4 Site Selection, Alternatives and Design Considerations

4.1 Introduction

1 This chapter summarises the alternatives considered in the development of the Onshore Works and the reasons for key design decisions.

2 The preferred grid connection location was identified by National Grid Electricity Transmission (NGET).

3 Alternatives have been considered in relation to the following scheme components:

- Cable Landfall;
- Onshore transmission infrastructure (overhead line versus underground cable);
- Onshore cable route; and
- Substation location.

4.2 Grid Connection Location

4 A number of potential grid connection points in the east of Scotland were considered by NGET, including locations in Angus, Fife and East Lothian. The connection options identified were Arbroath (Angus), Tealing (Fife), Cockenzie, Torness, Branxton and Crystal Rig II (all in East Lothian).

5 It is important to note that the grid connection location is offered by 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 for Neart na Gaoithe at Crystal Rig II.

6 Crystal Rig II was considered by NGET to be the preferred connection location due to grid capacity and providing best value to the consumer.

4.3 Cable Landfall

7 Following the decision on the connection location, detailed intertidal, environmental and technical surveys of potential landfall points at Skateraw and Thorntonloch and were carried out.

8 Although technically feasible, Skateraw was assessed to be more technically challenging due to exposed rock on the beach and environmentally sensitive due to the presence of a Site of Special Scientific Interest (SSSI). Thorntonloch is more suitable for cable landing due to the increased sediment cover and fewer environmental designations. As a result, Thorntonloch was taken forward and is assessed by this EIA.

9 Following the selection of Thorntonloch, further work was undertaken to identify the preferred landing point on the beach. Four possible landing points were identified between Thorntonloch Caravan Park and the cliffs to the south. Proximity to the caravan park restricted consideration of additional landfall points at the northern end, whilst options further south were restricted by the encroachment of offshore rock. Each of the four landfall points are described in **Table 4.1**, which also provides a summary of the key issues in respect of each of these.

Landing Site Option	Area	Summary of Issues
Landfall Option A	North of Thornton Burn	Option A would require the cable(s) to cross underneath or very close to the caravan park. If avoiding the caravan site, the cable would run through a field that is only 30 m wide at its narrowest point which would result in construction activities immediately adjacent to the Thornton Burn and caravan park. This has the potential to result in significant disturbance to residents at the caravan site and other nearby properties, as well as adverse effects on water quality and stream morphology at the Thornton Burn.
Landfall Option B	South of Thornton Burn	Option B is set further back from the caravan site and Thornton Burn. It also provides sufficient land for transition pits and associated intertidal construction works. Although it does require the Thornton Burn to be crossed by the cable, this can be achieved by trenchless methods thereby avoiding significant effects on water quality and stream morphology.
Landfall Option C	South of Thornly dwelling	This option has poor access and the presence of a steep bank to the beach would make open trenching technically difficult and potentially hazardous should the ground conditions dictate that Horizontal Directional Drilling (HDD) is not possible.
Landfall Option D	Cliff top to south	Similar to Option C, this option has poor access and the presence of a cliff to the beach would make open trenching impossible, should the ground conditions dictate that HDD is not possible.

Table 4.1: Summary of Thorntonloch landfall option locations and key issues

4.3.1.1 Selection of Preferred Cable Landfall Point

10 Options C and D were discounted due to the technical difficulties identified in **Table 4.1**. Options A and B were both considered feasible; however, due to the reduced risk of disturbance to residents of the caravan site and neighbouring properties, Option B was considered to be the most appropriate landing point. Option B was also preferable in terms of reducing the potential for adverse effects on the Thornton Burn. The alternative cable landfall points are shown in **Figure 4.1**.

4.4 Onshore Transmission Infrastructure

11 The most technically straightforward means of connecting overland between Thorntonloch and Crystal Rig would be via overhead lines; either on steel lattice towers ('pylons') or wooden poles. However, due to the potential for adverse landscape and visual effects, as well as potential effects on the setting of heritage features such as the Innerwick Conservation Area, a buried cable was considered to be the preferred option.

4.5 Onshore Cable – Appraisal of Potential Route Corridors

12 Following the selection of the buried cable and the preferred landfall at Thorntonloch, work was undertaken to identify the onshore cable route corridor to Crystal Rig.

