part of the offshore export cable route would be located in the Pembrokeshire Marine SAC. Landfall is close to/within Angle Peninsula Coast SSSI, Pembrokeshire Marine SAC, Regionally Important Geological Site (RIGS) and Geological Conservation Review (GCR) site. **On the basis of the above, West Angle Bay was short listed for further surveys and assessment.**
Freshwater West A	Except for Pembroke Dock, Freshwater West A was the landfall option closest to Pembroke Power Station. This route involved no interaction with existing port infrastructure. Landfall at Freshwater West A would require the crossing of Greenlink offshore and onshore. The offshore route would pass very close to the lease areas for Bombora and Marine Energy Test Area (META). Part of the offshore export cable route would be located in the Pembrokeshire Marine SAC. Landfall would be located in Pembrokeshire Marine SAC, Broomhill Burrows SSSI, Castlemartin SPA and GCR. **On the basis of the above, Freshwater West A was short listed for further surveys and assessment.**
Freshwater West B	Landfall at Freshwater West B would require the crossing of Greenlink twice offshore and once onshore. This route involved no interaction with existing port infrastructure. The offshore route would pass very close to the lease areas for Bombora and META.

Landfall Location	Constraints
	Part of the offshore export cable route would be located in the Pembrokeshire Marine SAC. Landfall would be located in Pembrokeshire Marine SAC, Broomhill Burrows SSSI, Castlemartin SPA and GCR. **On the basis of the above, Freshwater West B was short listed for further surveys and assessment.**
Freshwater West C	Landfall at Freshwater West C would only require the crossing of Greenlink once onshore. This route involved no interaction with existing port infrastructure. The exact technical difficulties of offshore installation were unknown due to missing seabed data however following a review of existing data the route would have to cross large sand banks and subtidal reefs. The associated environmental impacts of this route were considered unfavourable to alternative options. Part of the offshore export cable route would be located in the Pembrokeshire Marine SAC. Landfall would be located in Pembrokeshire Marine SAC, Castlemartin Cliffs and Dunes SSSI, Castlemartin SPA and GCR. **On the basis of the above, Freshwater West C was ruled out as a potential landfall.**
Bullslaughter Bay	The total length of cable is above the 80 km threshold and would require additional electrical infrastructure at landfall and the onshore substation. Landfall would be within Castlemartin firing range and the route would include sections through Castlemartin Cliffs and Dunes SSSI, Castlemartin Coast SPA, Limestone Coast of South West Wales SAC, Pembrokeshire Marine SAC, RIGS and GCR. **On the basis of the above, Bullslaughter Bay was ruled out as a potential landfall.**
New Quay	The total length of cable is above the 80 km threshold and would require additional electrical infrastructure at landfall and the onshore substation. Landfall would be within Castlemartin firing range and the route would include sections through Castlemartin Cliffs and Dunes SSSI, Castlemartin Coast SPA, Limestone Coast of South West Wales SAC, Pembrokeshire Marine SAC, RIGS and GCR. The offshore route is close to the Pembrokeshire Demonstration Zone (PDZ). **On the basis of the above, New Quay was ruled out as a potential landfall.**
Broad Haven South	The total length of cable is above the 80 km threshold and would require additional electrical infrastructure at landfall and the onshore substation. Landfall and the cable route fall within numerous environmental designations (RIGS, GCR, Stackpole SSSI, Castlemartin Coast SPA, Limestone Coast of South West Wales SAC, Pembrokeshire Marine SAC, NNR and the National Park).

Landfall Location	Constraints
	The offshore route is close to the PDZ. **On the basis of the above, Broad Haven South was ruled out as a potential landfall.**
Barafundle Bay	The total length of cable is above the 80 km threshold and would require additional electrical infrastructure at landfall and the onshore substation. Landfall and the cable route fall within numerous environmental designations (RIGS, GCR, Stackpole SSSI, Castlemartin Coast SPA, Limestone Coast of South West Wales SAC, Pembrokeshire Marine SAC, NNR and the National Park). The offshore route is close to the PDZ. **On the basis of the above, Barafundle Bay was ruled out as a potential landfall.**
Freshwater East	The total length of cable is above the 80 km threshold and would require additional electrical infrastructure at landfall and the onshore substation. Landfall and the cable route fall within numerous environmental designations (RIGS, GCR, Stackpole SSSI, Castlemartin Coast SPA, Limestone Coast of South West Wales SAC, Pembrokeshire Marine SAC, NNR and the National Park). The offshore route is close to the PDZ. **On the basis of the above Freshwater East, was ruled out as a potential landfall.**

3.10.1.8 Based on the above assessment the long list of 13 landfall options was short listed to four (see Volume 2, Figure 3.5):

- Angle Bay;
- West Angle Bay;
- Freshwater West A; and
- Freshwater West B.

3.10.2 Preliminary Offshore Export Cable Corridor

3.10.2.1 With respect to the offshore export cable route, preliminary offshore export cable corridors were developed by JFMS (2019b) during their initial assessment of landfall options. Constraint mapping, utilising existing data sources, was undertaken to inform the outline route development. The following data were sourced to inform the desktop review:

- OceanWise Marine Themes vector data: anthropogenic features/activities (cables, pipelines, wreck), bathymetry and administrative boundaries;
- Publicly available mapping sourced from Lle – geo-portal for Wales (Welsh Government, 2021) including environmental designations and third-party marine licences;
- Erebus Geological Desk Top Study, (Intertek, 2019) including review of existing data on sediment thickness, ground conditions and UK Hydrographic Office (UKHO) bathymetric data; and

- Data from previous scoping assessment, publicly available charts and additional bathymetric data from ‘Seacams’, Bangor University.

3.10.2.2 Constraints were identified following interrogation of the data, and exclusion and buffer zones were applied to relevant features. These ranged from user defined exclusion zones ‘avoid if at all possible’, danger zones ‘consider risks’ and ‘avoid at all costs’. These were applied to sites such as the MoD ‘Danger Area’ and explosives dumping grounds; sensitive features such as wrecks, sand waves and subtidal reefs; and other users e.g., Greenlink and shipping lanes.

3.10.2.3 The preliminary offshore export cable corridor was routed around these features and exclusion zones, to the four landfall options. The preliminary route was presented in the EIA Scoping Report (Volume 3, Technical Appendix 2.1: EIA Scoping Report) to NRW in December 2019 along with the short list landfall options (see Volume 2, Figure 3.5).

3.10.2.4 The JFMS (2019b) preliminary offshore export cable corridor informed a more detailed cable routing study undertaken by OWC in 2020. More detail is presented in Section 3.12.

3.11 Stage 6 (October 2019 – January 2020) EIA Scoping

3.11.1.1 A joint Screening and Scoping Opinion Request, supported by EIA Scoping Report for the Project (MarineSpace, 2019), was prepared and submitted to NRW in October 2019 (provided in Volume 3, Technical Appendix 2.1: EIA Scoping Report). The EIA Scoping Report reflected the design status of the Project at this point comprising the preferred array area and confirmed grid connection point at Pembroke Power Station. A preliminary offshore export cable corridor was identified but landfall selection had yet to be completed, therefore the short list of four sites, as outlined in Section 3.11.1, was provided (see Volume 2, Figure 3.4).

