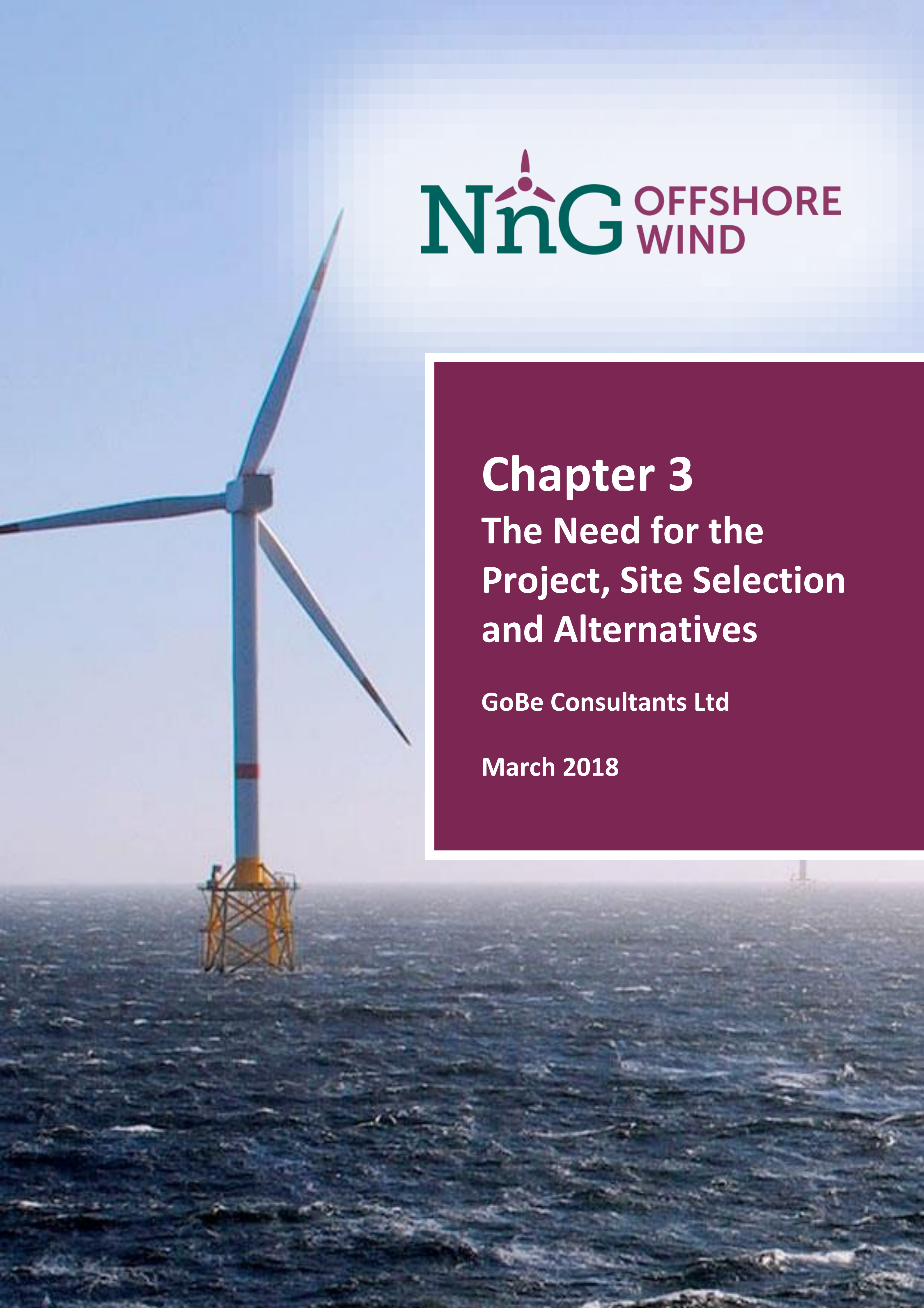

NnG OFFSHORE WIND

Chapter 3

The Need for the Project, Site Selection and Alternatives

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3 The Need for the Project, Site Selection and Alternatives

3.1 Introduction

1. This chapter provides an overview of the need for the Neart na Gaoithe Project (with cross reference to the main legislative and policy drivers summarised in Chapter 2: Policy and Legislation), it identifies the process of site selection and sets out the alternatives considered during the project development and design leading to the preparation of this EIA Report.

