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Abbreviations and Acronyms

EIA	Environmental Impact Assessment
ES	Environmental Statement
FID	Final Investment Decision
ICOL	Inch Cape Offshore Limited
OSP	Offshore Substation Platform
TCE	The Crown Estate
WTGs	Wind Turbine Generators

6 Site Selection and Alternatives

6.1 Introduction

1 This chapter provides details of the selection process and alternatives for the Development, including the identification of the Development Area and the Offshore Export Cable Corridor, and the alternatives considered during the project development and design. The chapter is supported by *Appendix 6A: Design Considerations*.

2 As described in *Chapter 1: Introduction, Section 1.3.1*, the identification of the Development Area was first undertaken as part of The Crown Estate (TCE) 2008 offer of lease areas for Offshore Wind development in Scottish Territorial Water (STW). The Development Area was put forward following a wide range of studies and application of environmental, economic and social selection criteria (see *Section 6.2* below), and in 2009 was one of ten sites awarded a potential exclusivity agreement, subject to a Strategic Environmental Assessment (SEA) to confirm the suitability of the sites in a national context. The Development Area and all other reasonable alternatives within the STW were assessed within the SEA, resulting in 6 of the 10 TCE lease sites selected as being suitable for sustainable offshore wind development in the short term. The Development Area was identified as one of the sites for short-term development and was adopted as such within the Scottish Sectoral Marine Plan for Offshore Wind.

3 As Inch Cape Offshore Limited (ICOL) already holds existing consents (Inch Cape 2014 Consent) at the Development Area and Offshore Export Cable Corridor (shown in Figure 1.1), and the purpose of this application is to maximise efficiencies whilst minimising environmental impacts, the selection and assessment of alternatives as detailed in the Inch Cape 2013 Environmental Statement (ES) has been reviewed and remains valid, details of which are provided below.

4 The Development Area for the Development lies wholly within the TCE lease area, and therefore the site selection and SEA assessment of alternative sites continues to be relevant. A summary of the site selection and screening process carried out by both ICOL (for TCE bid), and the Scottish Government (during the SEA process), are provided below in *Section 6.2*.

5 The Offshore Transmission Works (OfTW) comprises an Offshore Export Cable Corridor from the Development Area to landfall. The Development Area and Offshore Export Cable Corridor for this application are within the same boundaries as the Inch Cape 2014 Consent.

6 The location of the landfall is constrained by the need for proximity to the Grid Connection point, as well as the need to minimise environmental impacts as much as possible. The landfall for this application is located within the same boundaries as the Inch Cape 2014 Consent.

7 The Development Area and Offshore Export Cable Corridor are considered to be appropriate sites, in principle, for an offshore wind farm development and OfTW respectively.

8 This position is confirmed in a statement from the Scottish Ministers in the Section 36 Inch Cape 2014 consent (page 37)[1], which notes the following:

'The Scottish Ministers accept that the location of the Development was fully considered both prior to, and during, the application process and have undertaken a full and thorough consultation with relevant stakeholders and members of the public and are of the opinion that there are no considerations with regards to the proposed location of the Development that would require consent to be withheld.'

9 As it is ICOL's intention to progress with either the Inch Cape 2014 Consent or the consent applied for in this application, the primary alternative to the Development assessed within this Environmental Impact Assessment (EIA) report, is considered to be the Inch Cape 2014 Consent. A comparison of the key parameters of both alternatives is presented in *Section 6.5*.

6.2 Development Area

6.2.1 Identification of the Inch Cape Site

10 The following information identifies the site screening and selection process that preceded the Inch Cape 2014 Consent, which remains valid for the purposes of this application.

11 In 2008, by request of the Scottish Government, TCE invited potential developers to submit proposals for offshore wind farm sites within Scottish Territorial Waters (STW).

12 A broad study of wind resource and water depth data was undertaken to identify a suitable region for offshore wind farm development in STW. This study identified the most suitable physical characteristics existed off the east coast of Scotland. Analysis of other marine users and environmental parameters was used to narrow down the search area to the outer Firths of Forth and Tay.