3.11.1.2 The formal EIA Scoping Opinion, issued by NRW in January 2020 (provided in Volume 3, Technical Appendix 2.2: EIA Scoping Opinion), confirmed that the works fell within the categories of projects listed within Schedule A2, paragraph 21 of the Marine Works EIA Regulations, “Installations for the harnessing of wind power for energy production (wind farms)”. Therefore, NRW confirmed that a statutory EIA would be required to support the consent applications for the Project.

3.11.1.3 NRW’s Scoping Opinion has been recognised in the continued Project design and site selection refinement process and used to inform additional survey work, assessment methodology and identify sensitive receptors and impacts. Scoping opinion actions are listed in Table 2.2 in Chapter 2 Overview of EIA Methodology.

3.12 Stage 7 (August – November 2020) Offshore Export Cable Corridor and Landfall Surveys

3.12.1.1 Following consultation with NRW on the proposed survey specifications, a full geophysical (multibeam echosounder, side scan sonar, sub bottom profiler, magnetometer) and environmental survey (grab and drop-down video) was undertaken between August and November 2020. The survey was designed to cover a 450 m wide offshore export cable corridor. Preliminary offshore export cable corridors from the array area to shore were identified in the Cable Route Assessment (JFMS, 2019b) and subsequent cable routing studies were undertaken by the Principal Designer OWC ahead of the survey works.

3.12.1.2 OWC completed an evaluation of various offshore export cable routes for the Project; considering the four short listed landfall sites identified from the JFMS work: Angle Bay, West Angle Bay, Freshwater West A and Freshwater West B. The OWC review identified hard and soft constraints, risks and specific site conditions which could potentially affect the integrity of the cable from the array area to the short listed landfall locations.

3.12.1.3 The evaluation of risks and constraints focused on site specific ground conditions ascertained from desk reviews (Intertek, 2019), bathymetry, environmental constraints, third party seabed users and issues resulting from multiple activities such as shipping, fishing and military practices. This assessment also further explored the risks identified by JFMS in the proximity of the landfalls, including identifying any additional issues. The results and the associated considerations and assumptions were used to set the boundary conditions to undertake the export cable routing feasibility study.

3.12.1.4 A geophysical database and associated constraint maps were created in GIS to allow the desktop route selection process. The geophysical database was created using data that JFMS collected to undertake their preliminary Cable Route Assessment (JFMS, 2019b) along with additional layers to inform the desk top study. The export cable route and the corridor buffer zones were developed using GIS resources considering the following constraints, assumptions, and considerations:

- Shortest route possible;
- Avoidance of areas presenting technical difficulties for installation and maintenance;
- Identification of suitable landfall locations that have obstruction-free inshore approaches;
- Avoidance of areas such as anchorage areas, dredging areas, disposal areas; and munitions areas;
- Appropriate seabed geology and sedimentology for cable laying (avoidance of rock outcrops, high slopes over a long distance);
- Consideration of local weather patterns, tides and currents;
- Avoidance of areas of existing and proposed seabed development;
- Avoidance of wrecks;
- Minimum separation distances of 250 m from existing cables and 500 m from existing pipelines, where possible;
- Pipelines and cables to be crossed at right angles;
- Avoidance, where possible, of areas with environmental designations;
- Identification of fishing, anchoring and other risk areas;
- Proximity of other In Service (IS) cables and pipelines;
- Access for cable lay vessel during installation;
- Cable engineering and protection requirements;
- Existing power infrastructure; and
- Landfall considerations.

3.12.1.5 To obtain an indicative route ranking classification for the cable routing options, three main area of risk were used to develop the risk profiles, and a percentage of weighting was associated to each area based on the severity of the impact and costs for the Project. The areas of risk were as follows:

1. Cable Installation and Technical Risks;

2. Fishing and Shipping Activity Risks; and
3. Environmental Risks.

3.12.1.6 While developing the cable routing options, several considerations were made with regards to the constraints in the area, adhering to the industry standard approach for cable route design. The cable route optioneering took into consideration the suitability for the subsea burial tool to effectively bury the cable along the established cable route corridor. In making this cable route assessment, factors such as ground conditions, turning radii, vessel characteristics and water depth were also considered.

3.12.1.7 The preliminary route developed by JFMS 'Route 1' (JFMS, 2019b) was reviewed and optimised by OWC with the resulting 'Route 2' refined to mitigate the risk of crossing an area affected by hard substrate and rocky outcrops. 'Route 3' was further refined to completely avoid a cluster of rocky outcrops. 'Route 4' was developed in response to MHPA requirements to minimise potential interference with shipping traffic using the Western navigation channel in Milford Haven Waterway and to avoid interaction with subtidal reef in the proximity of Freshwater West beach (See Volume 2, Figure 3.6).

3.12.1.8 'Route 4' was also designed to avoid the Turbot Bank, a key part of the Pembrokeshire Marine SAC. This area also contained upslopes >15 degrees which would have posed additional potential risks for future subsea cable burial operations.

3.12.1.9 As a result of the GIS data analysis undertaken by OWC, nearshore cable routing options for approaches to landfall were developed based on 'Route 4'. Much of the offshore export cable corridor was the same for all landfall options with a number of separate (nearshore) sections developed. Cable landing feasibility at the proposed landfalls was considered and several routing approaches were considered to retain flexibility in the final route selection process.

3.12.1.10 The preliminary route option for the landfall approach to West Angle Bay and Angle Bay followed the primary shipping channel into Milford Haven. Following consultation with MHPA this was identified as a significant risk due to the heavy marine traffic and an alternative route was proposed through the East Row's Rocks channel.

3.12.1.11 The detailed review of the landfall approaches at Freshwater West A and B identified technical and environmental constraints that cumulatively reduced the feasibility of a landfall in this location for a demonstration scale project. The constraints included the proximity to the META and Bombora project sites, Greenlink cable corridor and landfall, Freshwater Beach, Castlemartin Firing Range, and interaction with sensitive habitats including subtidal reefs and large sandbanks.

3.12.1.12 The routing study determined that the technical and economic challenges of landfall at Freshwater West A and B were not optimal for a demonstration scale project. This conclusion was further supported by the review of existing geophysical data around Freshwater West that had been collected and reported for the Greenlink Interconnector project.

3.12.1.13 Notwithstanding the conclusions of the routing study, both Freshwater West A and B were included in the planned 2020 geophysical surveys however certain operational limitations during the survey meant only the two landfall options at West Angle Bay and Angle Bay were surveyed. A preliminary decision was made by the Project to postpone surveys at Freshwater West A and B until 2021.

3.12.1.14 The 2020 survey data were used to inform the next stage of landfall assessment and further develop the initial offshore export cable corridor (and indicative cable route) from the array area to the preferred landfall. These assessments were also informed by wider technical (including seabed and ground conditions), environmental, consenting (including third party interaction), programme and economic constraints.

3.13 Stage 8 (January - April 2021) Landfall Selection

3.13.1 Landfall site selection

3.13.1.1 In order to select the preferred landfall of the four short listed options, a detailed landfall assessment was undertaken on behalf of the Applicant by OWC, ITPE and MarineSpace (OWC, 2021). This study took into consideration all identified marine and terrestrial site constraints and restrictions, including seabed/ground conditions, onshore and offshore engineering constraints, third party interaction, local onshore and offshore environmental and physical constraints, and restricted/prohibited zones. The assessment also investigated which solutions existed for installation of the export cable at landfall, including a review of the cost-benefit of all options.