13 A desk study and site walkover were undertaken to identify environmental and technical constraints to identify potential route corridors.

14 Four potential route corridors between Thorntonloch and Crystal Rig were appraised and a summary of the results of the environmental appraisal desk study of each of these is provided in **Table 4.2** below.

Ref	Route Corridor Description	Landscape and Visual Amenity	Nature Conservation	Cultural Heritage	Recreation and Access
Route Corridor Option 1	Initially running south from Thorntonloch to Branxton and south of Oldhamstocks Mains, then turning southwest across Sheeppath Hill and Bransly Hill.	• Temporary effect on Area of Great Landscape Value (AGLV) covering area of landfall. • Temporary effect on AGLV covering Lammermuir Hills (approximately 8 km from the route).	• Passes close to four areas of ancient woodland and a SSSI.	• Potential temporary effect on setting of Dunglass Garden and Designed Landscape (GDL)	• Crosses the John Muir Way (corresponds with Core Paths 213/187) and crosses 'aspirational' path 309 which runs parallel to the John Muir Way.
Route Corridor Option 2	Southwest from Thorntonloch to Thornton, south of Innerwick, Thurston Mains to Elmscleugh Wood, Sheeppath Hill and Bransly Hill	• Temporary effect on Area of Great Landscape Value (AGLV) covering area of landfall. • Temporary effect on AGLV covering Lammermuir Hills (approximately 4.5 km from the route). • Higher area of construction therefore temporary disturbance likely to be visible from surrounding landscape.	• Cable route is largely along existing roads therefore limiting habitat loss. • Crosses a small area of Ancient Woodland.	• Close proximity to a Scheduled Monument (Castledene enclosure).	• Crosses the John Muir Way (also corresponds with Core Paths 213/187) and crosses 'aspirational' path 309.
Route Corridor Option 3	Same as option 2 to just north of Thurston Mains, then following local roads past Birky Bog to Woodhall Farm and along Crystal Rig access track.	• Temporary effect on Area of Great Landscape Value (AGLV) covering area of landfall. • Temporary effect on AGLV covering Lammermuir Hills (approximately 3 km from the route).	• Cable route is largely along existing roads therefore limiting habitat loss. • Passes close to a number of areas of Ancient Woodland.	• Close proximity to a Scheduled Monument (Castledene enclosure).	• Crosses the John Muir Way (corresponds with Core Paths 213/187) and crosses 'aspirational' path 309.
Route Corridor Option 4	Same as option 1 to Oldhamstocks Mains, continuing south the Cromwell Cottage, then turning southwest over Wrightman Hill, Wester Dod and Bransly Hill.	• Temporary effect on Area of Great Landscape Value (AGLV) covering area of landfall. • Temporary effect on AGLV covering Lammermuir Hills (approximately 11 km from the route). • Higher area of construction therefore temporary disturbance likely to be visible from surrounding landscape.	• Adjacent to one area of Ancient Woodland.	• Potential for temporary effects on the setting of a Conservation Area. • Potential temporary effect on setting of Dunglass GDL	• Crosses the John Muir Way (also corresponds with Core Paths 213/187) and crosses 'aspirational' path 309.

Table 4.2: Summary of Key Constraints for each Route Corridor Option[1]

[1] This table summarises work undertaken in 2009 and some of elements included may have changed (e.g. some aspirational Core Paths have now been adopted).

4.5.1.1 *Selection of Preferred Route Corridor*

15 Following the assessment of cable route options, a route was selected which merged parts of route corridor options 2 and 3. This preferred route option crosses the Thornton Burn and then the A1 immediately to the south of the junction for Thorntonloch. It then follows the A1 to the west, crossing the ECML before turning southwest and crossing fields between Innerwick and Thurston Manor. South of Thurston Manor, the route broadly follows local roads and the Crystal Rig access track to the grid connection point.