13 A more detailed analysis of environmental and technical constraints was then undertaken for the outer Firths of Forth and Tay to identify and assess viable sites for a wind farm development. From this analysis, the Development Area was identified as being the preferred location for development and thus a proposal was made to TCE for this site. Factors considered in this analysis were;

- Potential energy yield;
- Foundation type suitability;
- Seabed and tidal conditions;
- Nature Conservation Designations;
- Marine Ecology;
- Marine Mammals;

[1] http://www.gov.scot/Resource/0046/00460543.pdf [Accessed: 02/08/18]

- Ornithology;
- Fish Resources and Commercial Fisheries;
- Shipping and Navigation;
- Other marine users;
- Grid connection; and
- Visual amenity.

14 The distance from shore was considered particularly important as initial discussions with local stakeholders (e.g. fisheries and nature conservation bodies) highlighted potential conflicts in inshore coastal locations and potential increased impacts on other human environmental receptors (e.g. visual/seascape issues, tourism and recreation).

15 The key factors which led to the site being selected by ICOL as set out in their proposal to TCE, are:

- It has an excellent wind resource with the mean wind speed at 90 m then estimated at 9.51 m/s;
- At the closest point, the Development Area is approximately 15 km from the shore which will help minimise its visibility and potential conflicts with inshore uses;
- Water depths and ground conditions are suitable for a variety of foundation types;
- There is already electrical infrastructure near the coastline to enable an efficient connection to the national grid;
- There is good access to suitable ports and local supply chain for construction and operations. There are also nearby facilities for fabrication, assembly and maintenance support. The distance to these facilities will be important during operation as they will enable shorter response times for servicing thus improving operational availability and economic feasibility of the wind farm;
- There are no known Annex I habitats in the Development Area and it falls outside any designated conservation area; and
- There are no known active oil, gas or aggregate interests in the Development Area.

16 The proposal was submitted to TCE for their evaluation and in June 2011 TCE awarded an exclusivity agreement for the Development Area, following publication of *Blue Seas - Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters: Part A The Plan* (Marine Scotland, 2011).

6.3 Transmission Works

6.3.1 Grid Connection Agreement

17 The onshore grid connection was offered by National Grid Electricity Transmission (NGET) and accepted by ICOL in January 2012. NGET has a statutory duty, as a transmission licence holder, under Section 9(2)(a) of the *Electricity Act 1989* "*to develop and maintain an efficient, coordinated and economical system of electricity transmission*", and must appraise environmental, technical and economic constraints, as well as grid capacity and proposed connection date when considering alternative connection points. The following grid connection locations were assessed by NGET for Inch Cape: Arbroath, Tealing, Branxton, Torness, Cockenzie, Crystal Rig, Blyth (via land), Blyth (via sea) and Hawthorn Pit.

18 Following engagement between ICOL and NGET, a grid connection point was offered, and subsequently accepted, at Cockenzie, East Lothian. This connection was primarily chosen due to its ability to accommodate the capacity of the wind farm without the need for significant enhancement works by NGET.

19 The grid connection location informed the selection of the Offshore Export Cable Corridor and landfall options.

6.3.2 Offshore Export Cable Corridor

20 Various Offshore Export Cable Corridor alternatives were considered in parallel with the assessment of landfall locations, taking account of the potential grid connection location and using constraints mapping and technical analysis techniques to identify potential corridors for the connection. The starting point of the corridors was assumed to be located on the boundary of the Development Area with the end point at the connection at Cockenzie (see Figure 1.2, Chapter 1).

21 When assessing potential Offshore Export Cable Corridors, the objective is to minimise the route from the offshore substation to the landfall site, taking account of engineering, physical and environmental constraints, as well as potential conflicts with third parties. The corridor also needs to be determined considering the need for safe installation and the long-term integrity of the cables. Regard must also be given to the location of the grid connection and the likely onshore cabling routes as it may be preferable to increase the offshore route length in order to decrease the onshore route length, depending on the environmental, technical or commercial constraints of the onshore routing options.