3.13.1.2 Throughout the landfall selection process meetings were held with key stakeholders including the local communities, landowners and Angle Community Council to seek their views and understand the impacts associated with the installation of the export cable at the various landfall options.

3.13.1.3 A comparative risk assessment matrix was used to evaluate each site-specific risk through a qualitative ranking process, based on key risk constraints ranking and weighting. To obtain an indicative route ranking classification for the landing options, four main areas of risk were used to develop the risk profiles, and a percentage weighting was assigned to each risk area based on the severity of the impact and costs for the project. The key risk constraints are as follows:

- Offshore Cable Engineering and Installation and Technical Risks;
- Onshore Cable Engineering and Installation and Technical Risks;
- Offshore Environmental and Consenting Risks; and
- Onshore Environmental and Consenting Risks.

3.13.1.4 Within each risk discipline, a range of factors was assessed. A simple sensitivity analysis was also performed to understand the impact of each of the criteria on the overall weighting and ensure all risks from a technical, environmental, and consenting perspective were included.

3.13.1.5 Following the risk areas definition and related weighting criteria, a risk ranking process based on probability and impact was undertaken. All the landfall options were subsequently scored, evaluated, and included within the risk assessment matrix. The values selected at the time of this assessment were deemed appropriate, following peer review with OWC, ITPE and MarineSpace, to review the scoring and ensure consistency in the approach to the rankings.

3.13.1.6 The key conclusions relevant to the four landfall options are presented in Table 3.5.

Table 3.5 – Summary of Key Findings of Landfall Assessment (OWC, 2021)

Risk Category	Key Issues
Offshore Engineering / Installation	From an offshore installation perspective, the West Angle Bay landfall presented the advantage of minimising the cable length while avoiding with the area of highest vessel traffic density through the Milford Haven main shipping channel. The West Angle Bay landfall option involves the cable entering the Milford Haven waterway within a natural channel feature known as Row's Rocks channel. This reduces the risks related to the interaction with the Milford Haven main shipping channel. Further offshore, the preferred offshore export cable corridor to West Angle also reduces the overall number of third-party asset crossings required, including crossings of the main designated shipping lanes, and any interaction with Turbot Bank. The landing point at West Angle was considered less constrained from an offshore installation perspective, and overall presented a more efficient option when considering complexity, potential duration, and cost of construction.
Offshore Environmental / Consenting	All the nearshore landfall options contain an element of interaction with habitats that form qualifying features of the Pembrokeshire Marine SAC; however, the longer route to Angle Bay would result in the greatest amount of cable within the SAC thus increasing consenting risk. Based on knowledge at the time the decision was made (January 2021), it was judged that due to the limited options to route through the reef, the greatest risk of interaction/impact on the subtidal reef features that are a key component of the SAC comes via the Freshwater West A and B routes and landfall. The additional length of marine cable required to make landfall at Angle Bay compared to other landfalls presented additional seabed interaction, disturbance, and potential impact from an EIA, WFD and HRA perspective. There was also increased potential for impacts on water, sediment quality and WFD for the Angle Bay landfall due to its location in a lower energy, more sheltered part of the Estuary, i.e., adjacent to the large mudflat region of Angle Bay. Due to the proximity of the Angle Bay landfall to Angle Bay intertidal mudflat region, it was assumed that there would be greater scope for disturbance to birds that may utilise this area for feeding or over-wintering compared to other landfall areas. There was also a greater risk of indirect impacts to Angle Bay's seagrass beds, a Section 7 habitat under the Environment (Wales) Act 2016. There would be highest risk from interactions with port activities; navigation, commercial fishing and mariculture from the Angle Bay route (including Angle Bay Oyster Farm). Recreational and tourism and amenity risks were judged to be greatest for the Freshwater West A and B routes as this is a very popular beach. Therefore, based on the assessment of a wide range of offshore environmental and consenting risks, it was concluded that West Angle Bay landfall represents the most suitable (lowest risk) nearshore route and landfall from an offshore consenting perspective.

Risk Category	Key Issues
Onshore Engineering / Installation	<u>Landfall Location</u> The engineering assessment indicated that the West Angle Bay landfall location was the most advantageous from an onshore engineering/installation perspective. The landfall is a wide sandy beach with ample room to micro-site the cable and there is also a relatively small differential between the beach elevation and the adjacent field elevation, where there is also ample space for a cable transition bay. There is an existing single-track road allowing access to the landfall, however it was identified that an alternative temporary construction road may need to be built to mitigate the disruption to the village of Angle. The Angle Bay landfall option was assessed as being less favourable as it is a rocky beach with visible exposed bedrock in several locations. There is also a steep embankment between the beach and the potential location for the cable transition bay. Although, access is available from an existing single-track road, and there is ample space in the adjacent fields for a cable transition bay, HDD infrastructure if necessary, and a construction compound. The Freshwater A and B landfalls were assessed as being less feasible than both the West Angle Bay and Angle Bay landfalls, with respect to onshore engineering and installation. This is predominantly due to the large dune system between the landfalls, for which the Broomhill Burrows SSSI is designated, and any existing flat open area to locate the cable transition bays. To avoid damaging the sensitive dune system, it was considered likely necessary to undertake a drilling solution over significant distances, posing cost risk and requiring additional studies to determine technical feasibility. <u>Onshore Cable Route</u> Prospective cable routes were considered for each landfall option, with high-level constraints analysis carried out for both cross-country and largely road-based routes, for each landfall. Although the West Angle Bay landfall location itself was considered most suitable with respect to onshore engineering and installation, the cable route from West Angle Bay to the grid connection point is significantly longer than the other cross-country cable options, measuring approximately 10.8 km whilst Angle Bay, Freshwater West A and Freshwater West B would be approximately 6 km, 7 km and 7.7 km respectively. The West Angle Bay cross-country route is predominantly run over open fields and so was considered to be relatively straightforward in engineering terms. There are few width or height restrictions, although interaction with and suitable separation from the Greenlink cable would need to be carefully considered. The cable route from Angle Bay was assessed as having the least engineering constraint, being the shortest route considered, with few obstructions or restrictions, no significant water crossings, and the fewest interactions with identified existing underground services.