3.2 The Need for the Project

2. As described in Chapter 2: Policy and Legislation, Scotland has great potential for renewable energy development. Current estimates are that Scotland has up to 25% of Europe's offshore wind resource (Scottish Government, 2011). Chapter 2: Policy and Legislation provides more information on the policy context in support of renewable energy and offshore wind in Scottish Waters.

3. The Project will act to offset greenhouse gas (GHG) emissions that might otherwise be produced by other means of electricity generation and will also increase the security of electricity supply, thereby assisting with the delivery of UK and Scottish government policy and the meeting of renewable energy commitments. It will also provide socioeconomic benefits to Scotland and the UK and contribute to the development of the offshore wind industry in the domestic markets (see Chapter 15: Socioeconomics).

3.2.1 Emissions Reduction

4. As part of the renewable generation mix, the Project will help to reduce the emissions of CO_2, NO_X, and SO_2 during the operational phase equivalent to the annual emissions of CO_2, NO_X, and SO_2 from traditional thermal generation sources for the generation it replaces.

5. Mainstream participates in the Carbon Disclosure Project; an organisation that works with companies to disclose the GHG emissions of major corporations.

6. A Lifecycle Carbon Analysis (LCA) is a method of measuring a product or process's effect on the environment with regard to GHG emissions throughout its lifetime. During the fabrication, construction and operation of the Project, and as a result of its eventual decommissioning, carbon emissions will be generated and released. Over the lifetime of the Project, these carbon emissions will be offset by the net reduction in emissions through the low carbon wind energy technology.

7. A relevant parameter to measure this offset is the tonnes of coal equivalent saved over the lifetime of the Project. The range of tonnes of coal equivalent for the turbine sizes being considered was found by taking the range of expected energy production figures for the year and dividing by the tonnes of coal equivalent factor (8,141 kWh/ToCE) (Natowitz and Ngo, 2016).

8. The exact value for the Project will ultimately depend on the size of the wind turbines installed. However, indicative figures for 8 MW and 9.5 MW turbines are provided in Table 3.1 and Table 3.2 which demonstrate, for illustrative purposes, the estimated offset values for the Project over a 25-year operational period and over a 50-year operational period.

9. These indicative calculations provide an estimate of the tonnes of coal equivalent saved of 5.25 to 6.30 million ToCE for an 8 MW turbine choice, and between 4.98 to 6.03 million tonnes of coal equivalent for a 9.5 MW turbine over a 25-year period. Over a 50-year period these figures are doubled to up to

12.6 million ToCE for an 8 MW turbine choice and up to 12.06 million ToCE for a 9.5 MW turbine choice.

10. The lower production estimate for one year and over a 25-year period for both turbine sizes was analysed and found to be equivalent to the carbon sequestered by approximately 1.4 to 1.5 million acres of United States forests in one year.

Table 3.1: Tonnes of coal equivalent for lower production estimate

Turbine capacity	Tonnes of coal equivalent per year	Tonnes of coal equivalent (25 year[1])	Tonnes of coal equivalent per turbine (25 year[2])	Tonnes of coal equivalent (50 year[2])	Tonnes of coal equivalent per turbine (50 year[2])
8 MW	210,180	5,254,500	97,300	10,509,000	194,600
9.5 MW	199,410	4,985,250	106,060	9,970,500	212,120

Table 3.2: Tonnes of coal equivalent for higher production estimate

Turbine capacity	Tonnes of coal equivalent per year	Tonnes of coal equivalent (25 year[2])	Tonnes of coal equivalent per turbine (25 year[2])	Tonnes of coal equivalent (50 year[2])	Tonnes of coal equivalent per turbine (50 year[2])
8 MW	252,140	6,303,500	116,730	12,607,000	233,460
9.5 MW	241,190	6,029,750	128,290	12,059,500	256,580

3.2.2 Energy Provision

11. The Project will provide renewable electricity throughout its operational life. The number of homes equivalent that can be supplied with energy generated by the Project has been calculated using Equation 3.1 below, following Renewable UK guidance (Renewable UK, 2017).