16 Crossing the A1 and ECML are unavoidable for any route between the coast and Crystal Rig. The preferred corridor did however provide opportunities for benefits with respect to:

- Avoiding environmental designations;
- Avoiding local population centres;
- Good construction and maintenance access all along the route, thereby minimising construction disruption to the local road network and agricultural land; and
- Good use of existing infrastructure including the A1, minor public roads and the Crystal Rig II access track.

4.6 Refinement of the Application Boundary

17 The preferred route corridor was the subject of a Scoping Report submitted to ELC in January 2012. Following the receipt of the Scoping Opinion, more detailed work was undertaken to select the most appropriate location for the final Application Boundary within the preferred route corridor.

18 Work undertaken included environmental site surveys and desktop studies, as well as civil and electrical engineering studies. The studies informed the location of the Application Boundary and the choice of appropriate construction techniques, such as trenchless crossing methods. Key environmental and technical topics considered are summarised below:

4.6.1.1 *Environmental Studies*

- Ecology: avoiding sensitive or protected sites and species;
- Arboriculture: avoiding tree root protection zones;
- Landscape and visual amenity: avoiding protected sites and important landscape features;
- Cultural heritage: avoiding protected features and minimising damage to potential archaeology;
- Transport and access: minimising disruption to the local road network and road users;
- Noise and vibration: avoiding close proximity to residential properties;
- Hydrology: limiting impacts on sensitive watercourses;
- Agriculture: limiting land take and fragmentation; and
- Land use and access: limiting severance of walkways.

4.6.1.2 *Engineering and Technical Studies*

- A desktop geotechnical assessment;
- A review of cable installation methodologies;
- An underground services assessment;
- A construction compound assessment;
- Preparation of a discrete route section cost benefits analysis report; and
- Cable rating studies

19 Consultation with the stakeholders below also informed the refinement of the Application Boundary:

- East Lothian Council (including planning policy, development management, transportation, landscape, ecology, archaeology, environmental health and flood risk departments);
- Torness Power Station (via EDF energy);
- Transport organisations: Network Rail, BEAR and Transport Scotland;
- Scottish Power Transmission;
- Landowners along the route; and
- SNH, SEPA and Historic Scotland.

20 The design process involved a number of iterations as environmental and technical constraints were taken into account.

21 A summary of the design iterations is provided in **Table 4.3** below:

Rev	Comments/reasons
I	• First issue based on desktop work and on-site surveys.
II	• Route alternative identified at Thurston Manor to avoid technical constraints near Hunter Steading; • Short route alteration east of Croft Angry removed due to civil engineering difficulties; and • Other minor revisions.
III	• Removed construction access point near Skateraw Gate due to potential effects on residents in terms of access and disturbance; and • Increased area required near Birky Bog.
IV	• Route alternative proposed south of Woodhall Farm to minimise effects on Crystal Rig access track.

V	• Minor adjustments to widen length;
	• Minor access point changes;
	• Alteration east of Croft Angry to avoid area of Ancient Woodland;
	• Substation search area refined due to further substation design work;
	• Route alternative along road near Thurston Manor removed to:
	  ○ Reduce impact on local roads;
	  ○ Avoid risk of effects on Scheduled Monument; and
	  ○ Reduce cable route length.

VI	• Route moved to south of Ogle Lodge to minimise effects on local residential properties and to avoid technical difficulties associated with crossing the gulley north of the property; • Associated route revisions west of Ogle Lodge; and • Preferred construction compound location (and associated field access) identified.
VII	• Minor edits to Application Boundary.
VIII	• Revised crossing methodology proposed for Whittley Strip to avoid effects on local roads and Ancient Woodland; and • Revisions to Application Boundary around substation due to detailed substation design work.
IX	• Large scale background data added, along with associated revisions to Application Boundary; • Extra areas added at strategic locations for safe vehicle movement / turning and to accommodate wheel washing facilities;

Rev	Comments/reasons

	• Extra allowance provided at rail crossing to allow for compliance with Network Rail crossing guidance;
	• Extra space provided alongside route, east of Smithy Row to accommodate safe working on sloping gradient;
	• Construction compound access point moved to avoid infringing on tree root protection zone (Bosky, 2012); and
	• Application Boundary revisions around substation to allow for further construction works:
	  ○ Removal of existing access track;
	  ○ Temporary construction spoil storage; and
	  ○ Allowance for earth berms around substation and drainage.