Risk Category	Key Issues
	The main constraint identified on the Freshwater West A and B routes was immediately after landfall where the route must progress through a steep, large, environmentally significant dune system within the Broomhill Burrow SSSI. There is also requirement for the Freshwater West B route to follow a very narrow road, with little opportunity for improvement without disturbing the dune habitat. Beyond the dunes, however, the route from Freshwater West A or B would be essentially the same as the West Angle Bay cross-country route, albeit shorter. Overall, taking account of landfall and cable route considerations, the Angle Bay landfall option scored best in terms of onshore engineering, followed by West Angle Bay, Freshwater West A, and Freshwater West B.
Onshore Environmental / Consenting	The assessment determined that the least constrained option with respect to onshore environmental and consenting considerations is Angle Bay. This was considered to still present a number of environmental and consenting constraints that would require further consideration and mitigation of impacts, including the landfall and part of the cable route being within the Pembrokeshire Coast National Park and coinciding with the Wales Coast Path, and the presence of ecological and cultural heritage designations within the proximity of the landfall location and cable route. However, the Angle Bay landfall and onshore cable route would be through the fewest ecological designations (two, the Pembrokeshire Marine SAC and the Milford Haven Waterway SSSI) and would have the shortest cable length through the National Park. With the landfall locations and the majority of the cable routing of the Freshwater West A and B options falling within a similar area, they were assessed as being similarly constrained. The principal constraints identified for these options were associated with the landfall locations and western extents of the cable routes falling within two SACs (the Pembrokeshire Marine and Limestone Coast of South West Wales SACs), an SPA (Castlemartin Coast), and a SSSI (Broomhill Burrows), and within the particularly sensitive dune system of Broomhill Burrows SSSI. The area of landfall for these options was, therefore, considered to be highly sensitive to impacts on ecological receptors. The landfall at the popular Freshwater West (A and B) beach area is also a constraint in respect of potential impacts on tourism and recreation, and for both ecology and tourism, there is potential for cumulative impacts associated with the proposed landfall of the Greenlink interconnector in this same area, particularly wat construction phase for both projects. Significant effects are likely to be mitigable through suitable landfall design and good construction practice, however, it was considered that the presence of these statutory designations and tourism receptors categorised this location as highly sensitive.

Risk Category	Key Issues
	The landfall location at West Angle Beach was deemed to be more constrained than Angle Bay as multiple ecological, cultural heritage and geological designations are present, and the landscape character is particularly sensitive. The landfall location lies within two statutory ecological designations (Pembrokeshire Marine SAC and Arfordir Penrhyn Angle SSSI) and is in close proximity to a third (West Wales Marine SAC) with the cable route passing in proximity to a further three statutory ecological designations (Limestone Coast of South West Wales SAC, Castlemartin Coast SPA and the Broomhill Burrows SSSI). The cable route would also pass in close proximity to two Geological Conservation Review (GCR) sites (West Angle Bay and West Angle Bay (North). This was the longest cable route option, with approximately 7.5 km of the route being within the Pembrokeshire Coast National Park. Additionally, the landfall location and cable route fall in proximity to the West Angle Beach and the West Angle Bay Caravan Park, with the potential for impacts upon these socio-economic and tourism receptors. From an onshore environmental and consenting perspective only, the Angle Bay option was assessed as being lowest risk, followed by the two Freshwater West options, and marginally behind them, West Angle Bay. However, no onshore environmental/consenting constraints or risk which cannot be adequately addressed were identified for any of the options considered, and with all potential impacts were considered there exists appropriate mitigation measures or options. For example, route refinement can be undertaken to avoid designated areas along the onshore cable route. Although the offshore crossing of the Pembrokeshire Marine SAC is unavoidable for all options, the cable route and construction methodology can avoid potentially significant adverse impacts on designated habitats and species. Crossing the Arfordir Penrhyn Angle SSSI is unavoidable for the West Angle Bay option, however, HDD will be utilised, if technically feasible, reducing potential impacts to the site.

3.13.1.7 The risk assessment, taking account of onshore and offshore environmental/ consenting and engineering considerations, and considering the results of a sensitivity analysis to consider the effect of more heavily weighting each of those four categories, concluded that the West Angle Bay landfall was the preferred option, subject to c

3.13.1.8 Prior to confirming West Angle Bay as a preferred option, the Project Team held a meeting with Angle Community Council on the 3rd of March 2021 via zoom, to present the findings of the landfall selection study, and to receive any feedback regarding the selection process and preferred option.

3.13.2 Installation at Landfall

3.13.2.1 The preferred method for cable installation at landfall is HDD to minimise the disturbance and impacts on the intertidal zone, compared with open cut trench excavation. However, open cut trenching has been included within the PDE as a contingency option.

3.13.2.2 The initial Project design identified one HDD option, with the onshore exit point east of the West Angle Bay car park. This location was identified as being feasible for open cut trenching if an alternative to HDD is required. Recognising, however, the potential impact and disruption to beach users and the desire to include a further contingency option in the event that ground conditions were found to not be suitable for HDD at the identified location, a second, optional HDD route is proposed, approximately to the southwest of the first option. Ground investigation boreholes were drilled in two locations for each HDD route to characterise the bedrock and drift sediment. Figure 4.1b presents the landfall options in order of preference, which are as follows:

1 – Northern landfall HDD;

2 – Southern landfall HDD; and

3 – Northern landfall Open Cut Trenching (contingency option).

3.13.2.3 The final selection of the precise landfall location and orientation within the identified Project boundary, and the selection of HDD versus open cut trench, will be determined following detailed design, supported by additional pre-construction ground investigations and HDD feasibility and design work to be undertaken by a specialist contractor. Chapter 4: Proposed Development Description, Section 4.8.18 presents details on the technology and proposed strategy for the offshore electrical infrastructure installation process at landfall. For the purposes of the EIA, assessment has been carried out of potential environmental impacts associated with any of the potential options (i.e. HDD or open cut trenching at the northern location, or HDD at the southwest option).

3.14 Stage 9 (March 2020 – March 2021) Onshore Project Substation Location

3.14.1.1 The substation search area was broken down into 12 distinct zones, all of which were within 2 km of the connection point at Pembroke Power Station (see Volume 2, Figure 3.7). The 2 km search area was defined based on guidance from NGESO (2019) which states that single user asset cable connections at a transmission voltage must be equal or less than 2 km in length.

3.14.1.2 Over the course of the assessment the sites under consideration have been revised to narrow down the options under consideration. A preliminary assessment of the 12 zones was undertaken by ITPE (ITPE, 2020). This comprised three rounds to screen the original 12 zones to a short list of preferred substation options for further assessment. The rounds were as follows:

- **Round 1** - Initial desktop assessment of the identified options in relation to existing utilities and other known constraints such as flood risk and ground conditions.
- **Round 2** – A high-level risk assessment in terms of landscape and visual impact and associated consenting risks was undertaken by an external specialist. Zones identified as showstoppers or high risk were screeded out of further assessment.
- **Round 3** – Engagement with RWE on remaining substation locations as they own a significant portion of the land within the search area. RWE indicated that they are in the process of progressing a number of studies to determine land requirements for its future projects and were unable to provide an indication of what lands can be made available for 3rd party developers, if any. Furthermore, under Condition 3(2) of the Section 36 Consent for the Pembroke Generating Station, RWE is conditioned to retain an area of land to allow for the future installation of carbon capture plant. This area, referred to as the Blue Line Boundary (BLB), is defined on Drawing number UKP/PMB009/A. Sites developed within this boundary are likely to require additional consultation with the regulatory authorities, with subsequent amendments to the consents and generating licenses for the Pembroke Generating Station. Thus, identified options within the BLB were screened out of further assessment due to existing permit and commercial constraints.