Equation 3.1: Homes supplied equation

$$\text{Homes Supplied} = B \times 0.372 \times 8760/3900$$

12. In Equation 3.1, B is the installed capacity of the wind farm in kW, in this case taken to be 450 MW (450,000 kW), 0.372 is the decimalised capacity factor for offshore wind calculated by Renewable UK as a rolling average of the past five years using data (on an Unchanged Configuration Basis) from the Digest of UK Energy Statistics published by the Department of Business, Energy and Industrial Strategy (dimensionless) (Renewable UK, 2017) and 8,760 is the number of hours in one year. The average UK household annual energy consumption is taken to be 3,900 kWh/household (Renewable UK, 2017).

13. Applying this equation to the Project, using the Renewable UK published capacity factor for offshore wind of 37.2%, it is estimated to produce enough electricity each year to meet the needs of the equivalent of 376,000 households. Using a project specific capacity factor of approximately 45%, it is estimated that enough electricity will be produced each year to meet the needs of the equivalent of approximately 454,800 households.

14. The City of Edinburgh had approximately 230,831 households in 2015 (National Records of Scotland, 2016). As an indication of scale, in applying Equation 3.1, the Project would generate more locally produced electricity each year than the annual domestic demand of a city of this size.

[1] Assumes a 25-year operational period
[2] Assumes a 50-year operational period

3.2.3 Carbon Emissions Offset

15. During the fabrication and construction of the Project, carbon emissions will be generated and released. Over the lifetime of the Project these carbon emissions will be offset by the net reduction in emissions through the use of low carbon technology. As described above in Section 3.2.1, LCA can be used to calculate this.
16. The carbon payback period is analogous to the financial payback period, and represents the period of time before a product or project has saved more CO_2 emissions (CO_2e) than has been produced by its construction and operation.
17. For a 25-year operational period of the wind turbines, the Project will displace CO_2e from other energy sources by between 4.98 and 6.30 million tonnes coal equivalent and over the 50-year operational period this will be between 9.97 and 12.61 million tonnes coal equivalent (see Section 3.2.1 for further information).
18. The payback range for the Project has been calculated to be 0.8 years from the start of full commercial operation.

3.3 Site Selection

19. With the need for new generating sources having been established and the role of offshore wind developments recognised as a key element of Scotland's long-term energy mix in Scottish and UK Government policy, as summarised in Chapter 2: Policy and Legislation, the following section sets out the process that led to the location of the Project in the Forth and Tay region.
20. In May 2008, TCE invited expressions of interest from those companies wishing to be considered as potential developers of offshore wind farms within STW.
21. Prior to submitting a bid for the Project, Mainstream carried out a series of 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.
22. Specifically, the following initial process was applied during the site selection process:
    - Areas within STW of less than 60 metres (m) water depth were identified; and
    - Areas were refined to those that were within an economic distance of major grid connection points and suitable ports but that avoided areas with excessive wave heights.
23. This initial process identified three large areas for further assessment:
    - The outer Firth of Clyde;
    - The outer Solway Firth; and
    - The area to the east of the Firths of Forth and Tay.
24. These three areas were then subject to detailed environmental constraints analysis, which identified that the east coast sites were the least constrained (the outer Firth of Clyde having significant ornithology, and water depth challenges, and both west coast zones having shipping and Ministry of Defence (MOD) issues, as well as possible limitations with the geology and grid connection opportunities).
25. The east coast sites were subsequently investigated further by Mainstream and in greater detail to select the preferred sites for development.
26. Having assessed bird, marine mammals and navigation data, further technical appraisals of six potential east coast sites were undertaken in relation to:

- wind resource and energy yield;
- environmental (incorporating ornithology and marine mammals and landscape/seascape and visual impact);
- grid; and
- geotechnical conditions and foundation design.