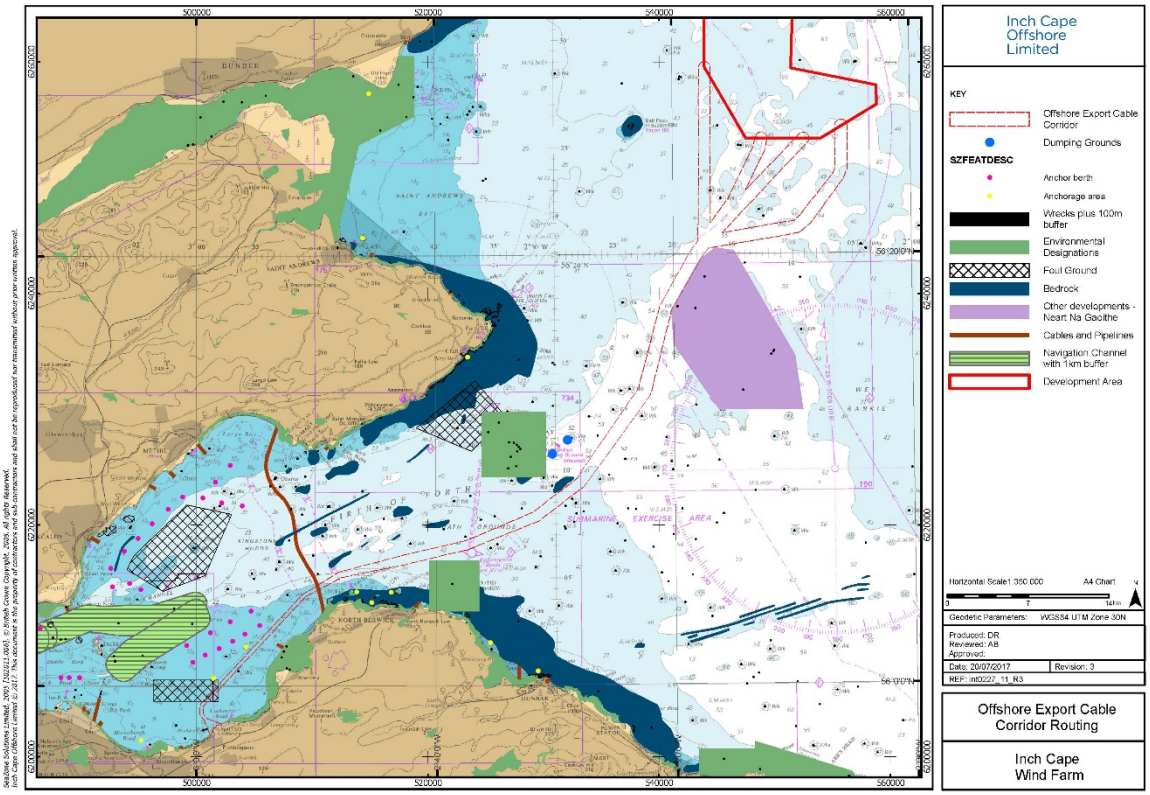
22 When choosing a corridor, the following factors need to be considered and weighed up against each other:

- Cable stability;
- Cable protection;
- Cable separation requirements;
- Ability to utilise existing cable lay construction methods;

- Minimisation of seabed pre-lay intervention requirements;
- Minimisation of seabed and cable post-lay intervention requirements;
- Minimisation of the number of cable and pipeline crossings;
- Minimisation of the environmental impact; and
- Minimisation of interference of all types.

23 When assessing the Offshore Export Cable Corridor options, routing through environmentally sensitive areas was avoided where possible and balanced against going through seabed zones which could cause an increased risk to both other users of the sea and the cable. Such considerations are shown in Figure 6.1.

Figure 6.1 Constraints Mapping and Offshore Export Cable Corridor Routing



24 To minimise the complexity of cable installation at the landfall, the angle of the cable at shore approach was chosen having regard to the following objectives:

- Minimisation of the shore pull length across the landing area to minimise the maximum pull load on the cable;
- Minimisation of the distance between the cable landing point and a water depth that would allow suitable vessels to come as close as possible to shore and minimise the length of near-shore trenching required;

- Maximisation of the distance from the coast to the first turn in the cable to simplify marine operations near-shore; and
- Where possible, locating the cable parallel to near-shore wave effects to ease installation and minimise the loads on any exposed part of the cable.

25 Seven routes to shore were originally analysed and considered feasible. A route to Cockenzie and Seton Sands was ultimately considered to be the most suitable option when taking account of all relevant criteria.

6.3.3 Landfall

26 As part of the routing exercise, six initial landfall locations were identified using technical and environmental constraints mapping along the East Lothian coast:

- Cockenzie;
- Prestonpans;
- Seton Sands;
- Gullane;
- Thorntonloch; and
- Pease Bay.

27 These six landfall options were assessed and all were considered feasible on environmental grounds with suitable mitigation measures implemented. Gullane, Thorntonloch and Pease Bay were not considered viable on commercial and engineering grounds (primarily due to potential onshore cable corridor length and associated constraints). Prestonpans was not considered viable due to lack of available onshore land.