3.14.1.3 Table 3.6 summaries the conclusions of this process.

Table 3.6 Summary of substation zones and short list constraints analysis (ITPE, 2020)

Site zone	Constraints
1A	Screened out in round 2 due to potentially unacceptable visual impact. **On the basis of the above, Option 1A was ruled out as a potential substation zone.**
1B	No major environmental or technical constraints were identified for Option 1B. Further study was identified as being required in respect of access and the interface with incoming and outgoing cables. **On the basis of the above, Option 1B was short listed for further assessment.**
2	Screened out in round 1 as there is an underground gas main that runs between RWE and the Valero Oil Refinery which lies directly underneath Option 2. This has been deemed as an immediate constraint preventing development for this zone. **On the basis of the above, Option 2 was ruled out as a potential substation zone.**
3	Screened out in round 1 due to potentially significant flood risk. The site is also within RWE's BLB. **On the basis of the above, Option 3 was ruled out as a potential substation zone.**
4	Screened out in round 2 due to potentially significant landscape and visual impact. **On the basis of the above, Option 4 was ruled out as a potential substation zone.**

Site zone	Constraints
5	Screened out in round 3 as site within RWE's BLB. **On the basis of the above, Option 5 was ruled out as a potential substation zone.**
6	Screened out in round 2 due to potentially significant visual impact. **On the basis of the above, Option 6 was ruled out as a potential substation zone.**
7	No significant constraints were identified in terms of existing facilities or landscape and visual impacts, and the zone is outside RWE's BLB. Further study was identified as being required with respect to interactions with Greenlink, and an adjacent operational wind turbine. **On the basis of the above, Option 7 was short listed for further assessment.**
8	No showstoppers were identified in terms of existing facilities or landscape and visual impacts. The zone is partially located within RWE's BLB. Option 8 was considered to have the potential for similar issues to option 1B, around access and the cable interfaces. In addition, the potential for localised contaminated land was identified. **On the basis of the above, Option 8 was short listed for further assessment.**
9	Presents no significant issues in comparison to the other zones. Although outside the BLB, Option 9 is within RWE land. **On the basis of the above, Option 9 was short listed for further assessment.**
10	Screened out in round 3 as site within RWE's BLB. **On the basis of the above, Option 10 was ruled out as a potential substation zone.**
11	Screened out in round 2 due to potentially significant landscape and visual impact, and partially within RWE's BLB. **On the basis of the above, Option 11 was ruled out as a potential substation zone.**
12	Screened out in round 2 due to potentially significant visual impact. **On the basis of the above, Option 12 was ruled out as a potential substation zone.**

3.14.1.4 Based on the above, Options 1B, 7, 8 and 9 were taken forward for more detailed assessment (ITPE, 2021).

3.14.1.5 Published sources of environmental and technical data were reviewed, together with information gained through a site reconnaissance walkover survey and a Phase 1 Habitat Survey of all substation options, to highlight the potential environmental and physical/engineering constraints on these options.

3.14.1.6 The data sources consulted as part of this constraint's assessment include the following:

- Simply Blue Energy 1 Floating Offshore Wind Farm: EIA Scoping Report (Marine Space, 2019);
- Project Erebus, Floating Offshore Wind Farm: Screening and Scoping Opinion (NRW, 2020);

- NRW GIS datasets on environmental designations and protected areas;
- Historic Environment Service Wales (Cadw) datasets on protected historic environment assets;
- British Geological Survey (BGS) mapping;
- RSBP relevant data;
- JFMS (2019b) 'Stage 2: Substation Outline Design' Report;
- Relevant information from other local proposed developments, such as the Greenlink project;
- Preliminary Ecological Assessment undertaken in Summer 2020 (Jon Hudson Ecological Consultancy, 2020);
- Health and Safety Executive (HSE) guidance;
- National Grid guidance;
- Local services data;
- Planning documents from Local Planning Authority; and
- Consultation with local landowners and asset owners.

3.14.1.7 A qualitative risk analysis of the potential physical, engineering, environmental and consenting risks has been undertaken for each substation location option. The risk assessment was produced by the assignment of risk rankings for a series of constraint categories, taking account of the significance of the risk and the potential for mitigation.

3.14.1.8 Key constraints considered in the risk assessment of the short-listed options were:

- Engineering/Installation constraints –
    - Interfaces;
    - Services and access;
    - Site conditions, including topography, ground conditions and flood risk;
    - Interactions with current and future development, including the nearby Greenlink interconnector development; and
    - Health, safety and security.
- Environmental/Consenting constraints –
    - Ecology;
    - Cultural heritage/historic environment;
    - Land use, socio-economics, tourism and recreation; and
    - Landscape and visual.

3.14.1.9 This is summarised in Table 3.7.

Table 3.7 Summary of key findings of substation assessment (ITPE, 2021)

Risk Category	Key Issues
Onshore Engineering / Installation	Overall, Option 9 was deemed to be the least constrained in terms of onshore engineering/installation risks, followed by Option 1B, then Option 7, with Option 8 the most constrained.

Risk Category	Key Issues
	Option 9 has fewer interactions with existing services than Options 7 and 8, has no significant access constraints or interactions with the Greenlink project and, unlike the other options, it avoids working next to a 11kV overhead line (OHL). Option 9 is roadside; access is likely to be from the south eastern corner of the area and telecom lines on poles which would need to be negotiated. All options have space within the area to accommodate a construction compound, however, Option 9 has additional space beyond the area earmarked to accommodate additional development. Option 9 is, however, the most constrained in terms of topography as it features a consistently increasing gradient sloping east to west from the site entry point. Option 1B also has fewer interactions with existing services than Options 7 and 8 and avoids interactions with Greenlink. However, a purpose-built access track may be required. In addition, although the site can accommodate a construction compound, an offsite construction compound may need to be considered. Option 7 has more interactions with existing services than Options 9 and 1B, would likely require removal of the existing adjacent wind turbine and would have the highest interactions with Greenlink. However, Option 7 would have less access constraints than 1B and 8. There is an existing access route, utilised by local farms, that can be used for Option 7. The road is minor at present and would need some reinforcement/improvements to accommodate the large plant. However, it is understood that works will be undertaken on this road for the purposes of the Greenlink project, which would likely improve the road to a standard that would exceed the Project requirements. Option 7 also had the lowest ranking in terms of topographical constraints, as it is earmarked for use as the construction compound for the Greenlink substation development and, therefore, a lot of the levelling exercise would already be undertaken. Option 8 has more interactions with existing services than Options 9 and 1B and presents the most access constraints of the options. A purpose-built access track may be required, and the western field boundary of Option 8 comprises dense scrub with a surface watercourse, representing more challenges for siting a new access. It also has the least preferable ground conditions, areas to the east were very marshy underfoot on the site visit. A large portion of it is within RWE's BLB which may restrict development and it is on potentially contaminated land.
Onshore Environmental / Consenting	Overall, Option 9 was deemed to be the least constrained in terms of onshore environmental/consenting risks, followed by Option 1B, then Option 7, with Option 8 the most constrained. All options have a similar risk in terms of ecology as none are within close proximity to designated areas and all four options have the potential to support protected species (such as bats, badgers, otters and toads). Similarly, all sites are relatively similar distances from historical assets, with none posing a significant risk. Option 9 is the most preferred option as it is based on green pastures of unspecified usage, there is no known contaminated land, and it is further away from potential developments or forests. It would also be less visible from the roadside and the Pembrokeshire Coast Path National Trail. As with Option 9, Option 1B it is based on green pastures of unspecified usage, there is no known contaminated land, and it is further away from potential developments or forests. However, it is partially located on the

Risk Category	Key Issues
	higher elevations of Greenhill and therefore a potential for a high level of visibility from the surrounding landscape, particularly the settled landscape and road network to the west and from the Pembrokeshire Coast National Park. Option 7 would likely require the removal of an adjacent wind turbine; however, this was identified as likely to be feasible (including acquisition of the ownership rights). It would have slightly higher visual impacts than Options 9 and 1B as it is next to the roadside and in proximity to Lambeeth Farm and the Pembrokeshire Coast Path National Trail, presenting a close interaction with these visual receptors. Option 8 is within approximately 100 m of the National Trail but is partially screened by the scrub around the path. The backdrop of tree line would likely reduce the visual impact of the site from the roadside. However, the site is within an area of potential contaminated land associated with historical landfilling, and a large portion of it is within RWE's BLB, which makes it the most constrained.