27. These assessments led to the selection of the Development Area.
28. In addition to these assessments, consultation was undertaken at that time with the Scottish Government, Maritime and Coastguard Agency (MCA), Chamber of Shipping, RSPB, SNH, Fisheries Research Services (FRS) (now Marine Scotland), Scottish Environmental Protection Agency (SEPA), Scottish Fishermen's Federation (SFF), Montrose Port, MOD, British Airports Authority (BAA), Civil Aviation Authority (CAA), Visit Scotland and Fife Council.
29. Following this process, the NnG site was selected as the preferred site and exclusive rights to develop the site were granted by TCE.
30. At a national level, a total of ten sites within STW were identified by different developers, with exclusive development rights granted by TCE. The sites were subject to a Strategic Environmental Assessment (SEA) by the Scottish Government, as part of the development of a draft national plan for offshore wind within STW (Scottish Government, 2010). The SEA ensured that environmental considerations were taken into account in selecting the sites to be taken forward to the development phase. A number of sites were dropped and those remaining were included in the Scottish Government's strategic plan 'Blue seas – Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters' (Scottish Government, 2011). Following the publication of this plan, Mainstream was awarded an AfL by TCE in July of 2011.
31. Of the original ten sites within STW, seven have been dropped; either due to environmental concerns identified through the SEA, or for technical feasibility reasons.
32. It is clear from the above assessments and plans, that the location of the Project is supported not only by Mainstream's analysis of relevant constraints but also by the sectoral planning policy developed by Scottish Government for STW.

3.4 Alternatives

33. The EIA Regulations require that an EIA Report must include details of the main alternatives studied by the applicant and the main reasons for selecting the chosen option taking into account the environmental effects.

3.4.1 The Application vs the Originally Consented Project

34. In considering alternatives, it is important to note that the primary alternative to the Project is the Originally Consented Project; if the Application is not successful NnGOWL will progress the originally Consented Project.
35. The Originally Consented Scheme itself was subject to revisions as it progressed through the consenting process and subsequently by variation to the Section 36 consent granted in 2016. The revisions in the Application were made for varying reasons, including reducing potential environmental impacts and incorporating up-to-date turbine technologies. The increased output per turbine that is now achievable means that a significant reduction in turbine numbers is possible whilst still delivering the overall 450 MW output. A reduction in turbine numbers is considered beneficial from environmental, technical and commercial perspectives.
36. The key changes in turbine numbers that have occurred since the original consent application in 2012 are summarised in Table 3.3.

Table 3.3: Reductions in Maximum Turbine Numbers for NnG

Milestone	Date	Maximum Number of Wind Turbines	Reason for Amendment
Original Application	2012	125	-
Addendum	2013	90	Technological advancement – increased turbine capacity, reduced number of turbines
Consent	2014	75	Technological advancement – increased turbine capacity, reduced number of turbines
Section 36 Variation	2016	75	Technological advancement – increased turbine capacity, reduced number of turbines
Application	2017	54	Technological advancement – increased turbine capacity, reduced number of turbines

37. The Consents allow for up to 75 turbines, whereas the Project will be constructed with a maximum of 54 turbines, if consent is granted within the expected timescale. The reduction in turbine numbers (compared with the Consents) would also result in a need for fewer foundations, plus a shorter construction period and less time installing driven piles.

38. It can be concluded that in all respects the Project (when applying worst case scenarios) would give rise to lesser environmental effects than the worst case considered for the Originally Consented Project.

3.4.2 Project Design Decisions and Alternatives

39. The following sections identify project design alternatives that have been considered in refining the Project to the form described in Chapter 4: Project Description. It considers:

- Turbine capacity, numbers and type;
- Turbine layout;
- Foundation options;
- OSP design;
- Grid connection;
- Offshore Export Cable route; and
- Offshore Export Cable landfall location.