28 When considering all factors the landfall options at Cockenzie and Seton Sands were found to be the preferred landfall locations for the Inch Cape 2013 Application and were included in the Inch Cape 2014 Consent.

29 Upon further refinement of the landfall location it has been determined that the landfall at Cockenzie is the preferred option due to environmental, economic, technical and land availability considerations such as;

- At Seton Sands there is a long section of shallow water which would be inaccessible for construction vessels;
- At Seton Sands there is outcropping rock in the shallow water. This would require extensive work to enable trenching or would result in a long horizontal directional drilling operation; and
- At Seton Sands the onshore cables would need to go through and/or around Port Seton and Cockenzie to reach the grid connection at Cockenzie substation.

30 Therefore, this application only considers Cockenzie for its landfall.

6.4 Design Process

31 As the Inch Cape 2014 Consent has already been granted, the reason for this application is to allow ICOL the ability to utilise Wind Turbine Generators (WTGs) that fall out with the Inch Cape 2014 Consent design. This allows the opportunity to make use of advances in technology and improvements in efficiency for offshore wind power generation, whilst minimising environmental impacts.

32 The following information provides the steps taken by ICOL during the design process.

6.4.1 Design Criteria

33 As part of the engineering development process the criteria listed below are central to the selection of design concepts and detailed design:

- **Health and safety:** the inherent safety by design through construction, operation, maintenance and decommissioning.
- **Technical:** the technical suitability of the available alternatives, given the site conditions.
- **Environmental:** the potential for minimising and avoiding environmental impacts.
- **Development economics:** whole life cost considerations and effect on revenue.
- **Programme:** the impact to delivery of the Development programme.
- **Wind farm performance:** the output and efficiency of the wind farm.
- **Technology maturity:** the benefits and risks associated with adopting newer technology over proven technology.

34 Further detail on this can be found within *Appendix 6A*.

35 The following sections discuss the evaluation and development of alternatives and decisions made based on these criteria. This led to the Design Envelope used in this EIA Report (further information on the Design Envelope can be found in *Section 7.4*).

6.4.2 Wind Turbine Generators

36 The development of WTG technology has been rapid in recent years. Principal improvements are the increase in energy yield through increased turbine diameter leading to reduction in the required number of turbines and associated support structures (see *Section 6.4.2*). The design parameters of the WTGs being considered is defined as part of the description of development in Table 7.3, *Chapter 7: Description of the Development*.

6.4.3 WTG Layouts

37 The final layout design of the wind farm will be dependent on the specific WTG selection and environmental, technical and economic constraints including the following factors:

- Prevailing wind direction, as WTG rows must be orientated to benefit from the dominant wind direction;

- Distance from adjacent WTGs to take account of wake effects and maximise efficiency of energy capture;
- Geological conditions;
- Bathymetry;
- Physical and spatial constraints; and
- Environmental and navigational safety considerations.

38 The final WTG and Offshore Substation Platform (OSP) locations will be decided at a later stage in the design process (see *Section 7.4*).

39 The design envelope accounts for a maximum of 72 WTGs located within the Development Area, this number has been identified after consideration of environmental, technical and economic factors.

40 The nominal minimum spacing between WTG's is 1,278 m and WTGs will either be laid out in a grid, where rows are aligned both down-wind and cross-wind, or in an offset grid where WTGs in the cross-wind rows are offset (Figures 7.9 and 7.10). Cross-wind rows will be aligned perpendicular to the predominant wind direction which is approximately 240°. In the down-wind direction the distance between rows may vary to maximise efficiency of energy capture and so the effective spacing may be larger. The grid or offset grid will be subject to micro-siting for each individual WTG of up to +/- 50 m to account for local technical constraints. All references to 'alignment' of WTGs should be considered as subject to this practical micro-siting requirement.

6.4.4 Foundations and Substructures

41 The substructures and foundations connect and secure the WTGs to the seabed. There are a range of substructure and foundation types that can be used for offshore wind developments. The final selection of foundation and substructure type will depend on various technical, environmental and economic factors such as water depths, compatibility with WTG, deliverability, constructability and whole life economics.