3.14.1.10 The initial conclusion was that Onshore Substation Option 9 has the lowest risk ranking when taking account of engineering, environmental and planning constraints (which inherently include consideration of programme and cost).

3.14.1.11 However, Option 9 is on land within the ownership of RWE as are Options 1B and 8. Discussions were held with RWE following the risk assessment and during development of the Project, RWE announced plans for the development of their site at Pembroke for new purposes (Pembroke Net Zero Centre). Consequently, it is not expected that development of the onshore substation on land owned by RWE at Pembroke would be viable.

3.14.1.12 Option 7 has been examined with respect to technical/engineering and environmental constraints and is considered suitable based on the assessment undertaken. It is considered the most suitable option outside of RWE's land holdings. Identified consenting sensitivities, including those related to ecology, land use and LVIA, were deemed likely to require assessment and the development of suitable mitigation measures to minimise where necessary. However, it is considered that a range mitigation measures commonly adopted for projects of this scale and nature can be deployed to offset the risk of adverse effects. These include sensitive design, appropriate environmental management during construction, and landscape planting. Therefore, Onshore Substation Option 7 was adopted for the Project.

3.14.1.13 It should be noted that for all options, the 132kV connection between the proposed substation and connection point requires the route to pass through RWE's landholdings and the BLB as described above, and therefore unavoidable. The project team considered how to minimise potential impacts to RWE commercial operations as part of the substation selection and route identification.

3.15 Stage 10 (January – April 2021) Offshore Export Cable Route Refinement and Burial Assessment

3.15.1.1 Following confirmation of West Angle Bay as the preferred landfall, data from the 2020 marine surveys were used to undertake further delineation and refinement of the offshore export cable. The objectives of the route refinement work and burial assessment were to avoid or minimise effects on certain features, including sand wave crests and boulder fields, and enable an initial assessment of expected cable burial and, if needed, cable protection. The latter point was a particular focus of the route refinement work to enable engagement with NRW, JNCC and other key stakeholders and better understand the implications of cable burial and protection on Pembrokeshire Marine SAC Annex I Habitats.

3.15.1.2 Extensive work was undertaken to determine the seabed conditions along the entire route and undertake an initial cable burial assessment. The initial review concluded that the majority of the cable was expected to be buried, however areas were identified where burial may not be possible due to seabed conditions i.e., presence of bedrock at the seabed surface or close to seabed level or where high-density boulder fields are present.

3.15.1.3 Where the preliminary cable burial assessment identified that cable burial would not be possible, due to hard substrates, further route refinement was undertaken to micro site the offshore export cable route. Where possible the route was refined further to avoid sensitive seabed features such as sand waves and boulder fields, and areas of cable protection necessary for surface laid cable were identified. Detailed charts depicting the offshore cable route were produced, showing avoidance of sand waves, micro siting around boulder fields and the burial status of the entire offshore export cable route, under the classifications set out in Table 3.8.

Table 3.8 Preliminary cable burial classification definitions

Category	Definition
Category 1	Target burial depth (2 – 2.5 m) should be achieved across the section within the limits of the selected burial tool
Category 2	Burial should be achieved but may be reduced in some localised areas requiring pre-lay seabed preparation (i.e., sand wave clearance, boulder clearance/removal), reduced speed, further tool passes, and/or external rock placement protection
Category 3	Burial expected to be achieved potentially at a reduced depth in significant section of the route (i.e. shallow burial due to the presence of subsurface boulders). Multiple passes or slower forward progress may be required to achieve target burial
Category 4	Burial performance is expected to be generally poor, although localised improvements in some areas can be achieved depending on tool capabilities. External rock placement protection required
Category 5	Burial is unlikely to be achieved. Surface lay with external rock placement protection required

3.15.1.4 The burial assessment informed early analysis of the potential interaction between cable protection and Annex I Habitats within the Pembrokeshire Marine SAC, with a focus on permanent habitat loss impacts to Annex I Reef (H1170) and Sandbank (H1110) habitat. Impacts were identified arising from the potential placement of rock armour directly on Annex I habitat (cable protection, cable crossing) and/or damage to Annex I Reef caused by open cut trenching within the intertidal area.

3.15.1.5 The total length of the offshore export cable is approximately 49,000 m, of which 6,866 m lies within the Pembrokeshire Marine SAC boundary. Preliminary findings suggested that of the 6,866 m in the SAC boundary, up to 3,143 m may require some form of rock protection, resulting in a predicted footprint of 10,204 m^2 of rock protection in the SAC. This assumed a worst-case scenario of a rock berm base width up to 11 m.

3.15.1.6 Volume 2, Figure 3.8 shows a section of the offshore export cable and Annex I habitats determined by the 2020 habitat survey. Annex I Reef habitat is present in the area surrounding the subtidal cable route however the cable route was refined to follow a natural channel Row's Rocks thus not intersecting any subtidal reef habitat.

3.15.1.7 On the basis of these preliminary findings, meetings were held with NRW Advisory and the Marine Licence Team to discuss the implications on the Pembrokeshire Marine SAC as a result of the placement of rock protection where complete cable burial could not be achieved. A Technical Note "Initial Assessment of Interaction between Potential Cable Protection and Annex I Habitats within Pembrokeshire Marine SAC" (MarineSpace, 2021) was produced and shared with NRW for discussion.

3.15.1.8 Following further review these estimates of interaction between Annex I habitat and cable protection were refined, and it was confirmed the offshore export cable route would result in the following interaction:

- Cable protection at the Greenlink Interconnector cable crossing interacts with 0.0021 km^2 of the Annex I Turbot sandbank, 0.011% of the feature itself (19.1 km^2), and 0.0041% of all Annex I sandbanks in the Pembrokeshire Marine SAC (51.59 km^2) (Lle Geo-Data Portal, 2021).
- Temporary habitat disturbance across Turbot Bank from sandwave levelling, will occur across approximately 0.008 km^2, which is 0.0419% of the total extent of this feature in the SAC, and 0.015% of all Annex I sandbanks in the SAC (Lle Geo-Data Portal, 2021).
- Within the intertidal zone, no habitat loss of Annex I habitat was predicted. The HDD exit points in the shallow sublittoral is identified to overlap with 210 m^2 (0.00021 km^2) of sublittoral fringe rock, 0.000047% of the 444.68 km^2 of geogenic Annex I reef reported to be present within the SAC (Lle Geo-Data Porta, 2021). The area of potential open cut trenching footprint, a contingency to HDD, was identified to overlap with 146 m^2 (0.000146 km^2) of sublittoral fringe rock, 0.000032% of geogenic Annex I reef in the SAC.
- Temporary disturbance on both subtidal and intertidal Annex I reef from installation of the offshore export cable route, and potential open cut trenching during installation, interacts with 0.96 km^2 of these features, which is 0.22% of all geogenic reef reported in the SAC.
- Open cut trenching across the intertidal, will interact with Annex I mudflats and sandflats features by 0.003 km^2 causing temporary habitat disturbance from trenching and associated activities within the 10 m corridor. This is 0.02% of the total extent of this features estimated to be in the SAC (19 km^2; Lle Geo-Data Portal, 2021).