3.4.2.1 Turbine capacity, numbers and type

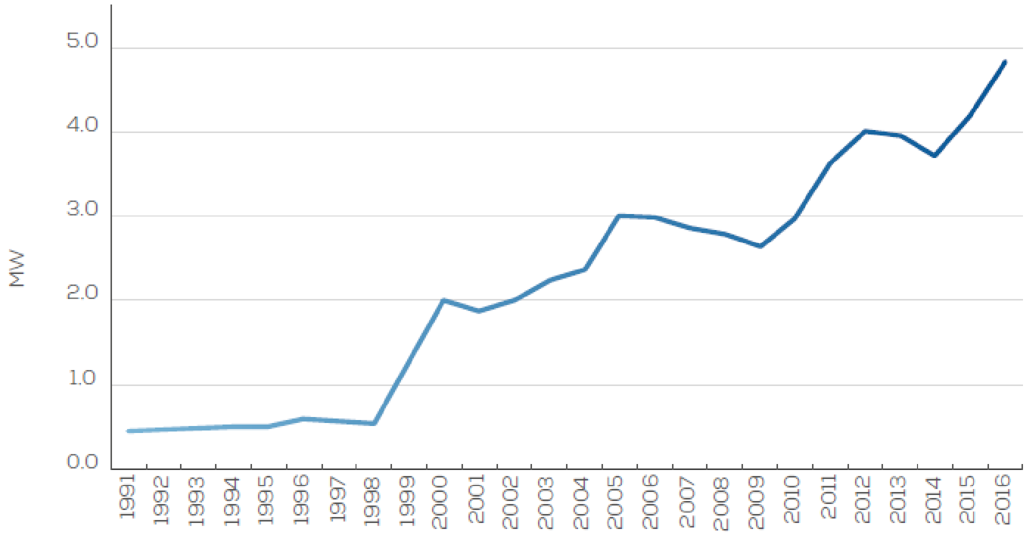
40. As noted in Section 3.4.1, the Project design has been subject to revisions through the process of developing the Project so that the Original Application comprising up to 125 turbines is now reduced to the Application for up to 54 turbines (for the same 450 MW maximum installed capacity).

41. This design decision has been predominantly driven by the increasing capacity of individual turbines available on the market; as individual turbine capacity has increased, the corresponding number of turbines needed to meet the 450 MW project capacity has decreased.

42. This trend in offshore turbine size is identified in the 2016 offshore wind trends and statistics report by Wind Europe (Wind Europe, 2017) and is summarised in Figure 3.1, it is noted that the average turbine size installed in 2016 was 4.8 MW; by comparison in 2010, average turbine rated capacity was in the order of 3 MW. The Wind Europe report also notes that in 2016 8 MW turbines were installed and

operational for the first time, reflecting the rapid pace of technological development. Vestas, one of the world's leading turbine supplier already offers a 9.5 MW turbine, whilst Siemens (another leading turbine manufacturer) is currently offering the aforementioned 8 MW machine.

Figure 3.1: Average offshore wind turbine rated capacity over time (source: Wind Europe, 2017)



43. The specific turbine model that will be installed at the Offshore Wind Farm is yet to be identified. However, the turbine type will comprise of a three-bladed, horizontal axis unit, with nacelle based generators.

44. Two-bladed, vertical axis, hydraulic transfer or other novel turbine types have not been included in the Project design envelope as such turbines for a development of this scale will not be commercially available by the time construction commences.

3.4.2.2 Turbine Layout

45. Turbine layout design refers to the positioning of the turbines within the Wind Farm Area taking into account localised constraints such as ground conditions, environmental constraints, navigation or technological considerations. The final layout for the Project will be determined as part of the final Project engineering design process and following the award of consents and the appointment of the relevant suppliers and contractors. It is expected that any consents granted by the Scottish Ministers would require the final layout to be approved, in consultation with relevant stakeholders, prior to construction (as is the case for the Originally Consented Project).

3.4.2.3 Foundation Design

46. Both site and market conditions have an effect on the design selection of the wind turbine and OSP 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. The 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.

47. The physical conditions at the Wind Farm Area mean that monopile and tension leg platform foundations have been discounted since the water is too deep and too shallow respectively for the use of these solutions. Insufficient sediment depth over a large part of the site means that suction caisson foundations have also been ruled out on technical grounds.

48. Table 3.4 below summarises those foundation options, which are not considered feasible for the Project.

Table 3.4: Discounted foundation types

Foundation type	Reason for unsuitability
Monopile	This type of structure is best suited to water depths ranging between 0 m to 30m. Depths on the site are between 45 – 55 m. XL monopiles could, in theory, be installed in up to 50m water depths, but monopiles of the size that would be needed are not yet commercially available. In any event the shallow bedrock at the site would render installation very challenging
Tension leg platform	Water depth under 60 m is considered too shallow.
Suction caisson	Insufficient sediment depth across the site.
Gravity base	Insufficient number of foundations needed to make it an economically viable solution.
Floating	Floating foundations have not been deployed on a major commercial scale to date although a number of demonstrator sites have utilised or are in the process of deploying floating foundation solutions. It is not anticipated that these will be commercially available for installation by the time construction commences.

