

Chapter 4 Site Selection, Project Alternatives and Design Evolution

4.1 Introduction

- 1 Schedule 4 of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 and Schedule 3 of the Marine Works (Environmental Impact Assessment) Regulations 2007 require that an Environmental Statement (ES) must include details of the main alternatives studied by the applicant and the main reasons for the applicant's choice, taking into account the environmental effects of those alternatives and of the project as proposed.
- 2 Where alternatives are known to exist it is important to document them in order to provide reassurance that the development presented for evaluation is the most appropriate option.
- 3 Chapter 2: Climate Change and the Need for the Project, discusses the need for renewable energy and offshore wind as a specific technology. This chapter briefly discusses alternatives to offshore wind before focusing on the site selection process undertaken when choosing the Neart na Gaoithe site, the key design decisions and the alternatives considered during the environmental design process leading to the preparation of this ES.

4.2 Alternatives to Offshore Wind

- 4 As described in Chapter 2: Climate Change and the Need for the Project, Scotland has great potential for renewable energy development. Current estimates are that Scotland has up to 25% of Europe's offshore wind resource (Marine Scotland, 2011). Chapter 2 provides more information on the benefits and advantages of offshore wind and Chapter 3: Regulatory and Policy Context describes the policy context in support of renewable energy and offshore wind.

4.2.1 Alternative Renewable Energy Sources Technologies

- 5 Onshore wind is a proven technology and has been exporting power to the electricity grid since 1991. However, suitable locations both in terms of wind resource and local community compatibility are increasingly difficult to find and consent. In England and Wales, for example, almost 50% of all onshore wind farm applications are rejected (Barclay, 2011). Conversely, the planning system in the offshore environment has recently been streamlined and the wind resource is consistently stronger. Onshore wind farms, while an important contributor to the energy mix, cannot provide the scale of generation required, and are therefore not considered as alternatives to offshore wind projects.
- 6 Other marine renewable generation technologies, such as tidal stream and wave power devices, have yet to be proven at a commercial scale in the offshore environment. These technologies cannot therefore be considered as alternatives to commercial scale offshore wind at this time.
- 7 Similarly, while Scotland offers potential for further deployment of hydro-electric, biomass and other forms of onshore renewable energy generation, the scale of the Scottish Government's ambition, and the level of renewable capacity required mandates the deployment of offshore wind farms.

4.2.2 The Do Nothing Approach

- 8 Environmental Impact Assessment (EIA) practice suggests that an ES should consider the "do nothing" potential alternative. However, as discussed in Chapter 2: Climate Change and the Need for the Project, and Chapter 3: Regulatory and Policy Context, addressing the causes of climate change is a high priority pledge by both the Scottish and UK Governments.

- 9 Furthermore, climate change has the potential to give rise to significant adverse social and economic impacts. Natural changes in climate are now understood to be accelerated above background levels by human activity, in particular by the creation and release of greater volumes of greenhouse gases. The Neart na Gaoithe project will play its part in combatting climate change by reducing emissions from the electricity generation sector. When viewed at a Scottish level, Neart na Gaoithe's contribution to the Scottish Government's renewable energy target is significant, potentially offsetting the equivalent of 508,518 tonnes of CO₂ annually.
- 10 As described in Chapter 2: Climate Change and the Need for the Project, the increase in offshore wind development is in line with current European, UK and Scottish Government policy. Exploring alternative sources of energy, increasing efficiency and reducing the national carbon footprint are key aims set out in national legislation and European Directives, as described in Chapter 3: Regulatory and Policy Context.
- 11 In addition to contributing to Government climate change targets, developing an alternative source of energy in Scotland is vital to maintain a secure long term electricity supply. An over reliance on imported fuels leaves the nation vulnerable to fluctuations in supply and cost and competition for resources.
- 12 Therefore, in the context of legislation and government policy, climate change and security of supply, "the do nothing approach" is not an option.