3.16 Stage 11 (January – May 2021) Onshore Cable Corridor and Route

3.16.1.1 The development of the cable corridor has been governed by the:

- The grid connection point, as confirmed under the grid connection agreement with (NGESO) and confirmation of the location of the duct by WPD through which the connection will enter the existing substation.
- Landfall identification and selection (refer to Section 3.10)
- Substation identification selection (refer to Section 3.15)

3.16.1.2 As noted in Table 3.5, the West Angle Bay landfall results in the longest linear cable route, approximately 10.8 km, however, it is predominantly through open agricultural land. Access to the landfall and beginning of the route was identified as sensitive due to proximity to the town of Angle. In addition, the route will travel through the Arfordir Penrhyn Angle SSSI and is in close proximity to three other designated sites and has the longest route through the National Park, as outlined in Table 3.5. Sections of the route interact with existing and proposed assets, including the Greenlink cable and the high pressure oil pipeline operated by Mainline. Therefore, appropriate separation and engineering design is required to ensure no unacceptable impacts.

3.16.1.3 The entire cable corridor was refined over several months, as baseline survey data was gathered and liaison with landowners progressed. Measures were taken to minimise potential environmental impacts of the onshore works, avoiding areas of high environmental or planning constraint. The engineering assessments provided insight on the issues around design, construction, and operation, for supplying and installing the cable assets.

3.16.2 Cable Corridor Considerations

3.16.2.1 The focus of the cable route refinement included the following criteria:

- Construction access;
- Construction space;
- Natural features;
- Environmental sensitivities (e.g. habitats, protected species, water environment, cultural heritage features);
- Infrastructure obstacles;
- Nature of current and potential future land use, based on liaison with landowners;
- Commercial demands for asset owners within the cable corridor
- Ground conditions; and
- Health and Safety

3.16.2.2 The use of the land, i.e., public roads, existing footpaths, commercially or privately land, and the specific usage of that private land, was considered in refining the route. Using main or minor roads was also considered advantageous to gain access to carry out construction works.

3.16.2.3 Avoidance or minimal impact on potentially sensitive ecological resources such as hedgerows, woodlands and water crossings has been considered.

3.16.2.4 Existing infrastructure such as railways, roads, electrical infrastructure and telecoms, and built-up areas have been considered. Although it was not possible to select route options which avoid existing infrastructure completely, the route refinement sought to identify the most appropriate crossing locations.

3.16.3 Cable Corridor Outcomes

3.16.3.1 Overall, cross-country options for the West Angle route were considered to be more feasible than the road routes, also allowing for flexibility in selecting temporary construction compounds. This is due to most of the existing road network being a narrow single-track design, and often representing the only existing access for location business and domestic premises. It is worth noting, however, that the final cable route corridor does make use of the existing road network to some extent, where there were considered to be suitable mitigation options to appropriately manage disruption.

3.16.3.2 As noted above, landfall installation through the Arfordir Penrhyn Angle SSSI is unavoidable for the West Angle Bay option, however, HDD will be utilised, if technically feasible, reducing potential impacts to the site.

3.16.3.3 In addition, the cross-country cable route has been refined to avoid other designations, particularly the Broomhill Burrows SSSI, the Limestone Coast and South West Wales SAC, and Castlemartin Coast SPA. The route refinement has also been informed by the EIA process, itself, with adequate mitigation applied to reduce impacts identified by each topic assessment. Further details are provided in each relevant topic assessment chapter.

3.17 Stage 12 (April – October 2021) Final Offshore Export Cable Corridor Refinement .

3.17.1.1 Following reconnaissance level geotechnical Site Investigation (SI) surveys, undertaken during May 2021, further refinement was completed on the offshore export cable corridor. A review of the early cable burial assessment was undertaken, and additional lengths of the cable route were reclassified as Category 1, confirming the target burial depth 2 – 2.5 m should be achieved.

3.17.1.2 During the period April to October additional consultation was undertaken with NRW, JNCC and the Wildlife Trust to identify outstanding issues and refine the offshore export cable corridor further. These included meetings in:

- May 2021 – to discuss the approach, baseline and initial findings of the marine and coastal processes assessment;
- June 2021 – to share a draft version of Chapter 6: Marine and Coastal Processes for review; and
- September 2021 – to discuss outstanding comments on the coastal process assessment specifically cable protection and sediment supply in proximity to Turbot Bank.

3.17.1.3 Informed by additional surveys and studies, set out in Section 3.17.1.1, and as a result of the detailed stakeholder consultation the following refinements were made to the final offshore cable route:

- Consent boundary refined to include a “funnel” as the export cable corridor enters the array area, to allow flexibility in assigning lead turbine; and

- The narrowing of the consent boundary, and thus the offshore export cable corridor, through Row's Rock channel to exclude the raised bedrock reef on either side of the channel.

3.18 Stage 13 Final Project Details and Locations for Consent Applications

3.18.1.1 The final selection of the above option has been combined to create the PDE for use in the consent applications and the accompanying EIA. Full details of the proposed development for the Project are provided in Chapter 4: Proposed Development Description.

3.19 Summary

3.19.1.1 A detailed, multi-stage site selection process has been undertaken. In line with the EIA Regulations, all available options were assessed during this process and reasons for the selected option provided.

3.19.1.2 The process began with defining the need for the Project, specifically that the Project will play a key role in helping reach the UK's net zero by 2050 goal. The selection process started with the initial area of search, the Celtic Sea region, followed by individual steps to identify the most feasible option for each stage of the project – the array area, offshore export cable corridor, landfall, onshore cable route and substation. Each stage took engineering, environmental and consenting constraints into consideration to identify the Best Practicable Environmental Option (BPEO) for the Project.

3.19.1.3 The interactions between each stage were key to this process, for example the landfall and onshore and offshore cable route cannot be considered in isolation as they are all linked. This ensured the most feasible option for the Project, overall, was chosen.

3.19.1.4 Following completion of this process, the PDE was defined for use in this EIA. To summarise, the selected components of the Project comprise:

- An array located approximately 35 km southwest of the Pembrokeshire coastline in the Celtic Sea comprising between 6 and 10 floating WTG, with a total capacity of up to 100 MW, and the associated semi-submersible floating platforms and mooring infrastructure. The offshore array site boundary will measure approximately 43.5 km^2.
- Array cables and an offshore export cable, a single, approximately 49 km, to landfall at West Angle Bay in one of the two locations described in paragraph 3.13.2.2;
- Approximately 14.5 km of onshore cabling between the West Angle Bay landfall and the grid connection at Pembroke Power Station; and
- An onshore substation located approximately 850 m south of Pembroke Power Station.
- Full details of the proposed development for the Project are provided in Chapter 4: Proposed Development Description.