49. Steel jackets with pile foundations are, therefore, considered to be the most feasible option for the Project on both a technical and economic basis. Chapter 4: Project Description provides more detail on the design, fabrication and installation of these foundation types.

3.4.2.4 OSP Design

50. The most efficient location for any OSP is chosen based on optimising the electrical design and this can often result in selection of a position located at the geographic centre of the Wind Farm Area. However, locating the OSP(s) at this point may have implications on access and maintenance logistics, and such location may not have favourable ground conditions. The final OSP locations (a design involving either one or two OSPs may be selected) will be assessed throughout the detailed design process taking into consideration 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 of installation of one versus two OSP(s).

3.4.2.5 Grid Connection

51. Whilst this EIA Report covers only the offshore aspects of the Project, it is important to highlight the work undertaken to identify the onshore grid connection locations as this informs the rationale for the selected Offshore Export Cable Corridor and landfall location.

52. Options for grid connection were examined in advance of submission of the Original ES. Onshore grid connections are offered by National Grid Electricity Transmission (NGET) depending on grid capacity and proposed connection date. The potential connection options considered were Arbroath, Tealing, Cockenzie, Torness, a new substation at Branxton, and Crystal Rig II Onshore Wind Farm. Following a high-level study by NGET in 2009, a connection point was offered to NnGOWL at Crystal Rig II Onshore Wind Farm.

3.4.2.6 Offshore Export Cable Route

53. Early environmental and technical assessments as well as the location of the grid connection point resulted in the Offshore Export Cable route to Thorntonloch being taken forward as the only option.

54. There will be two High Voltage Alternating Current (HVAC) cables installed within the Offshore Export Cable Corridor. The width of the Offshore Export Cable Corridor is 300 m, which will allow for micrositing of the Offshore Export Cable. Once laid, each Offshore Export Cable will be within a ~30 m wide corridor which will be marked on Admiralty charts. CES leases the designated areas to ensure the integrity of the Offshore Export Cable and to manage the requirements of other potential users of the seabed.

3.4.2.7 Offshore Export Cable Landfall Location

55. Following the decision on the preferred Offshore Export Cable route, two potential landfall locations were identified: Thorntonloch and Skateraw. Detailed intertidal, environmental and technical surveys were conducted at each of the two landfall options.

56. 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 was considered to be more suitable for the landfall due to the increased sediment cover and the lack of environmental designations.

57. As a result, the landfall at Thorntonloch is the option considered in the EIA process.

3.4.3 The Do Nothing Approach

58. EIA practice suggests that an EIA Report should consider the 'do nothing' potential alternative. The 'do nothing' scenario details what would happen at a location should the Project not proceed. In this context, the 'do nothing' scenario at this particular location will include the construction of an offshore wind farm in accordance with the Original Consent, along with natural environmental changes or established activities in the area such as climate change or commercial fishing activity.

59. As discussed in Chapter 2: Policy and Legislation, addressing the causes of climate change through the development of a low carbon economy, and specifically renewable energy, is encapsulated in legislation from both the Scottish and UK Governments as well as being a cornerstone of energy policy.

60. Furthermore, climate change will 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 GHGs. The Project will contribute in combatting climate change by reducing GHG emissions from the electricity generation sector. When viewed at a Scottish level, the Project's contribution to the Scottish Government's renewable energy target is significant, potentially offsetting the CO_2 of 252,140 tonnes coal equivalent annually (see Section 3.2.3.)

61. As described in Chapter 2: Policy and Legislation, 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, policy and European Directives.

62. In addition to contributing to Government emissions 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.

63. The principle of offshore wind as suitable development in this location has been established through the consenting of the Original Application for 75 turbines. If the Project is not delivered or consented, the reduction in turbine numbers to 54 (maximum) will not be realised and the 'do nothing' scenario

will be the construction and operation of NnG in accordance with the Original Application and Consents.

3.5 References

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