4.3 Site Selection and Assessment of Alternative Sites

- 13 In May 2008 The Crown Estate (TCE) invited expressions of interest from those companies wishing to be considered as potential developers of offshore wind farms within Scottish Territorial Waters (STW).
- 14 Prior to submitting a bid for the Neart na Gaoithe site, Mainstream carried out a series of high level desk-based assessments to determine those sites in STW with the potential to be taken from development sites to fully consented and constructed wind farms.
- 15 In addition to these assessments, consultation was undertaken with the Scottish Government, Maritime and Coastguard Agency (MCA), Chamber of Shipping, Royal Society for the Protection of Birds (RSPB), Scottish Natural Heritage (SNH), Fisheries Research Service (FRS), Scottish Environment Protection Agency (SEPA), Scottish Fishermen's Federation (SFF), Montrose Port, Ministry of Defence (MOD), British Airports Authority (BAA), Civil Aviation Authority (CAA), Visit Scotland and Fife Council.
- 16 The site selection process is discussed in detail within the project Scoping Report (EMU Limited (EMU), 2009), which can be downloaded from www.neartnagaoithe.com.

4.4 Strategic Environmental Assessment

- 17 As discussed in Chapter 2: Climate Change and the Need for the Project, the Scottish Government has determined that offshore wind is likely to be a significant contributor towards renewable energy and climate change targets. Following site selection by individual developers and TCE identification of initial lease areas, in 2010, the Scottish Government developed a draft strategic plan 'Blue Seas - Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters' ('the Plan') to provide a framework for future development of offshore wind. The Plan was then subject to a Strategic Environmental Assessment (SEA), which assessed the potential environmental impact of the near term options (until 2020) for offshore wind development at a strategic level. The final Plan was published in March 2011 and takes into account the findings of the SEA.

18 Ultimately, the Plan aims to balance competing demands on the offshore environment and ensure any future potential development is sustainable for Scotland. It also provides guidance and recommendations to be applied at the project level EIA for each potential development, further details of which are provided in Chapter 5: Project Description and Chapter 7: Engagement and Commitments. The Plan confirms Neart na Gaoithe as one of six STW development options considered viable in the short term (refer to Chapter 1: Introduction for additional information). Following publication of the Plan, the developer was awarded an Agreement for Lease by TCE in July of 2011.

4.5 Project Design Decisions and Alternatives

4.5.1 Foundation Design

19 Both site and market conditions have an effect on the design selection of the wind turbine and substation foundations. Water depth and underlying geology significantly influence the selection of specific foundation types. Economics and long-term maintenance requirements are also a powerful driver. A combination of a harsh and challenging environment and the relative difficulties associated with arranging access increases the cost of a single foundation relative to the overall cost of the wind farm and can have a significant effect on the overall financial viability of the development.

20 Physical conditions on site have resulted in monopile and tension leg platform foundations being discounted, as the water is too deep and too shallow, respectively. Insufficient sediment depth over a large percentage of the site has led to suction caisson foundations being ruled out on both technical and economic grounds. The high uncertainty and consequential cost of long-term maintenance of jack-up foundations, as well as the high cost of steel for the fabrication, have led to this option also being discounted.

21 Future design options not considered commercially available within the consenting and construction period such as floating foundations have also been ruled out. Table 4.1 below summarises those foundation options which are not considered feasible for the Neart na Gaoithe development.

Foundation type	Reason for unsuitability
Monopile foundations	Have not successfully been installed in waters of over 40 m. Depths on the site are between 45-50 m.
Tension leg platform foundations	Water depth of under 60 m is considered too shallow.
Suction caisson foundations	Insufficient sediment depth across the site.
Jack-up foundations	Uncertainty over long-term maintenance requirements.
Floating foundations	Unlikely to be commercially available prior to the planned installation date.

Table 4.1: Rejected foundation types

22 Two foundation options, gravity base and jacket foundations, are considered feasible both technically and economically and are being considered as potential installation options. Chapter 5: Project Description provides more detail on the design, fabrication and installation of these foundation types. Both options have been assessed as part of the EIA and discussed within this ES.

4.5.2 Wind Turbines

23 Wind turbines are subject to hostile environmental conditions and it is essential that they are engineered and optimised to survive the specific conditions they will experience on site. In addition to the engineering criteria, it is also essential that those turbine models considered are commercially available at the time of construction.

24 The turbine models listed in Table 4.2 have been highlighted as potential options (see Chapter 5: Project Description for further information). These range from a 3.6 MW turbine to a 7 MW turbine. All the candidate turbine types identified are three-bladed, horizontal axis units, with nacelle based generators. Therefore any

two-bladed, vertical axis, hydraulic transfer or other novel turbine types have not been included in the assessment.