3.20 References

Baines ME, Earl SJ, Pierpoint CJL, Poole J (1995). The west Wales grey seal census. CCW Contract Science Report No. 131. Countryside Council for Wales, Bangor

Baines, ME.,Evans, PGH., (2012) Atlas of the Marine Mammals of Wales. CCW Marine Monitoring Report No. 68. 2nd edition. Accessed July 2019. Available at https://www.seawatchfoundation.org.uk/wp-content/uploads/2015/05/ATLAS-Marine-Mammals-of-Wales-FINAL.pdf

BEIS (Department for Business, Energy and Industrial Strategy) (2020). *New plans to make UK world leader in green energy*. Accessed December 2020. Available at: https://www.gov.uk/government/news/new-plans-to-make-uk-world-leader-in-green-energy

Billcliff Energy Consulting (2019). *Grid Connection Strategy*. Document no: SBE/19/001/1

Catapult (2017). *Benefits of Floating Offshore Wind to Wales and the South West*. Accessed February 2021. Available at: https://www.marineenergywales.co.uk/wp-content/uploads/2020/01/Benefits-of-Floating-Offshore-Wind-to-Wales-and-the-South-West.pdf

Crown Estate (2019*). 100 MW capacity Test and Demonstration*. Accessed February 2021. Available at: https://www.thecrownestate.co.uk/en-gb/what-we-do/on-the-seabed/energy/offshore-wind-innovation-and-demonstration/

EDS High Voltage Group (2019). *Substation and Electrical Systems Outline Design.*

Feingold, D., Evans, P.G.H., (2013) *Bottlenose Dolphin and Harbour Porpoise Monitoring in Cardigan Bay and Pen Llŷn a'r Sarnau Special Areas of Conservation 2011 – 2013*. Accessed July 2019. Available at: https://cdn.naturalresources.wales/media/686178/eng-report-004-bottlenose-dolphin-and-harbour-porpoise-monitoring-cardigan-bay-and-pen-llyn.pdf.

Intertek (2019). *Erebus Floating Windfarm Geological Desk Top Study*. Report for Simply Blue Energy. Report No. P2324_R4791_Rev1. 13 September 2019.

ITPE (2020). *Onshore Infrastructure Environmental Baseline & Constraints Assessment. Appendix F - Onshore substation siting and layout engineering assessment*. BGW Document No ERE-CON-ITP-CON-ENV-0055. Issued October 2020.

ITPE (2021). *Erebus – Onshore substation recommendation*. BGW Document NO ERE-OSS-ITP-TNT-MLT-0001. Issued March 2021

JFMS (2019a). *Project 'Erebus' Stage 1 Route Assessment and Array Design.* Document No: 11731-REP-001.

JFMS (2019b). *Project Erebus Stage 2: Cable Route Assessment.* Document No: 11731-REP-002

JFMS (2019c). *Project Erebus Stage 2: Electrical System Outline Design.* Document No: 11731-REP-002

JNCC (Joint Nature Conservation Committee) (2019). *At sea densities of all modelled seabird species combined, for the breeding season.* Accessed July 2019. Available at: https://data.gov.uk/dataset/8cb338b3-3c0e-46bd-afb8-3ac008ab31b6/at-sea-densities-of-all-modelled-seabird-species-combined-for-the-breeding-season

Jon Hudson Ecological Consultancy (2020). *Erebus Project: Preliminary Ecological Assessment of Potential Cable Routes and Substation Locations near Angle and Rhoscrowther, Pembrokeshire.* BGW Document No ERE-CON-ITP-CON-ENV-0055, Appendix D. Issued October 2020.

Lle (2019a). *Seabirds at Sea*. Accessed July 2019. Available at: https://lle.gov.wales/catalogue/item/SeabirdsAtSea/?lang=en

Lle (2019b). *Wales' grey seal photo-identification database: EIRPHOT (1992-2016).* Accessed July 2019. Available at http://lle.gov.wales/catalogue/item/EIRPHOT/?lang=en

Lohrengel, K., Evans, P.G.H., Lindenbaum, C.P., Morris, C.W., Stringell, T.B (2018). *Bottlenose Dolphin Monitoring in Cardigan Bay 2014 – 2016. NRW Evidence Report 191. Accessed July 2019.* Available at https://cdn.naturalresources.wales/media/687852/eng-evidence-report-191-bottlenose-dolphin-monitoring-in-cardigan-bay-2014-2016.pdf

MarineSpace Ltd (2019). *Simply Blue Energy 1 Floating Offshore Wind Farm: Environmental Impact Assessment Scoping Report*

MarineSpace (2021) *Initial Assessment of Interaction between Potential Cable Protection and Annex I Habitats within Pembrokeshire Marine SAC*. Document No:

NGESO (National Grid Electricity System Operator) (2019). Connection and Use of System Code (CUSC). CUSC Section 1 - Applicability of Sections and Related Agreements Structure v1.14. Accessed March 2020. Available at https://www.nationalgrideso.com/industry-information/codes/connection-and-use-system-code-cusc-old?code-documents=&search=&order=title&sort=desc&page=0

NRW (Natural Resources Wales) (2020). *Screening and Scoping Opinion.*

OWC (Offshore Wind Consultants) (2021). *Erebus – Landfall Summary Recommendation Note.* Document No: ERE-CAB-OWC-TNT-ELE-0003 Rev B01

RSPB (Royal Society for the Protection of Birds) (2019). *Seabird Tracking*. Accessed July 2019. Available at: https://www.rspb.org.uk/our-work/conservation/projects/tracking-seabirds-to-inform-conservation-of-the-marine-environment/.

Thaxter et al (2012). *Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas.*

UK Government (1989). *The Electricity Act 1989*. Accessed March 2021. Available at: https://www.legislation.gov.uk/ukpga/1989/29/contents

UK Government (2007). *The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended)*. Accessed March 2021. Available at: https://www.legislation.gov.uk/uksi/2007/1518/contents

UK Government (2009). *Marine and Coastal Access Act, 2009*. Accessed April 2021. Available at: https://www.legislation.gov.uk/ukpga/2009/23/section/126

UK Government (2017). *The Conservation of Offshore Marine Habitats and Species Regulations, 2017*. Accessed April 2021. Available at: https://www.legislation.gov.uk/uksi/2017/1013/pdfs/uksi_20171013_en.pdf accessed 04/02/2021

UK Government (2017). *The Electricity Works (Environmental Impact Assessment) (England and Wales) Regulations 2017*. Accessed March 2021. Available at: https://www.legislation.gov.uk/uksi/2017/580/contents

UK Government (2019). *The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019.* Accessed February 2021. Available at: https://www.legislation.gov.uk/uksi/2017/1012/regulation/29/made

Welsh Government (2016). *Welsh National Marine Plan*. Accessed January 2021. Available at: https://gov.wales/sites/default/files/publications/2019-11/welsh-national-marine-plan-document_0.pdf

Welsh Government (2021). Lle – geo-portal for Wales. Accessed September 2020. Available at: http://lle.gov.wales/home