X	• Widening of Application Boundary around Innerwick to provide extra construction space.

Table 4.3: Project design iterations

4.7 Substation Location

22 Work undertaken by Xero Energy (2011) focused on the identification of a substation compound location in the vicinity of the existing Crystal Rig II substation. This section summarises the initial constraints identified and the reasons for discounting/selecting sites.

4.7.1.1 Site Constraints

23 Site appraisal work commenced with the identification of engineering and environmental constraints, which are identified below.

4.7.1.2 Environmental Constraints

24 Key constraints include visual effects particularly from a public right of way, known as The Herring Way, located to the west of the site. Ecological considerations included blanket bog to the north of the substation site, as well as ecologically sensitive areas of land to the east and northeast of the existing substation. A small watercourse runs through the area, to the north and east of the existing substation.

4.7.1.3 Existing and Planned Infrastructure

25 Constraints include energy transmission infrastructure (Crystal Rig II substation, planned extensions and a 400kV transmission steel tower line) as well as the Crystal Rig wind farm infrastructure (turbines, cables and access tracks).

4.7.1.4 Civil Engineering Constraints

26 Cross-fall slopes cover most of the site. The Neart na Gaoithe substation compound will cover a large area and a certain amount of earth works will be required to provide a level area. Drainage issues are expected with some saturated, low-lying locations, particularly to the north and east of the existing substation.

4.7.1.5 NnG Substation Factors

27 For site selection purposes, an approximate area measuring 165m by 200m was assumed. For technical reasons, the distance between the proposed Crystal Rig II extension and the Neart na Gaoithe substation should be as short as possible. Construction access for abnormal loads was also considered. In addition, during construction, it was anticipated that a large area next to the substation location would be required for spoil storage.

4.8 Discounted and Selected Areas

28 Land immediately to the south of the Crystal Rig II substation is congested with existing infrastructure for the Crystal Rig II wind farm, with land availability restricted by the requirement to take account of potential turbine topple distances. It is also relatively far from the proposed connection point to Crystal Rig II substation extension.

29 Furthermore, the eastern side of the existing Crystal Rig II substation is bounded by the site access track and the 400kV overhead lines, running north-south. The land at this location is low lying with standing water. It is also within close proximity of the 400kV overhead lines, creating difficulties with access and construction clearances. Finally, it would require two relatively long 400kV circuits to run between this location and the connection point (the proposed SPT NnG Scheme).

30 Areas to the south and east of the existing substation were ruled out on this basis. Areas to the north and northwest of the existing substation were selected and taken forward for layout design. The layout presented in the final Application Boundary was further informed by a desire to reduce earthworks and limit drainage impacts, as well as a requirement not to impinge on a buffer around existing turbines.

4.9 Summary

31 As set out above, the detailed design of the proposed Onshore Works has evolved as information about the constraints and features relating to the scheme were gathered, consultation comments received and the EIA progressed. A range of technical, environmental and land use considerations have influenced the final proposed landfall location, onshore transmission infrastructure, onshore cable route and the substation location.

32 The preferred scheme was determined to be the landfall location, cable corridor and substation layout that minimise impacts as far as possible for surrounding receptors whilst remaining technically feasible. The final landfall, cable corridor and substation site is the subject of this planning application and EIA, as illustrated in **Figure 5.1.**

4.10 References

Bosky Trees (21 May 2012) Arboricultural Method Statement for the Installation of Underground Cables Beneath Trees and Woodland

Connelly Contracting (May 2009) Neart na Gaoithe Offshore Wind Farm Export Cable Routeing Report.

ETA Ltd (10 August 2011) Neart na Gaoithe Offshore Wind Farm Export Cables Shore Landing Review.

LUC (December 2009) Neart na Gaoithe Offshore Wind Farm: Onshore Cable Routeing Review of Planning and Environmental Constraints: Option 2 Crystal Rig II

Transmission Capital (March 2010) Firth of Forth Offshore Wind, Report into Grid Connection Options and the Need for Developer Co-ordination.

Xero Energy (October 2011) Neart na Gaoithe Grid Options Report.