Turbine capacity (MW)	Rotor diameter (m)	Number of turbines required for 450 MW maximum capacity
3.6	120	125
4	113	112
5	116	90
5	128	90
6	120	75
6	150	75
6	126	75
6	Expected to be in the range of 145 m with an upper limit of 152 m	75
6	Expected to be in the range of 155 m	75
7	164 m	64

Table 4.2: Wind turbine options following selection against a number of alternatives

4.5.3 Turbine Layout Designs and Alternatives

25 Turbine layout design refers to the positioning of the wind turbine generator within the site boundary taking into account localised constraints such as ground conditions, environmental constraints or technological considerations. Given the range of possible turbine types and foundations there are many turbine layout options.

26 In order to produce an indicative layout upon which to carry out an assessment, a constraints mapping exercise was undertaken in which all known limitations (constraints) were overlain on a map of the offshore site. The constraints were considered to be physical, for example water depth and underlying geology, or environmental, such as the presence of archaeological features.

27 Indicative layout diagrams are provided in Chapter 5: Project Description.

4.5.4 Offshore Substation Design Options and Alternatives

28 The most efficient location for any offshore substation is at the electrical centre of the grid which is generally located at the geographic centre of the wind farm. However, locating the substation at this point may pose difficulties for access and maintenance. Locating the substation in the centre of the wind farm also adds a significant distance to the length of the export cable.

29 The following indicative locations are being considered (refer to Figure 4.1):

- One offshore platform located at array periphery (location SS 1);
- One offshore platform located within array (location SS 4); or
- Two offshore platforms located within array (location SS 2 and SS 3).

30 Substation locations were selected with a minimum distance of 500 m to turbine locations. At this stage, without detailed site geotechnical information, it is assumed that substations can be installed between turbines.