42 Various foundation and substructure alternatives were assessed using the criteria outlined above for WTGs.

43 Floating foundation/substructures were eliminated following evaluation due to water depth.

44 The following foundation types are feasible for the Development in whole or in part (see *Section 7.6* for more information):

- Driven Piles;
- Drilled Piles;
- Monopiles;
- Suction Piles; and

- Gravity Base.

45 The following substructure types are feasible for the Development in whole or in part (see *Section 7.6* for more information):

- Steel-framed structures; and
- Gravity Base Structures.

46 The foundation and substructure types which are still in consideration are detailed in the *Chapter 7*. The type which represents the worst case, for each receptor, has been utilised in the assessments and identified in each chapter accordingly.

6.5 Alternatives

6.5.1 Inch Cape 2014 Consent

47 ICOL consider that the primary alternative to the Development is the Inch Cape 2014 Consent.

48 As this application aims to increase efficiencies as well as minimise the environmental impacts, the following section provides a summary of the comparison on the differences in design and likely associated impacts between this application and the Inch Cape 2014 Consent.

49 With less infrastructure required to build out the project, there is an increase in construction and generation efficiencies (see *Section 6.4.2*) resulting from the adoption of recently introduced WTGs (or those currently under development) which offer increased energy yield through increased turbine diameter which leads to a reduction in the required number of turbines and associated support structures.

50 Table 6.1 below details the key design differences between the Inch Cape 2014 Consent and the development parameters being applied for, and assessed, in this application. Relative to the Inch Cape 2014 Consent design envelope, the Development results in a 34% reduction in turbines and substructures, a 66% reduction in the number of Export Cables, a 46% reduction in the length of inter-array cabling, environmentally this therefore results in less direct physical impact on the seabed as well as a reduction in construction time frames.

51 *Chapter 9* to *17* of this EIA Report identifies the environmental impacts associated with the Development and *Chapter 18* also provides a summary of effects compared with those from the Inch Cape 2013 ES.

Table 6.1: Comparison between the Inch Cape 2014 Consent parameters and the parameters applied for and assessed in this application.

Parameter (Maximum)	2014 Consent	2018 Application
Number of turbines	110	72
Tip height	215 m	291 m
Met masts	2	0
OSPs	5	2
Inter-array cabling length	353 km	190 km
Export Cable Length	83 km	83 km
Number of Export Cables	6	2
Rotor Swept Area below 50 m	165,000*	87,000
Estimated Construction Duration	3 years	2 years

*Commitment made by ICOL following 2014 Consent

6.5.2 General Efficiency Overview

52 A report carried out by BVG associates (2016) anticipate that new and emerging wind farm technology innovations may contribute a 33% reduction in the Levelised Cost of Energy from the Final Investment Decision (FID) in 2014 to FID in 2030, with the increase in turbine size the major contributing factor.

53 This application will allow ICOL the option to utilise the largest turbines, with potentially the highest rated generating capacity, available on the market (and within the project time frames). With more efficient rotors, these turbines have greater reliability and deliver increased energy production throughout the lifetime of the Development.

54 The design envelope applied for in this application, with an increased maximum hub height allows turbines access to higher wind speeds at increased heights above sea level and therefore an increased energy production, thereby making each more efficient.

55 With the increase in turbine size, and as is evident in the reduction of total turbine numbers being applied for in this application, further cost efficiencies are made through the reduction of foundation and construction costs. All of which reduces the cost of energy produced by the Development as well as minimising the area of disturbed seabed, and thus associated environmental impacts.

56 Therefore, the benefit of using larger turbines comes from both:

- Increase production due to higher maximum hub heights (and access to higher wind speeds); and
- Reduced cost of construction and operation due to the reduced number of turbines.

6.5.3 The 'No Development' Scenario

57 If this application for the Development is not approved, ICOL would be entitled to implement the Inch Cape 2014 Consent and install an offshore wind farm and offshore transmission works. The relative impacts (positive and negative) of the two proposals will therefore be a material consideration in the determination of the applications. Therefore, the 'no development' scenario has been considered to determine what would occur if neither the Inch Cape 2104 Consent nor the Development (applied for in this application) went ahead.

58 Should neither the Inch Cape 2104 Consent nor the Development (applied for in this application) be progressed and a 'no development' scenario occur, energy generated from the wind farm would therefore not contribute to the Scottish Government's renewable energy target in line with Government polices (see *Chapters 2, 3* and *8*). In the 'do nothing' scenario this contribution would have to be provided through other appropriate developments within the same timescale.

References

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