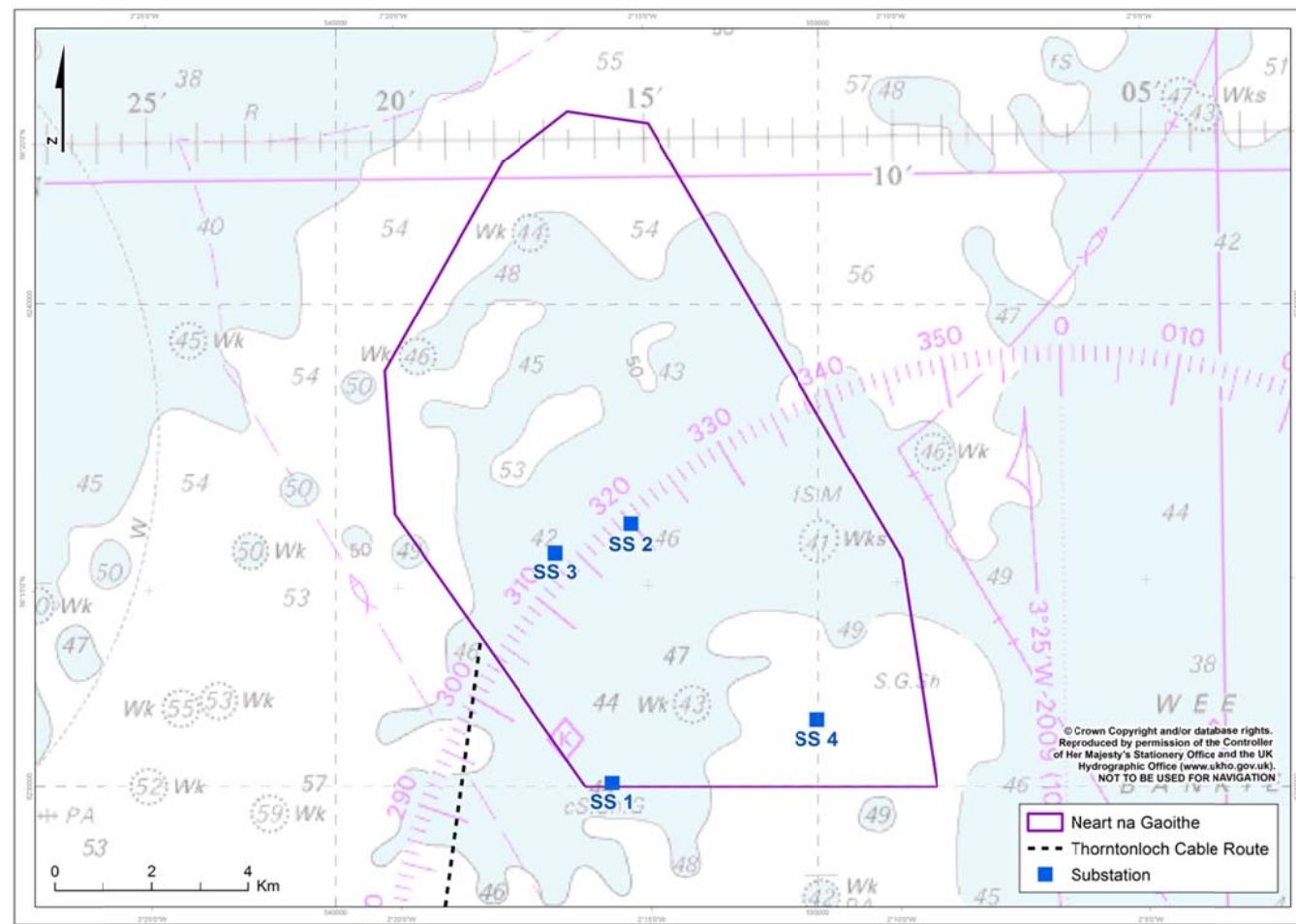


Figure 4.1: Indicative substation locations

- 31 These four offshore substation options will be further assessed throughout the detailed design process using a number of criteria, including:
- Energy loss through cabling;
 - Redundancy in equipment to ensure maximisation of generation transmission;
 - Operation and maintenance considerations; and
 - Capital Expenditure (CAPEX) of installation of one versus two substations.

4.5.5 Alternative Grid Connection Options

- 32 While this ES covers only the offshore aspects of the Neart na Gaoithe project, it is important to highlight the work undertaken to identify the onshore grid connection location, as this informs the rationale for the selected offshore cable route.
- 33 Options for grid connection were examined in parallel with the EIA. The connection options identified were Arbroath, Tealing, Cockenzie, Torness, a new substation at Branxton, and Crystal Rig 2. However, it is important to note that the onshore grid connection is offered by National Grid Electricity Transmission (NGET) depending on grid capacity and proposed connection date, and is not chosen by the developer. Following a high level study by NGET in 2009 a connection point was offered to the developer at Crystal Rig 2 onshore wind farm.

4.5.6 Alternative Offshore Export Cable Route

34 The Scoping Report (available at www.neartnagaoithe.com) details the two export cable routes which were originally considered, to three potential landfall points. Early environmental and technical assessments as well as the location of the grid connection point resulted in the export cable route to Thorntonloch/Skateraw being taken forward as the only offshore export cable route.

35 There will be two high voltage alternate current (HVAC) cables within the export cable route corridor. The width of the cable corridor is 300 m which will allow for micrositing of the cable(s). Once laid, each export cable will be within a 30 m designated area which is marked on Admiralty charts. TCE leases the designated areas to ensure the integrity of the Neart na Gaoithe export cables and manage the requirements of other potential users of the seabed.

4.5.7 Alternative Landfall Locations

36 Following the decision on the preferred export cable route, detailed intertidal, environmental and technical surveys of the two potential landfalls (Thorntonloch and Skateraw) were carried out.

37 Although technically feasible, Skateraw was considered to be more technically challenging due to exposed rock on the beach and environmental sensitivity due to the presence of a Site of Special Scientific Interest (SSSI). Thorntonloch beach is more suitable for cable landing due to the increased sediment cover and the lack of environmental designations.

38 As a result the landfall at Thorntonloch is the only option considered in this assessment.

4.6 Approach to the Assessment Criteria

39 To carry out an assessment of the potential impacts arising as a result of the Neart na Gaoithe offshore wind farm before a final engineering approach is confirmed, a range of design parameters is assessed within which the wind farm will be built. This range of design parameters is known as the Rochdale Envelope and is discussed in Chapter 5: Project Description and Chapter 6: The Approach to Environmental Impact Assessment.

4.7 Developing a Project Description

40 A full description of the design parameters corresponding to the engineering options introduced in this chapter is contained in Chapter 5: Project Description. The Project Description also outlines installation techniques and anticipated durations of the construction, operation and decommissioning activities.

4.8 References

Barclay, C., 2011. *Consents for Wind Farms – Onshore*. House of Commons Library Standard Note SN/SC/4370.

EMU, 2009. *Neart na Gaoithe Proposed Offshore Wind Farm Scoping Report*. Report reference 09/J/1/06/1419/0848. Available online from: <http://www.neartnagaoithe.com> [accessed 21 June 2012].

Marine Scotland, 2011. *Blue Seas - Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters, Part A: The Plan*. Marine Scotland. Crown Copyright.